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The New Demosponges, *Chaunactis olsoni* and *Haplistion nacoense,* and Associated Sponges from the Pennsylvanian Naco Formation, Central Arizona

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ABSTRACT

Several complete specimens and many fragments of the new haplistiid demosponge *Chaunactis olsoni* have been collected from the Pennsylvanian Naco Formation in central Arizona, along with *Haplistion nacoense* n. sp., a new monaxonid genus and species, *Nacospongia radiata,* and a possibly related monaxonid sponge. Heteractinid sponges are represented in the collection by a single isolated sexiradiate spicule. The new *Chaunactis* species is a disc-shaped to broad open funnel-shaped sponge with radial skeletal tracts of dendroclones cored by oxeas and united into a firm net by other tracts and isolated dendroclones. Tracts are separated by relatively large canals that are normal to the gastral surface, but which do not open as distinct large ostia through the dense dermal and gastral layers. The new *Haplistion* species is a relatively fine-textured digitate form, and the new monaxonid sponge is a disc-shaped form with radiate internal architecture. These are the first sponges reported from the Naco Formation and they occur in an alternating red mudstone and argillaceous lime mudstone to wackestone/packstone sequence.

INTRODUCTION

The Naco Formation contains an abundant fauna of brachiopods, bivalves, gastropods, bryozoans, corals, crinoids and other echinoderms (Brew and Beus, 1976; Webster, 1981; Sumrall, 1992; Webster and Olson, 1998). Sponges have not been reported previously from the formation. The present paper documents the occurrence of a new haplistiid rhizomorine sponge and of heteractinid sponges, represented by a single spicule, in the formation. Specimens were collected from near the small community of Pine, located in Gila County, in central Arizona (Figure 1). Most specimens from the formation are fragments found scattered within mudstone layers, but whole demosponges do occur and are best preserved in limestone beds.

The Pine sponge locality is located in road cuts and associated exposures a few meters north of the junction of Control Road and Arizona State Highway 87 (Figure 1), approximately 2 miles southeast of Pine. The locality is in sec. 4, T. 11 N., R. 9 E, (unsurveyed) on the Buckhead Mesa 7.5-minute quadrangle.

The Naco Formation ranges from Middle through Late Pennsylvanian age and unconformably overlies the Mississippian Redwall Limestone. Huddle and Doborovoly (1945, 1952) and Brew (1970) reported that the Naco Formation was deposited in a marine transgression over a Late Mississippian-Early Pennsylvanian karst topography. The Naco Formation thins and eventually pinches out westward where it grades into the Pennsylvanian-Permian Supai Formation (Jackson, 1951; Brew, 1970; Brew and Beus, 1976).

Brew (1965) subdivided the formation into three members, the Alpha, Beta, and Gamma Members. The sponges described here are most likely from the Beta Member, which is composed of fossiliferous interbedded sequences of mudstone and limestone (Figure 2). The Pine locality is probably age equivalent to the Kohl Ranch locality described by Brew and Beus (1976) and is Desmoinesian. Exposures of the Naco Formation at the Pine locality consist of interbedded thin units of argillaceous limestone, mudstone, and wackestone/packstone. A detailed measured section of bed 8 (Figure 2B), from approximately 8.5 meters up to 10 meters above the base, illustrates those interbedded relationships. Specimens of sponges were collected from mudstone layers as associated float of this unit.

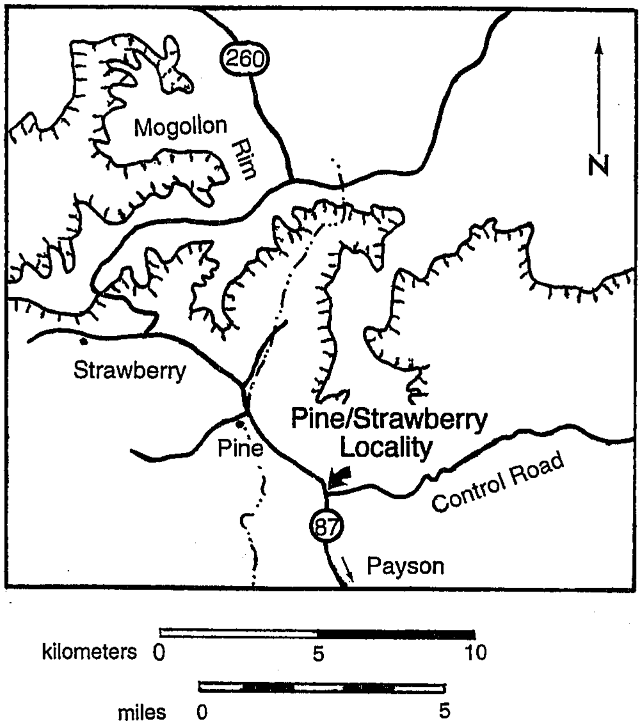

Figure 1. Index map to the sponge locality near Pine, along Arizona State Highway 87, on the Buckhead Mesa 7.5-minute quadrangle, Gila County, central Arizona.

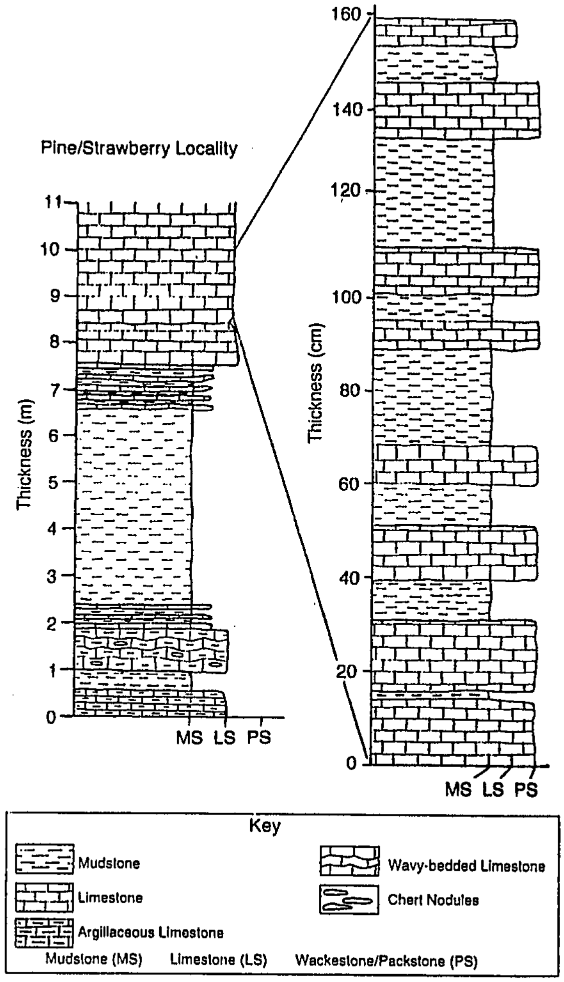

Figure 2. Stratigraphic sections of part of the Naco Formation exposed at the sponge locality near Pine. A, section exposed at the locality; B, detailed section of the 1.6 m of sponge-bearing beds in the upper part of the sequence.

All the specimens utilized in the study are deposited in collections of The Museum of Northern Arizona (MNA).

SYSTEMATIC PALEONTOLOGY

Class DEMOSPONGEA Sollas, 1875
Order LITHISTIDA Schmidt, 1870
Suborder RHIZOMORINA Zittel, 1878
Family HAPLISTIIDAE de Laubenfels, 1955

Diagnosis.—"Massive to foliate sponges with radial architecture; skeletal net regular and open, composed of radial spicule tracts connected by horizontal tracts; tracts composed of rhizoclones, together with dendroclones and smooth monaxons, in parallel orientation; tracts may be hollow or may be cored with smooth monaxons; a specialized dermal net of smooth monaxons may be present" (Finks, 1960, p. 86–87).

Type genus.—*Haplistion* Young and Young, 1877.

Genus HAPLISTION
Young and Young, 1877

Diagnosis.—"Form of sponge spherical to lobate, digitate, or irregular; surface hispid because of projecting ends of radial tracts; point of origin of radial tracts commonly eccentric to peripheral, new tracts added by intercalation; spicule tracts compact to hollow but apparently not cored, and composed of rather straight rhizoclones, with stubby or warty lateral processes, dendroclones, strongyles, and oxeas; the smooth monaxons may be concentrated on the outside of the tracts in some species; no distinct dermal net apparent, but surface may have borne strongyles and oxeas in tangential orientation, or outermost horizontal tracts may expand and fuse laterally on parts of the surface; a few large circular canals may be present, parallel to the radial tracts." (Finks, 1960, p. 87).

Type species.—*Haplistion armstrongi* Young and Young, 1877.

HAPLISTION NACOENSE n. sp.
Plate 2, figures 4, 6

Diagnosis.—Stalked erect lobate to incipiently digitate bladed sponge with both horizontal and vertical tracts commonly 0.4–0.5 mm in diameter, and skeletal pores between mostly 1.0–1.2 mm in diameter or across, with a few ostia of canals to 2.0 mm in diameter; tracts composed of rhizoclones with nodose shafts approximately 0.02 mm in diameter and to 0.5 mm long.

Description.—The holotype and only known specimen of the species is a stalked, erect palmate to incipiently digitate sponge 77 mm high, but broken at the base. It expands upward from an elliptical stalk 13 x 27 mm across at the broken base, to 14 x 33 mm at the top of the stalk, 25 mm above the base and at the bottom of the abruptly expanding upper part of the sponge. The upper part widens to over 80 mm wide and it is 18–23 mm thick on crests of the three, vertical, thickened finger-like lobes. Those lobes are laterally attached and separated by thin areas only 13–15 mm thick.

The dermal surface is generally formed by an irregular reticulate grid of tangential tracts, but locally with preserved pointed tips of radial tracts. These skeletal tracts range 0.3–0.6 mm in diameter, although most are 0.4–0.5 mm in diameter. Tracts swell to 0.6–0.7 mm across where horizontal and vertical ones merge so that individual tract segments appear I-shaped, with a narrow central shaft and expanded ends in the zone of merging. They are generally separated 1.0–1.2 mm apart around circular to subquadrate skeletal pores. Ostia of coarser canals, up to 2.0 mm in diameter, are locally evident in the skeleton. Tracts appear to lack coring spicules and to be hollow, although dense chalcedonic silicification has obscured internal structure in most tracts.

Tracts are composed of small rhizoclones that have straight to gently curved, double tapering, shafts 0.015–0.02 mm in maximum diameter and up to 0.5 mm long. They are sculptured with small nodes or points, up to 0.015–0.02 mm in diameter, which are distributed irregularly along the shaft, but are commonly 0.04–0.05 mm apart where most apparent on spicules exposed on tract surfaces around skeletal pores. These elements are fused to adjacent spicules in the skeleton and produce rigid tracts. There are approximately 3 parallel spicules per 0.2 mm, measured laterally around the circumference of characteristic tracts. This would indicate approximately 25–30 spicules in a single layer, and that there may be a hundred spicules per transverse section, even if the tracts are hollow.

Discussion.—Finks (1960) subdivided the then known species of *Haplistion* into subgroups based upon dimensions of the mesh spaces and diameters of the skeletal tracts. The species here is most similar to those species of his Subgroup A, of Group 2, which have mesh spaces of 1.0 mm or more and radial tracts mostly 0.5–1.0 mm in diameter. Most of these species are spheroidal and are clearly different from the palmate-digitate species described here. *Haplistion artiense* Tschernyschew, 1898, is lobate or digitate but has coarse canal openings and skeletal tracts, considerably coarser than in the Naco species. The Leonardian *H. aeluroglossa* Finks, 1960, is also a lobate to subdigitate species, but it has skeletal tracts only 0.15–0.30 in diameter and canal openings that are also smaller than in the species described here. *H. verrucosum* Dunikowski, 1884, is a flattened starlike lobate sponge with a distinctive, coarsely nodose, dermal layer and with mesh spaces less than 0.5 mm across. Dimensions of tracts in this Permian species from Spitzbergen are unknown, but it clearly is a different species.

A Visean lobate to subdigitate species, *Haplistion mega* Rigby and Mundy, 2000, has been recently described from North Yorkshire, England. That species has mesh spaces 1.8–2.8 mm across, which are considerably coarser than in the Naco species. It also has radial tracts that are coarser than in the new species described here, but its concentric tracts are smaller and range 0.5–0.7 mm in diameter, similar to those of the New Mexico species.

Material.—The holotype, MNA N9482, from the Naco Formation at the Pine locality, is the only known representative of the species.

Etymology.—*Nacoense*, named for the Naco Formation from which the holotype was recovered.

Genus CHAUNACTIS Finks, 1960

Diagnosis.—"Foliate or flabellate sponges with differentiated incurrent and excurrent surfaces; radial tracts originating at base of sponge and dichotomizing upward; tracts loose and open, composed chiefly of irregular rhizoclones in non-parallel orientation, and either hollow or cored with long, smooth monaxons; specialized dermal layer present, which may be composed of a rectangular net of bundles of parallel monaxons; prosochetes and apochetes parallel to horizontal tracts and differentiated from each other by size, shape, or spacing." (Finks, 1960, p. 93).

Type species.—*Chaunactis foliata* Finks, 1960

CHAUNACTIS OLSONI n. sp.
Plate 1, figures 1, 3–5,
Plate 2, figures 1, 3

Diagnosis.—Circular to ellipsoidal discoidal sponges; central juvenile area of disc thin and thickness increases radially outward to ramped or beveled edge of disc; skeletal tracts radiate from the center of the sponge and are cross-connected by concentric tracts; those of the principal endosomal skeleton are predominantly 0.5–0.7 mm in diameter, separating circular to elliptical vertical exhalant canals 0.5–0.8 mm wide and up to 1.6 mm high, radially; thin dense dermal and gastral layers with radial and concentric tracts up to approximately 0.10 mm in diameter, generally with ostia 0.20–0.30 mm in diameter, smaller than major canals of interior; tracts of both endosomal and outer skeleton cored by oxeas and coated with rhizoclones and less common dendroclones.

Description.—Sponges in the collection range from distinctly circular to elliptical discoidal, with diameters that range from 2.7 to 13.5 cm. A typical cross section is thin in the center, increases in thickness toward the outer rim, but then decreases abruptly to a rounded or ramped edge. Central areas range from 3 to 5 mm thick, and increase in thickness radially to 8–9 mm in smaller and intermediate sponges, to 13–18 mm in larger sponges with a distinct outer rim.

Radial tracts diverge from the center of the sponge and with cross-connecting concentric tracts form a moderately regular radially expanding gridwork in the endosomal skeleton. Both types of tracts are expressed as low ridges on upper and lower surfaces. Radial tracts are relatively straight and diverge from the center of the sponge, with additional tracts inserted to keep moderately uniform spacing as the skeletal structure expands. Radial tracts average 0.5 mm in diameter but may reach up to 1.1 mm in diameter in more robust specimens. Distances between radial tracts range 0.4 to 1.6 mm, and approximately 8 tracts occur per 10 mm, laterally. Tracts are traceable over the relatively flat dermal and gastral surfaces and over the rim to the outer ramp. Details of their spicule composition is usually obscure because of coarse chalcedonic replacement of nearly all specimens, although a few specimens do locally show tracts cored by doubly tapering oxeas and coated by irregularly oriented rhizoclones and possible dendroclones.

Concentric endosomal tracts are transverse to radial ones and are less continuous, usually bridging only between adjacent radial tracts, although some concentric arc segments apparently parallel the outer rounded margins of the sponges and may be at the same general level between three or four radial tracts. Such concentric tracts range from single rhizoclone or dendroclone spicules to spicule clusters that range 0.2 to 1.0 mm in diameter, but average approximately 0.5–0.7 m in diameter or wide.

Adjacent radial tracts are separated by radially aligned series of vertical exhalant canals that may be circular and up to 0.8 mm, or radially ellipsoidal and range 0.4 to 1.6 mm high and 0.5–0.8 mm wide. These canals are commonly of smaller diameter in central parts of discoidal sponges but increase in diameter outward in the radial skeleton. Smaller probably inhalant canals, 0.3–0.4 mm in diameter, occur locally within concentric tracts, between the larger exhalant openings.

Vertical sections of the sponges show moderately well-defined upper and lower "layers" of skeleton in which numerous, uniformly spaced, vertical exhalant canals are well developed. Average thickness of these relatively uniform "layers" is approximately 2 mm. Inner parts of the skeleton have less obvious structure and may appear as openings in some preservations, but with vertically and radially divergent spicule tracts in other sponges that are better preserved. These more interior, less obviously canalled, parts of the skeleton increase in thickness radially. That interior "layer" may expand from only 1 mm thick near the center of small sponges to 4–8 mm thick in the outer ramp or rim of larger ones.

Vertical sections through parts of several discoidal sponges show iron-stained red impressions of thin divergent skeletal tracts, which may be traceable for 15–20 mm in the massive chalcedonic replacements. These tracts are horizontal at mid-height, but lower ones arch gently downward to meet the presumed lower dermal surface at angles of 15–20 degrees. Other tracts arch more abruptly upward to meet the probable upper gastral surface at angles of 30–45 degrees. These tracts include oxeas that are 0.04–0.05 mm in diameter. Lengths are unknown because of obscure preservation in the heavily silicified interiors of all the sectioned samples. More complex spicules have not been identified in the thin sections and nature of spicules in tracts between canals is uniformly obscure because of massive replacement.

Thin, dense, dermal and gastral layers are locally well preserved on several specimens. These layers are composed of radial and concentric tracts that are smaller and more closely spaced than those in the endosomal part of the skeleton. Typical radial dermal tracts are approximately 0.10 mm in diameter and occur 4 radial tracts per l mm parallel to the disc margin. Such tracts are separated by ostia that range 0.20–0.25 mm wide and 0.25–0.30 mm long, radially. Such openings occur approximately 10 per 5 mm in single radial series.

Dermal and gastral tracts are commonly cored by 4–6 oxeas per section, although some have only a single oxea inside the rhizoclone- and dendroclone-coated rods. Oxeas are up to 5 mm long and 0.06 mm in maximum diameter, although most are only fragments of spicules approximately 0.02 mm in diameter and to 1 mm long. Dendroclones in these outer tracts are commonly X-shaped forms, with central shafts 0.2 mm long and 0.02–0.03 mm in diameter. Rays 0.015–0.02 mm in diameter extend to 0.04 mm long beyond shaft ends before their tips are lost in the siliceous replacements. Some more robust, but shorter, I-shaped dendroclones also occur in these thin dermal-gastral tracts and have shafts only 0.10 mm long but which are up to 0.04 mm in diameter. Their ray tips are usually obscured in their silicified common junctions. Rhizoclones in the dermal and gastral layers have main shafts 0.015–0.02 mm in diameter and short branching rays that diverge from along the main shaft to articulate with other spicules. They are commonly curved around margins of ostia but may be more irregular in others parts of the dermal-gastral tracts.

Two sizes of oxeate spicules occur on outer and ramp surfaces of specimens, or in associated irregular spicule occurrences. Largest of these spicules may have been parts of foreign root tufts and commonly appear transported where they are irregularly strewn over sponge and matrix surfaces. They have diameters of up to 0.2 mm and lengths greater than 1 cm, but they are rare. Most specimens with more *in situ*-appearing concentrations are locally covered with finer spicules, which have diameters of approximately 0.1 mm or less and lengths of up to 5 mm. Such spicules are not preserved on some specimens, but on others they form a dense thatch more-or-less aligned parallel to the radial tracts, or they may form a layer of irregularly oriented spicules. A number of specimens have distinct separate clusters of parallel monaxial spicules on ramp surfaces or other clusters that splay out from a tract axis. Both occurrences may represent distal continuations of ends of radial tracts.

Discussion.—Finks (1960) described three species of the genus *Chaunactis,* including the Pennsylvanian type species, *C. foliata,* and two other unnamed Permian species designated as *C.* species 1 and *C.* species 2. Both of the latter are considerably coarser textured than these Naco sponges and therefore are clearly different. The type species *C. foliata* is finer textured than the Permian forms and is most similar in skeletal and canal dimensions to the new species described here. However, *C. foliata* is an asymmetrical ear-shaped to palmate sponge that apparently grew vertically, in contrast to the more likely horizontal living position of the flat, radially discoidal, Naco species.

Both Pennsylvanian species have thin dense dermal and gastral skeletal layers of relatively fine radial tracts and cross-connecting concentric or horizontal tracts. Radial and concentric dermal-gastral tracts in both species are thin, averaging approximately 0.10 mm thick in the new Naco species, but only 0.02–0.05 mm in the type species. Isolated single spicules may also occur in positions of concentric tracts in the new Naco species. Radial tracts are spaced 0.2–0.3 mm apart, laterally, in both species, and concentric tracts in the outer thin skeletal layers are 0.2–0.4 mm apart

Most of the skeleton is considerably coarser textured than that in the outer layers in all four species of the genus. Radial tracts average 0.5 mm and range up to 1.1 mm in diameter in the Naco species, but range 0.2–0.6 mm in diameter in *Chaunactis foliata.* Radial and concentric tracts are separated by arched canals that may be circular and 0.8 mm in diameter or ellipsoidal and 0.5–0.8 mm wide and 0.4–1.6 mm long in the new species and 0.3–1.2 mm across in the type species. Such minor differences might be results of differential preservation, and were it not for the distinct differences in living habits and growth forms, these two finer-textured species of the genus might be considered as a single taxon.

Etymology.—*Olsoni,* named after Thomas Olson who collected the original sponge material.

Material.—Holotype, MNA N9483A, and paratypes, MNA N9484–N9492, with 60 associated reference specimens, all from the Naco Formation at the Pine locality.

Order MONAXONIDA Sollas 1883
Family Uncertain
Genus NACOSPONGIA n. gen.

Diagnosis.–Discoidal, possible flattened spheroidal, sponge with interior layer of horizontal, weakly radiating to parallel monaxial spicules and upper and lower layers of irregularly spaced and oriented, weakly tufted, oxeas; lacks obvious canals and ostia

Discussion.–Comparisons with somewhat similar sponges are treated in discussion of the type species below.

Type species.–*Nacospongia radiata* n. sp.

NACOSPONGIA RADIATA n. sp.
Plate 1, figure 6

Description.—One nearly complete discoidal sponge, the holotype, and several fragments composed of irregularly oriented to radially arranged monaxial spicules occur in the collection. The nearly complete holotype is ellipsoidal, 28 mm across and 43 mm long, with a maximum medial thickness of approximately 8 mm. The sponge tapers laterally to rounded edges 2–3 mm thick. Both upper and lower surfaces are blanketed with irregularly spaced and oriented, to weakly radially tufted oxeas. A vertical section through the sponge lacks obvious canals and no distinct ostia are evident on either surface.

A vertical section cut near one end shows three generally identifiable skeletal layers within the sponge. An inner layer of horizontal, weakly radiating to parallel spicules is 2–3 mm thick, and upper and lower layers, in which the spicules diverge upward and downward, respectively, at angles of 10–15 degrees from spicules of the inner layer, are of the same general thickness. Spicules in the outermost 0.5–1 mm of both upper and lower layers curve to become tangential to outer surfaces of the sponge.

Spicules on the exterior are oxeas that range up to at least 5 mm long, with most 3.5–4.0 mm long. Maximum lengths are difficult to determine for nearly all exposed spicules have broken tips. Typical spicules have maximum midlength diameters of 0.15 mm, although a few range up to 0.18 mm in diameter. They taper in both directions. Interior spicules cut in the thin section are 0.15–0.18 mm in diameter and many have clearly preserved axial canals that are 0.035–0.040 mm in diameter. Some axial canals are now open, but others are filled with limonite-stained silica.

Discussion.—Original shape of the loosely-spiculed sponge is impossible to determine, for it may have been much more nearly spheroidal than the present elliptical cross-section would indicate. However, there is significant consistency in orientation of interior spicules, which would suggest that the sponge has been only slightly modified and that it probably had an originally ellipsoidal skeletal structure.

Coniculospongia Rigby and Clement, 1995, from the Devonian of Tennessee, is a funnel-shaped to bowl-shaped or discoidal sponge with a radiating skeleton of oxeas, but it lacks the irregular exterior thatch of *Nacospongia,* and is considered to be a different sponge. *Belemnospongia* Ulrich *in* Miller, 1889, is also a radiating, probably discoidal sponge, but it is composed of long oxeas that are more or less fasciculate, in a structure unlike that of *Nacospongia.*

Sphaeriella Rigby and Pollard-Bryant, 1979, from the Mississippian of Alabama, is a spheroidal sponge with radiating skeletal structure of long thin monaxons, but it has distinct canals parallel the unclumped spicules, and is thus different from *Nacospongia.*

Material.—Holotype, MNA N9493, from the Naco Formation, Pine locality.

SPECIES A
Plate 1, figure 2

Description.—A single inverted funnel-shaped small sponge occurs on MNA N9494, attached to a fragment of *Chaunactis.* The small circular sponge is approximately 18 mm in diameter, although partially buried in matrix, and is approximately 2 mm thick in the thickest central part of the skeleton. It consists of distinctly radiating smooth oxeas in an unbundled, uniform-appearing, thatch. Spicules were inserted within the thatch in outer parts of the skeleton to maintain a uniform structure, lacking canals. The skeleton appears interleaved and small- and large-diameter fragments of spicules occur side-by-side throughout the skeleton.

Oxeas are mostly 0.12–0.14 mm in maximum midlength diameter, although a few spicules are up to 0.18 mm in diameter. They are at least 3 or 4 mm long, but how much longer is impossible to tell because tips are broken or buried. Microscleres are unknown in the siliceous preservation.

Discussion.—This small sponge has a distinctly radiating fabric, much more regular-appearing than that of *Nacospongia,* and because of that they are separated here. However, the small sponge could be an immature representative of the interior part of that species, where the skeletal structure is more likely radiating than is seen in the outer irregularly spiculed exterior. It is difficult to evaluate that possible relationship because the interior structure of *Nacospongia* is not well known. Neither species has distinct canals in their radiate skeletal structures. Oxeas are major spicules in both sponges and are of similar diameters. Incomplete spicules in both make lengths difficult to compare.

Material.—The single representative of the species occurs on MNA N9494, Naco Formation, Pine locality.

Class Uncertain
ROOT TUFTS
Plate 2, figure 5

Description.—Fragments of root tufts occur in the collection as parallel tracts of monaxons. One larger fragment is composed of two layers, or tufts, 2–5 mm thick, in a stratified sequence of siliceous reddish mudstone. Spicules are parallel to each other and to stratification within each of the layers, but spicule fabrics of the two layers are at angles of 60–70 degrees to each other. Individual spicules in both layers range to 0.25 mm in diameter, although most are 0.15–0.20 mm in maximum diameter, and they taper in both directions, presumably to sharp tips. Longest fragments preserved are up to 14 mm long, but these probably represent only small parts of the complete spicules, for the amount of taper in the fragments is not great. In any section, numerous smaller diameter spicules occur between the coarser ones and have diameters of 0.10 mm or less. These could be only distal tips of the coarse spicules, but some appear to be parts of small spicules, based on their double taper.

Numerous spicules in the tufts have preserved axial canals, some as openings and others as limonite-stained siliceous fillings. In common spicules, 0.15 mm in diameter, such canals are 0.07–0.08 mm in diameter, but in some larger spicules, 0.18 mm in diameter, axial canals may be only 0.04–0.06 mm across. Some spicules 0.16 mm in diameter have obviously secondarily enlarged, open, canals 0.10 mm across, in the silicified preservation.

Discussion.—Relationships of the root tufts to taxa identified in the Naco Formation are unknown. These tufts are probably not related to the rhizomorine *Chaunactis olsoni* n. sp., although thatches of small short monaxons do occur in the dermal layer of that species. The coarse tufts are probably not related to the small discoidal monaxial demosponge either, and are also unlikely parts of the heteractinid sponges, represented by the single isolated sexiradiate spicule in the collection. These root tufts may be from sponges otherwise not yet discovered in the Naco Formation.

Material.—Figured fragment, MNA N9495, Naco Formation, Pine locality.

Class HETERACTINIDA de Laubenfels, 1955
Order OCTACTINELLIDA, Hinde, 1887
Family WEWOKELLIDAE King, 1943
Genus and species uncertain
Plate 2, figure 2

A single isolated sexiradiate spicule occurs associated with numerous irregular monactine spicules in one fragment in the collection. The spicule is a small element with six slightly reflexed tapering rays that radiate at equal angles from a central "disc" 0.16 mm in diameter. These rays have basal diameters of 0.05–0.06 mm and taper distally so that 0.2 mm out from the disc they are approximately 0.03 mm in diameter. On none are distal tips exposed so full ray lengths are not known, but one ray is traceable for 0.3 mm before being covered with matrix.

Discussion.—Although the isolated spicule cannot be even generically identified, it does document the occurrence of heteractinid sponges in the Naco Formation in central Arizona.

Material.—Figured specimen, MNA N9496.

ECOLOGICAL IMPLICATIONS

Brew (1965) concluded that sediments of the northwestern wedge of the Naco Formation accumulated in a shallow shoreward facies. Abundant clastic material and the dominance of reddish and reddish-brown sediments are evidences used by him to determine the depositional environment of the Beta Member in its northwestern extent. However, lack of great lateral continuity of individual beds may suggest that the sediments possibly accumulated in local restricted shallow basins.

Most specimens of the common demosponge were found in isolated mudstone layers. A few specimens are preserved on surfaces of less terrigenous limestone layers. Though the sponges are thought to have lived on muddy substrates, the influx of large quantities of mud may have caused the death of many of the sponges. The occurrence of sponges within the mudstones suggest that some may have been washed into depressions by the currents that brought in the mud that buried them. Other evidence that the sponges were buried quickly by muds include: 1) great number of sponges; 2) lack of superficial spicules on some specimens; 3) preservation of spicules that seem to have been washed off upper surfaces onto the sponge ramps; and 4) the associated dispersed spicules also found in mounds. Terrigenous influence on the quiet waters may have generated the influx of mud into the environment.

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PLATE 1

Sponges from the Naco Formation of central Arizona.

Figures *1, 3–5. Chaunactis olsoni* n. sp., *1,* two well-preserved, nearly complete, sponges on a slab of limestone include the holotype (A) and a paratype (B), MNA N9483, X1; *3,* clusters of monaxial spicule thatch on the outer ramp at the margin of a fragment of the discoidal sponge, MNA N9489, X3.5; *4,* vertical section through a paratype showing extent of exhalant canals and the divergent skeletal structure of the interior of the sponge, MNA N9488, X3.5; *5,* large discoidal paratype with prominent radial skeletal structure as exposed on the gastral surface, MNA N9485, X0.6.

Figure *2.* Sponge species A, with radiating skeletal structure of smooth oxeas, MNA N9494, X3.5.

Figure *6. Nacospongia radiata,* n. gen, n. sp., holotype, irregularly arranged oxeas of discoidal sponge, MNA N9493, X 3.5.

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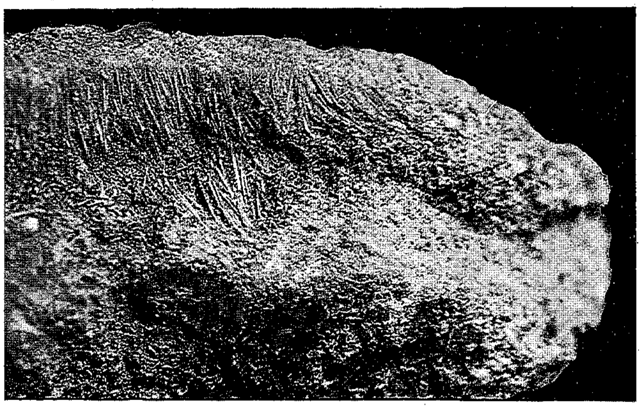

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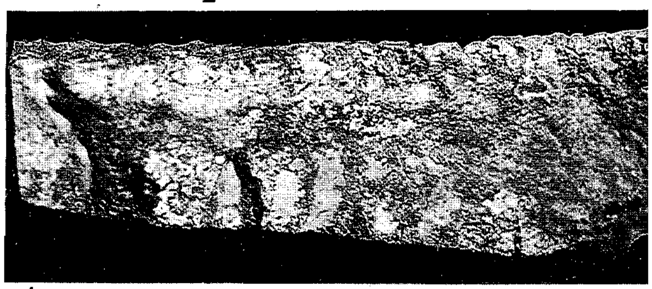

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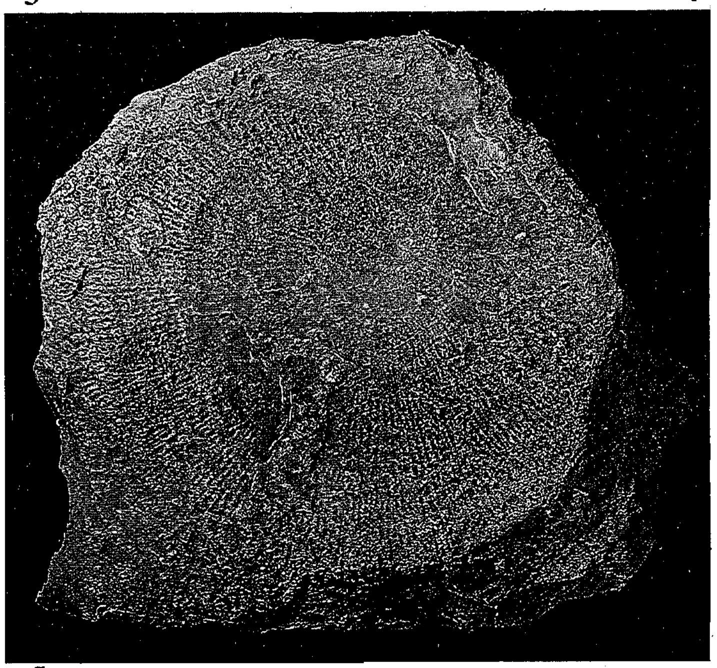

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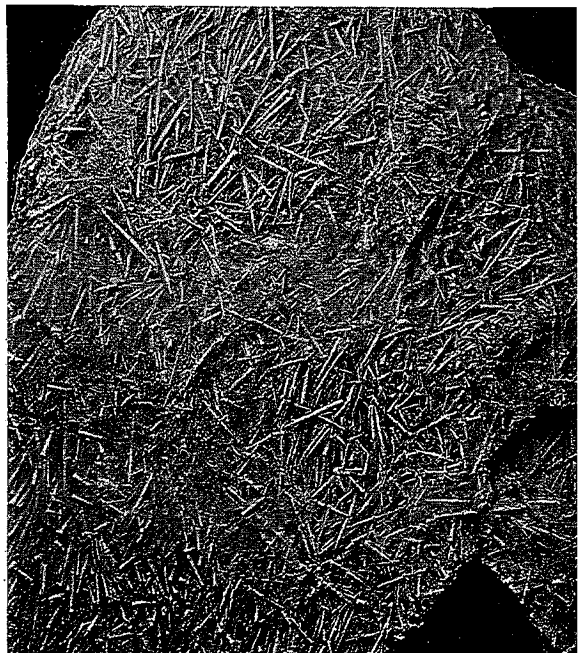

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PLATE 2

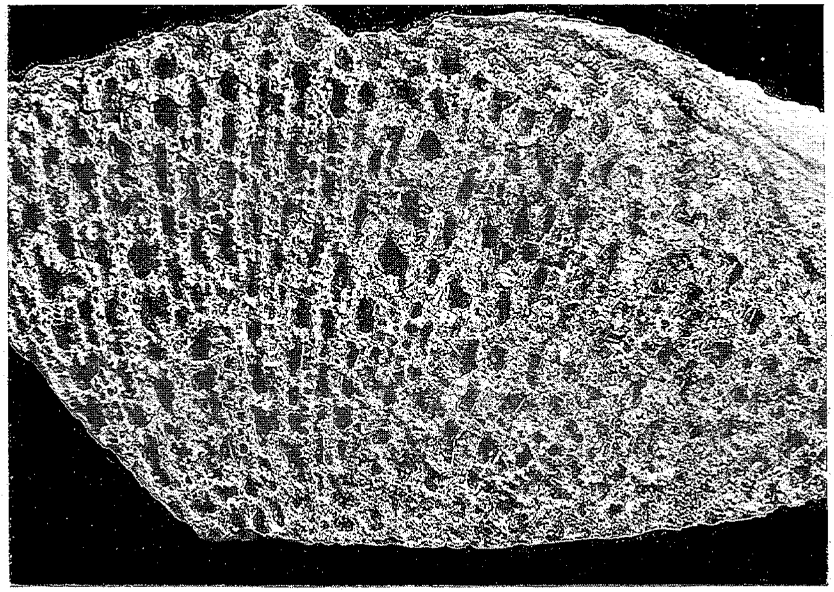
Sponges of the Naco Formation of central Arizona.

Figures *1, 3. Chaunactis olsoni* n. gen, n. sp., *1,* isolated paratype fragment with prominent radial structure of the skeleton and canal development on the upper gastral surface, dendroclones are rung-like spicules bridging radial elements, MNA N9484, X3.5; *3,* calcareous paratype fragment in red mudstone showing fine-textured gastral layer and interruptions of radial skeletal structure by exhalant canals, MNA N9486, X2.

Figure 2. Isolated sexiradiate heteractinid spicule (arrow) associated with probably unrelated fragments of monactine spicules, MNA N9496, X8.5.

Figures *4, 6. Haplistion nacoense* n. sp., holotype, MNA N9482, *4,* side view of stalked, erect lobate sponge with irregular skeletal grid of tangential tracts of rhizoclones, arrow marks location of tracts shown in Figure 6, X1; *6,* photomicrograph showing tracts of bundled small elongate rhizoclones, X20.

Figure 5. Root tuft fragment of aligned monaxial spicules in reddish mudstone, MNA N9495, X 3.5.



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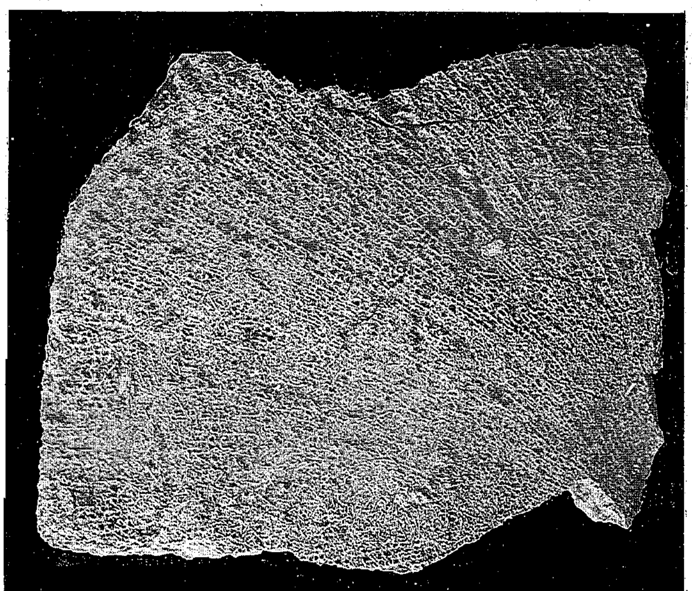

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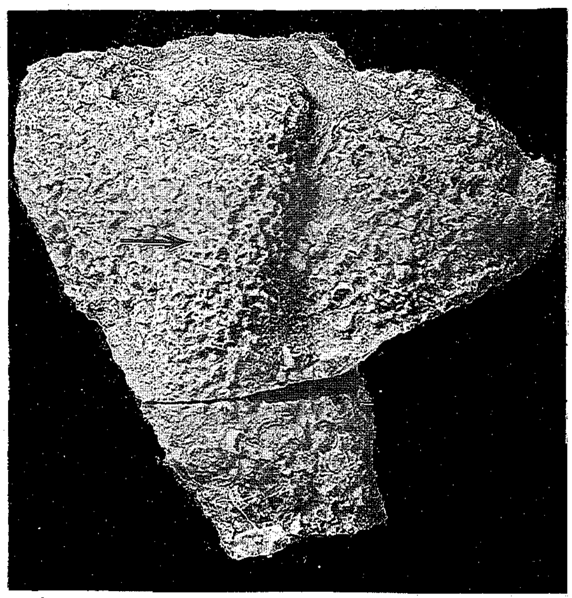

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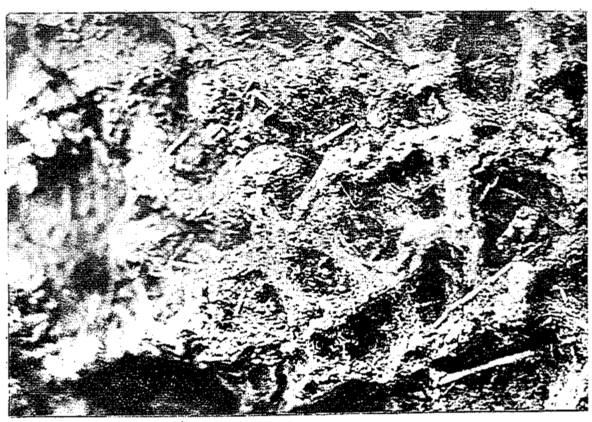

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