"Supposed medusoid molds from the Mississippian Napoleon (Upper Marshall) sandstone, Napoleon, Jackson County, Michigan" by Norman W. Melvin

Open-File, Dept. of Geology, Univ. of N. Mex. 1963

THE UNIVERSITY OF NEW MEXICO
DEPARTMENT OF GEOLOGY
ALBUQUERQUE, NEW MEXICO

April 24, 1963

AIR MAIL

Mr. Edward Kirkby
Department of Conservation
Lansing 26, Michigan

Dear Mr. Kirkby:

When I first read your inquiry of April 2, asking whether Norman Melvin's paper was in open-file at either our Department Library or at the University Library, I assumed that you wanted to borrow it.

This paper was written for a Graduate Problems course and ordinarily the faculty member keeps such papers in his own office file, not the Departmental Library. Inasmuch as I had used a red pencil rather extensively on certain pages and planned to go over these suggestions with Mr. Melvin, I decided to write him and ask him if he objected to my sending you this marked-up copy.

Mr. Melvin is in Tucson, Arizona for several weeks. He wrote me last week that he did not object to my sending you my copy of the report. However he suggested that I make a list of the necessary changes so that he could forward them to his friend at Lansing to whom he had already sent a copy of the paper.

This would be quite a chore for me and I would prefer to send you my copy and let you make changes from it. If there is no rush, why don't we wait until Melvin returns from his Tucson trip?

Sincerely yours,

Stuart A. Northrop

Stuart A. Northrop

P.S. If for bibliographic purposes you wish to cite the paper as being in open-file at the Department of Geology, University of New Mexico, Albuquerque, New Mexico, you may do so. If you need the copy right away, let me know.

April 2, 1963

Dr. Stuart A. Northrop
Chairman
Department of Geology
University of New Mexico
Albuquerque, New Mexico

Dear Sir:

We would appreciate knowing if Norman W. Melvin's paper entitled "Supposed medusoid molds from the Mississippian Napoleon (Upper Marshall) sandstone, Napoleon, Jackson County, Michigan" is in open-file at either your Department Library or at the University library? This paper was prepared for Geology 281, and is dated January 29, 1963.

Thank you.

Very truly yours

GEOLOGICAL SURVEY DIVISION

Edward Kirkby
Geologist

EK:nd

SUPPOSED MEDUSOID MOLDS FROM THE MISSISSIPPIAN NAPOLEON (UPPER MARSHALL) SANDSTONE, NAPOLEON, JACKSON COUNTY, MICHIGAN

by

Norman W. Melvin

Geology 281

January 28, 1963

Illustrations

Contents

ABSTRACT

A study of the molds occurring in the Napoleon sandstone of Mississippian age near the town of Napoleon, Michigan, revealed the presence of an amino acid, probably proline. Paper chromatographs were run using an n-butyl alcohol/ammonia mixture and developed with ninhydrin. The amino acid is thought to be selectively adsorbed upon clay particles in the cementing matrix. The clay seems to be a kaolinite-hallyosite mixture, as shown by a DTA log trace.

The assemblage of fossils may represent a thanatoceonose of medusae which were washed into the more saline Marshall sea from the open ocean and then quickly buried by sands settling out of storm-agitated waters.

The fossils were compared with illustrations in several works covering both fossil and living medusae. The modern families most closely resembling the molds seem to be the Trachylinidae and the Rhizostomae, although no definite classification has been proposed in this report.

INTRODUCTION

There is present throughout the geologic column a large number of poorly preserved, often obscurely marked fossils. Many of these specimens probably should be included in the Class Hydrozoa although taxonomic identification of individuals in most instances is almost impossible. The fossils generally represent internal molds of the lobes and canals of the living medusae. Preservation of a medusa is rather difficult when one considers that the living creature contains between 92 and 98 percent water, the actual percentage increasing as the salinity of the water decreases (Hyman, p. 382). However, under certain conditions preservation is possible. Shrock and Twenhofel (p. 110) and Caster (p. 1028) report that the chitinous internal covering of the siphonophore float aids in preservation. The writer has observed a medusa float on the beach of Chimana Grande Island off the northern coast of Venezuela which, although exposed to the air and tropical sun, retained much of its original shape and was rubbery to the touch. Under such circumstances, it is not unlikely that an occasional individual may be preserved.

PURPOSE AND SCOPE

This study was undertaken to determine if the molds actually represent organic remains and, if possible, to determine a general classification for these objects. The scope of this report is necessarily limited by the distance from the collection site and the scarcity of preserved surface features. Actual field measurements were not made during this study although the writer has examined the type area in the past.

GEOLOGIC SETTING

The type locality for the Napoleon sandstone is in the quarries on the east edge of the town of Napoleon in Jackson County, Michigan (Monnett, p. 634-35). The specimens collected for this report were obtained from these quarries and forwarded to the writer by Mr. William E. Mantek of the Michigan Geologic Survey.

The outcrops at the type locality are medium grained, friable, quartzose sandstones which are very light buff on fresh surfaces but which weather to light grey on exposure. The molds are normally the same color as the surrounding rock but occasionally have splotchy brown surface stains. Bedding planes in the rock range from one to four inches thick and are interrupted by the molds. For this reason the molds are deleterious to the economic production of flagstone material which is the sole product of the quarries. The molds appear on two horizons, separated by a barren zone some twelve feet thick. Some directional alignment of the molds has been reported (Mantek, personal communication). Local quarrymen refer to these molds as "elephant footprints", a reference to their overall appearance and alignment. A more logical, though hardly as colorful, explanation is that the molds represent medusae floats cast upon an ancient strand line.

The Napoleon sandstone is considered to be a facies of the Marshall formation and is not always distinguishable from it in subsurface cuttings (Hard, p. 135). The present outcrop area of the Napoleon sandstone and its stratigraphic position are shown in Figures 1 and 2.

The mineralogy of the Napoleon sandstone is relatively simple with quartz comprising over 90 percent of the grains and the remainder mostly plagioclase and chert. The heavy mineral content is approximately one percent and is mainly magnetite, pyrite and limonite with lesser amounts of hematite, leucoxene, zircon, tourmaline, rutile and hornblende. Stearns and Cook (p. 431) consider the presence of plagioclase in thin sections as proof that scarcity of

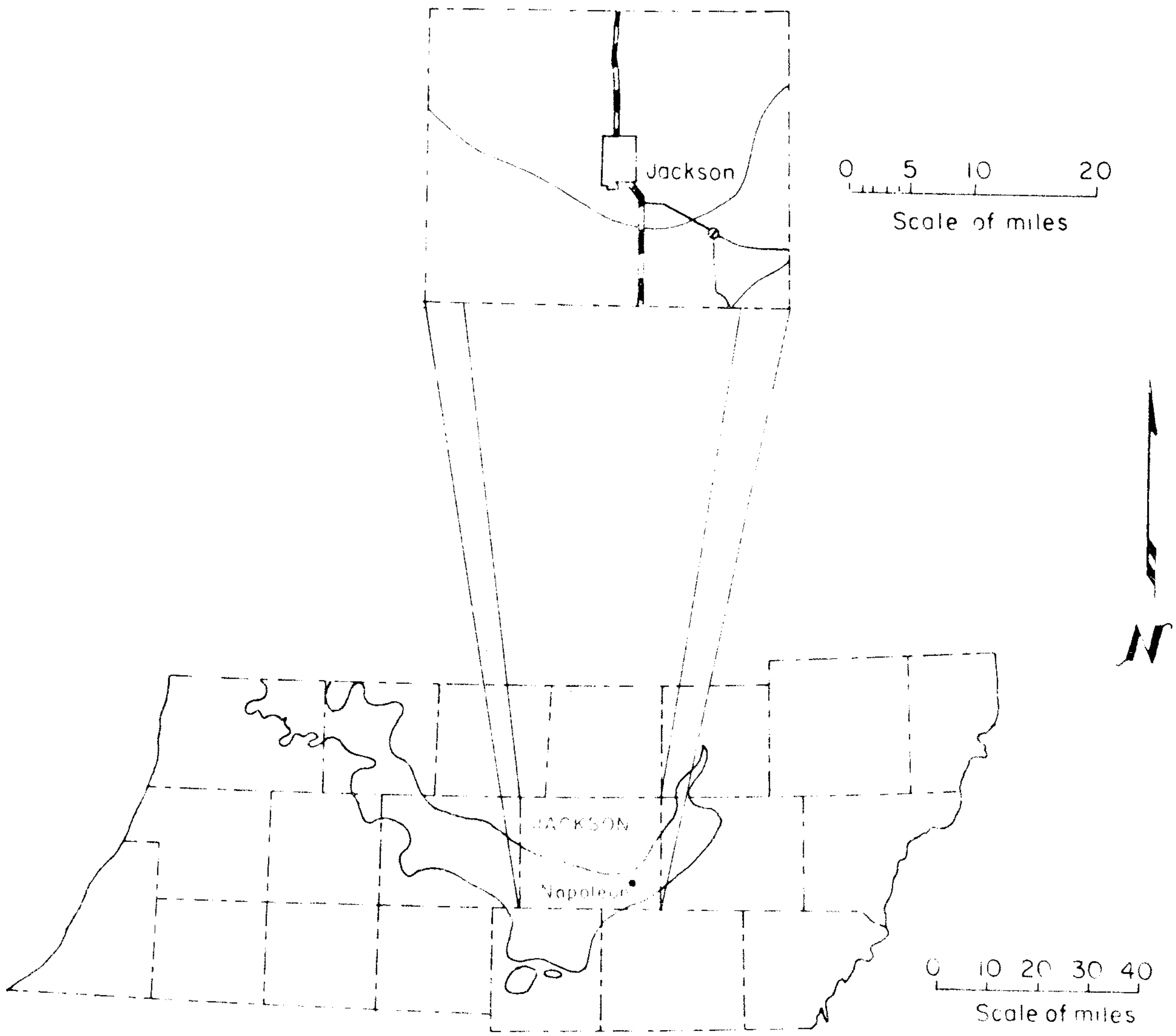


Fig. 1 -- Bedrock map of the Marshall formation in Southern Michigan (after Monnett, 1948).

System	Series	Group	Formation	Thickness and lithologic description of formations in Central Michigan.
MISSISSIPPIAN	IOWAN	Meramec	Bayport limestone	0-100'(?). Wh., gy & bl. foss. ls. Wh. & gy. ss. & cgl.
		Osage or Meramec	Michigan formation	250-400'. Gy., gn., bl. & bk. sh. Gyp., anhy., dol. & ls. Calc. & dol. sh. sandy sh. & lent. ss near base.
		Kinderhook	Napoleon sandstone or Upper Marshall	60-120'(?). Wh., yw. & gy. sli. cem. ss. Locally pink or red & indist. from Lower Marshall.
			Lower Marshall formation	60-150'(?). Red., hemat. sh. & ss. Some gy. & gn. shales, cgl. & gritstones. Often grades into Upper Marshall formation.
			Coldwater shale	800'-1000'. Bl., gy., gn. & dk. gy. shale. Sandy, calcareous & dolomitic layers.

Fig. 2.--Stratigraphic sequence in Central Lower Michigan from well logs and cuttings (modified from Hard, 1934).

heavy minerals in the formation is due to lack of these minerals in the parent rock rather than to past depositional changes.

The general environment of deposition during Marshall time was one of shallow seas bordered on the east by the low-lying, arid Laurentian uplands (Monnett, p. 685). Most of the sediments deposited in the study area were from the east after being transported for short distances (Stearns and Cook, p. 431). Medium- to fine-grained sands were occasionally carried into the area from the emerging Wisconsin Highland to the west, especially during storm conditions. Waves and currents frequently disturbed the shallow sea bottom over its entire area (Monnett, p. 683).

Stearns and Cook (p. 432) consider the lack of organic material as indicating the absence of reducing conditions but this same condition could arise from an increased salinity of the sea. Hard (p. 138) reports marine fossils from the lower Marshall formation but that the Napoleon sandstone is non-fossiliferous with the exception of some carbonized wood fragments. In view of the increasingly restricted nature of the Marshall seas with the attendant rise in salinity, it seems likely that the molds found at Napoleon represent two death assemblages and that the actual habitat of the creatures was probably quite different. Caster (p. 19) reports that stranded jellyfish are often preserved with the oral side upward, probably caused by the bouyancy of the various pouches. That the Napoleon molds are generally found with the larger portion upward further substantiates the belief that the Napoleon molds represent a thanatocoenose of stranded medusae.

METHODS OF INVESTIGATION

Geological analysis

The molds were subjected to examination by comparison with illustrations and descriptions by various authors, the most helpful of which were by Wolcott (1898), Mayer (1928), Bigelow (1928), Ruedemann (1934), Hyman (1940) and Caster (1942). Unfortunately, the molds do not seem to resemble any of the fossil medusoid descriptions and only partially resemble the modern Leptomedusoid Zygocanna vagans Bigelow (Bigelow, Plate 42, Fig. 5, p. 362). The modern Trachymedusa Ptychogastria antarctica (Caster, p. 190) also resembles the molds and this species has been used by Caster as closely resembling his Cretaceous Kirklandia texana.

A second method of analysis was the use of paper chromatography to determine the organic content, if any, of the molds. The methods for analyzing fossils for amino acid content has been outlined by Abelson (1957). Only single direction chromatographs were run, utilizing an n-butanol/ammonia mixture followed by the use of ninhydrin as a developing agent. A DTA analysis of an internal portion of one of the molds revealed a kaolinite-hallyosite(?) mixture with a strong quartz peak and a possible organic indication (Dr. Abraham Rosenzweig, personal communication).

Chemical analysis

Methods for paper chromatograph analyses have been given by Lederer and Lederer (1953) and by Block and Weiss (1956). The first step in the analysis of amino acids by paper chromatography is to hydrolize the protein to break it down into its constituent amino acids. However, no such treatment is necessary in the preparation of fossil material as the peptide chains break down naturally over the years, leaving only the individual amino acids. The smaller amino acid molecules are soluble in water and will gradually be lost. Abelson (1957, p. 88) considers alanine, glutamic acid, glycine, isoleucine, proline and valine to be relatively stable over periods ranging into millions of years while arginine, aspartic acid, lysine, phenylalanine, serine, threonine and tyrosene are less stable. Aspartic acid and glutamic acid tend to be adsorbed upon precipitating calcium carbonate during laboratory experiments and an overabundance of these two amino acids would indicate contamination from ground water rather than being contained within the original animal.

Abelson's method of analysis consisted of crushing the fossil material and treating the residue with hydrochloric acid. The solution was then poured through an ion-exchange column. The amino acids were absorbed by the resin and then rinsed with an ammonia solution to remove the amino acids for concentration and study.

The treatment of the molds in this study was somewhat different in that the original creature contained no hard parts and no carbonate material was present. The molds analyzed were broken open and a quantity of the material removed from the internal portion where the chance of surface contamination was less. The material was crushed and separated into samples for analysis. The first sample was leached with 5% HCl for five hours and the second sample of broken chips leached with n-butanol for the same amount of time. The solutions were then run on a single direction paper chromatograph strip using an n-butanol/ammonia mixture (970 ml. n-butyl alcohol/30 ml. 56% NH_4OH). The strips were suspended in the solution for 12 hours, dried, then developed with a 0.25% 1, 2, 3 triketohydrindene (ninhydrin) spray. The strips were then placed in an electric oven at 55°C for approximately 5 minutes.

A second group of experiments was run with crushed material only and the leaching process allowed to go to dryness under a fume hood for both the HCl and n-butanol solutions. A small amount of each solution was added to the dried materials and run in the same solvent as the first experiment for 15 hours. The strips were developed by the ninhydrin spray and treated as in the first experiment. Some contamination of the strips from handling was observed upon development.

Additional methods for paper chromatograph analyses are given by Lederer and Lederer (p. 74-89; 197-204) and by Block and Weiss (P. 71-110). Two-directional analyses are more useful but the apparatus for such a procedure was not available. The single-direction chromatograph tank was on loan from the University of New Mexico Chemistry Department and was recalled before further experimentation could be attempted.

RESULTS

Only two strips indicated any amino acid other than contaminants. These were the strips obtained from the concentrated solutions. The amino acid appeared as a faint yellowish tinge near the point of origin of the sample. A table of amino acid reactions to ninhydrin development is given by Lederer and Lederer (p. 200-201). This table indicates that the amino acid detected in this experiment is probably proline, one of the more stable, though simple amino acids. These results were in agreement with Dr. Riedesel (personal communication) of the Biology Department who indicated that the samples contained a "reasonable amount of aliphatic amino acid".

FOSSIL DESCRIPTION

The fossils are apparently external molds in fine-grained sandstone of two types of organisms as shown in Plate 1A and 1B. The specimen shown in Plate 1A represents the smaller type while the single specimen available as shown in Plate 1B is much larger and has more detail preserved. The two types will be designated Species "A" in the case of the smaller specimens and Species "B" in the case of the single large specimen for discussion purposes in this report.

Plate 1A. Species "A" showing mark-
ings on smaller end.

Plate 1B. Species "B" showing flut-
ing with sand filled central
area.

Species "A" are flattened, distorted molds of what appear to be medusoid individuals possessing an exumbrella. The size ranges from small individuals measuring 4 or 5 inches across the shorter dimension by 7 or 8 inches on the long dimension to very large individuals measuring some 10 or 12 inches by 14 to 17 inches. Species "B" is generally larger but some small individuals of this species have been observed by the writer in the collection at the Michigan Geologic Survey. The flutings around the smaller end of Species "A" seem to be canals(?) as shown by Zygocanna vagans Bigelow in Plate 42, Fig. 5 (p. 362). Bigelow (p. 316) reports that the number of canals in this species varies from 29 to 46. Careful counting of the flutes shown in the specimens reveals about 32 per specimen although the poor preservation in some cases renders this figure somewhat arbitrary. No other features are preserved on the molds with the exception of some vague knobs on the smaller end which may or may not have been a part of the living creature (see Plate 2A).

Species "B" shows much more detail and the fluting is very pronounced as shown in Plate 1A. The central area of the mold has evidently been filled with sand, obscuring any details present. There also seems to be a faint,

Plate 2A. Species "A" showing faint markings in central upper area (foreground).

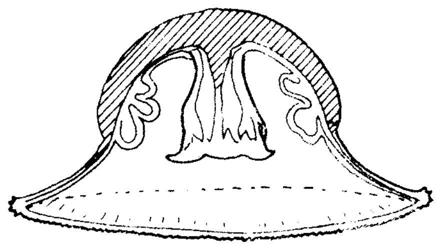
Plate 2B. Species "B" showing fluting with faint ridge (arrow) on upper surface.

though persistent, irregular low ridge encircling the mold. This ridge is midway between the inner and outer edges as shown by the arrow in Plate 2B. Species "B" seems to represent a much modified float which may have supported a colony rather than a single individual. Mayer (p. 206-232) describes and illustrates many of the Family Rhizostomae which appear rather similar to the Species "B" of this report.

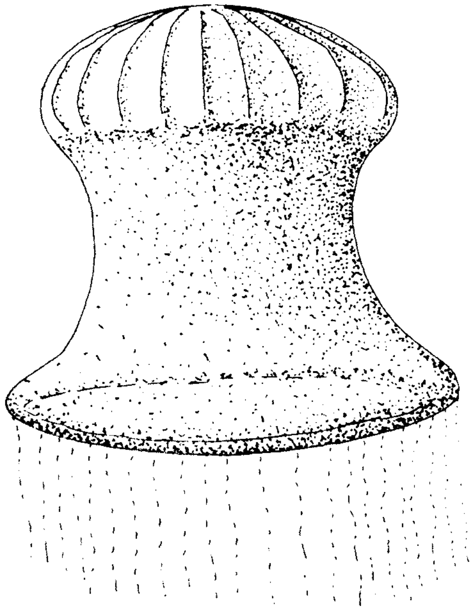
Of the medusae described by Mayer, Cephea octostyla (p. 209, 232) seems to resemble the molds most closely. Cephea actostyla has a low dome, small warts on the central upper portion of the bell with a tough gelatinous substance. The float may be a foot or more in diameter and the creature is a free swimming form. The Family Rhizostomae does not have marginal tentacles. Comparisons between living medusae and restorations of the possible living form of the fossils are shown in Fig. 3.

DISCUSSION

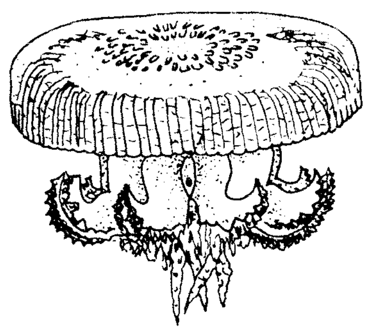
The study of fossil medusae is extremely difficult and classification into groups as gross as families are is usually uncertain. The reason for such difficulties is two-fold. The preservation is generally poor and



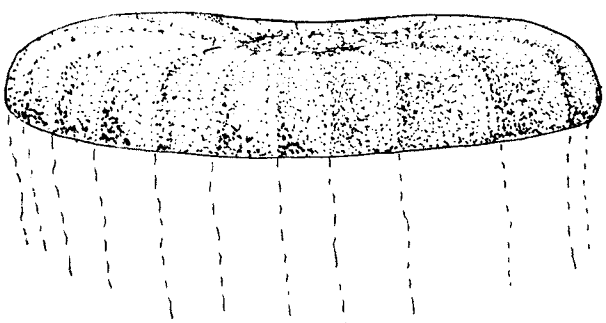
3A. Ptychogastria antarctica
(after Caster, 1942).



3B. Species "A" restoration



3C. Cephea octostyla
(after Mayer, 1928).



3D. Species "B" restoration

Fig.3-- Comparison of fossil restorations and modern medusae.

classification of various groups is dependent upon such minor items as ocelli, gonads, pouches and stomachs. These items unfortunately are not usually preserved and only the Middle Cambrian Burgess shale of British Columbia yields impressions in sufficient detail to ensure confident classifications (Fenton and Fenton, p. 73). Fine specimens are also obtained from the Jurassic Solenhofen limestone of Germany.

Monnett (p. 685) considers that the first isolation of the Mississippian sea covering Michigan occurred during the uplift which began the deposition of the Napoleon sandstone. The climate at that time was increasingly arid with a high rate of evaporation. Increased evaporation caused an increase in salinity and culminated in the deposition of anyhydrite and gypsum in the conformably overlying Michigan formation before a return to more normal deposition again occurred in the Bayport limestones. Further indication that life became increasingly more hazardous for normal marine life in Napoleon time is the disappearance of marine fossils upward from the base of the Marshall formation.

Therefore, it would seem likely that the two zones of fossils found near Napoleon, Michigan represent periods during which medusae from the open ocean were washed into the much saltier Marshall sea. Death probably occurred soon after the animals entered the more saline water and burial must have been by the sands thrown into suspension by wave action over the shallow bottom.

CONCLUSION

From the results obtained by this study, it now seems quite likely that the molds occurring in the sandstone quarries near Napoleon, Michigan represent a thanatoceonose of medusae. Two differing types are considered to be represented and there appears to be an affinity for the Trachymedusae in the case of Species "A" and Rhizostomae in the case of Species "B".

The medusae probably did not live in the Marshall sea as the salinity was much higher than normal sea water. Evidence for this consideration is given by Monnett (p. 685) as arid conditions increased evaporation and partial to complete isolation of the Marshall sea from the open ocean. The medusae are considered to have been washed into the Marshall sea and then rapidly buried, perhaps in a deltoic or lagoonal area, by the settling of sand from the storm-agitated waters.

The discovery of the amino acid proline(?) in the molds was heartening and this fact shifts the burden of proof onto those who argue for a non-organic origin for these molds. Contamination from outside sources is not considered to be a contributing factor in the presence of the amino acid. A possible reason for the retention of amino acid in a fossil of an animal lacking hard parts may be that the clay matrix (a kaolinite-hallyosite(?) mixture) absorbed and held the amino acid. The low permeability of the clay matrix would then have prevented the leaching of the amino acid by ground water or, for that matter, any contamination from outside sources. Other factors contributing to the preservation of this amino acid were the shallow depth of burial, lack of later volcanic activity and rather temperate climate, all of which contributed to a low temperature range where amino acids are most stable (Abelson, p. 89).

REFERENCES

Abelson, Philip H., 1956, Paleobiochemistry, Sci. Amer., v. 195, p. 83-92.

_____ 1957, Organic constituents of fossils, in Treatise on marine ecology and paleoecology, Geol. Soc. America, Mem. 67, 1957, p. 87-92.

Bigelow, Henry B., 1919, Hydromedusae, siphonophores and Ctenophores of the "Albatross" Philippine expedition, in Papers on collections gathered by the "Albatross" Philippine expedition, U. S. Nat'l Museum, Bull. 100, v. 1, 1928, pp. 279-362.

Black, Richard J., and Weiss, Kathryn W., 1956, Amino acid handbook, Springfield, Ill., Charles C. Thomas, 386 p.

Caster, Kenneth E., 1942, Two siphonophores from the Paleozoic, Paleo. Americana, v. 2 (no. 14), 33 p.

_____ 1945, A new jellyfish (*Kirklandia texana* Caster) from the Lower Cretaceous of Texas, Paleo. Americana, v. 3 (no. 18), 52 p.

_____ 1957, Problematica, in Treatise on marine ecology and paleoecology, Geol. Soc. America, Mem. 67, 1957, p. 1025, 1032.

Fenton, Carroll L., and Fenton, Mildred A., 1958, The fossil book, Garden City, New York, Doubleday, 482 p.

Hard, Edward W., 1938, Mississippian gas sands of Central Michigan area, Am. Assoc. Petrol. Geologists Bull., v. 22, pp. 129-174.

Hyman, Libbie H., 1940, The invertebrates: Protozoa through Ctenophora, New York, McGraw-Hill, 726 p.

Lederer, Edgar, and Lederer, Michael, 1953, Chromatography, New York, Elsevier, 460 p.

Mayer, Alfred G., 1919, Report upon the Scyphomedusae collected by the United States Bureau of Fisheries steamer "Albatross" in the Philippine Islands and Malay Archipelago, *in* Papers on collections gathered by the "Albatross" Philippine expedition, 1907-1910, U. S. Nat'l Mus., Bull. 100, v. 1, p. 175-233.

Monnett, V. Brown, 1948, Mississippian Marshall formation of Michigan, Am. Assoc. Petrol. Geologists, v. 32, p. 629-688.

Ruedeman, Rudolf, 1934, Paleozoic Plankton of North America, Geol. Soc. America Mem. 2, 141 p.

Shrock, Robert R. and Twenhofel, William H., 1953, Principles of invertebrate paleontology, New York, McGraw-Hill, 816 p.

Stearns, Margaret D., and Cook, Charles W., 1932, A petrographic study of the Marshall formation and its relation to the sand of the Michigan Series formation, Mich. Acad. Sci., Arts and Letters, Papers, v. 16, p. 430-437.

Walcott, Charles D., 1898, Fossil Medusae, U. S. Geol. Survey, Mono. 30, 201 p.