THE IOWA CORALS.

BY T. E. SAVAGE.

"The earth has gathered to her breast again
And yet again, the millions that were born
Of her unnumbered, unremembered tribes."

The corals constitute one of the conspicuous animal groups of ancient as well as modern times. Their beautiful coralla grace every period in which life's records are abundantly preserved. Among the fossils of Iowa few occur in a more perfect state of preservation, and none are possessed of a finer elegance or more delicate beauty than those of her ancient coral forms. At certain horizons coral remains occur in great profusion, and they are widely distributed in many of the strata of the state. Because of the readiness with which the species can be recognized, and on account of the limited range of many of the corals, they furnish to the geologist one of the most satisfactory means of determining the age of the rocks, and of distinguishing the successive geological formations exposed in the state.

Since the greater portion of the rocks which appear at the surface in Iowa belong to the Paleozoic era, all of the fossil corals are old-fashioned forms; types which lived in those far distant ages while yet the continents were small and life was young and the new earth was warmer than it is today. Of course these ancient corals were exclusively marine. Probably, like their modern relatives, they lived at no great depth, in waters that were warm, and free from rapidly accumulating sediments. Fast anchored to the ocean's floor these delicate creatures flourished in the tepid waters of that summer sea, nor ever felt the blighting chill of winter. They grew upon a stony pedestal of their own building and bore aloft a circlet of retractile tentacles by means of which they captured their food. Like other

aquatic animals, they utilized for respiration the oxygen diffused in the water that surrounded them.

Within their watery home these lowly forms found life replete with joy. They never breathed the flower perfumed air, nor felt the gentle wind's caress, nor the soft sunbeam's kiss; but oft the restless waves that hurried back and forth above their beds would pause to fondle them, and, in passing, would leave for them abundant stores of food. As these lowly creatures lived and labored they extracted from the sea water calcium carbonate and with it built ever higher the house on which they grew. This skeleton or corallum is the only portion of the coral with which in the fossil state we have to do.

Some of these ancient corals were simple and independent in their habits of growth. Others lived in colonies which were formed by the incomplete separation of the individuals when increase was effected by cleavage or by budding. The coralla of these colony-forming corals were of various shapes and sizes depending upon the position in which the new buds were produced, and the manner in which the new individuals or corallites continued to grow with respect to one another and to the parent polyp.

In the class Anthozoa, of which the corals are members, there are generally recognized two principal Paleozoic groups, the Tetracoralla and the Hexacoralla. The chief basis of distinction between the fossil members of these two groups is the arrangement of the septa or longitudinally-extending, radiating plates. Between these septa, during the life of the coral, were suspended the folds of the mesenteries which tissue was active in the secretion of the calcareous skeleton.

Among the Tetracoralla the septa in each corallite were disposed in four quadrants in such a manner that the entire number was some multiple of four, and the animal possessed bilateral symmetry. In the members of the Hexacoralla the original septa were usually six in number. As the individ-

uals increased in size, new ones were introduced midway between adjacent septa previously existing in such a manner that the number was always some multiple of six, and the symmetry of the animal was radial. Almost all of the fossil representatives of the Hexacoralla in Iowa belong to the subgroup Tabulata. They are, without exception, compound corals with numerous tabulæ or transverse diaphragms, and but poorly developed septa. The number of septa that were present in each corallite of either of the above groups corresponds with the number of tentacles with which the individual polyp was endowed.

In the rocks of the Ordovician system are preserved the remains of the earliest corals found in the state. In these deposits is encountered the peculiar fossil *Receptaculites oweni* Hall whose coral kinship is uncertain. This form is present in abundance in the rocks of Dubuque and Clayton counties, near the top of the Galena-Trenton stage. In this stage, too, there occurs the closely related species *Ischadites iowensis* Owen. These same rocks, and especially those of the Maquoketa stage in Howard county, contain the remains of *Streptelasma corniculum* Hall, the earliest representative of the true corals known in Iowa. As its specific name implies, this is a simple, horn-shaped form. It belongs to the highly successful family Zaphrentidæ whose members persisted throughout all of the ages of the Paleozoic era.

During a portion of the Silurian period the conditions were much more favorable for the development of coralline life than those of any period that went before. The series of rocks in Iowa which were deposited during this period is known as the Niagara. The beds are almost universally dolomitic, having suffered the change from limestone to dolomite since the sediments were laid down. These resistant ledges weather but slowly. They stand in vertical cliffs and abrupt escarpments bordering all of the larger streams of the area over which the Niagara limestones immediately underlie the drift. (See plate I, figure 1.)

Fig. 1. Ledge of Niagara limestone in Delaware county, showing the cliff-forming tendency of the "Coralline Beds" of the Delaware stage. [Iowa Geological Survey.]

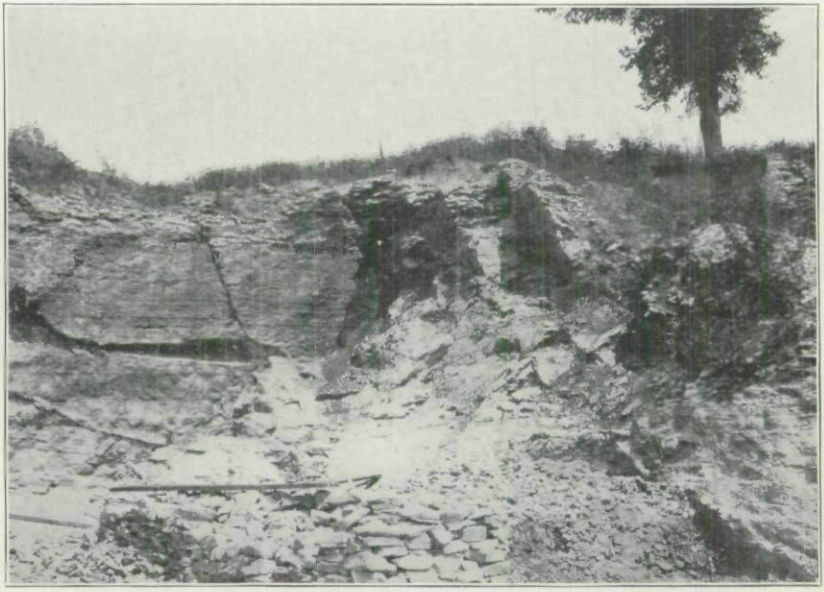

Fig. 2. Exposure of Cedar Valley limestone near Vinton, Iowa. The acervularia davidsoni coral reef appears at the top of the exposure.

PLATE I.

The imbedded coral skeletons which were originally built up of calcium carbonate have usually become silicified; the calcareous material of the framework having been completely replaced by silica. In some cases the coral skeleton has been dissolved out of the stony matrix and the fossils now exist only in the form of moulds, a cavity marking the position of the various portions of the original framework.

Professor Calvin* has shown that the life of this time in Iowa was not uniformly distributed over the sea bottom, but was more or less segregated in colonies. These fortunate areas teemed with a rich and varied population among which, both in number of individuals and the variety of forms, the corals exceeded any other group of animals in that old Niagara sea.

During the Delaware age the Niagara corals attained their maximum development. At this time the Tetracoralla were abundant. Near where now stand the towns of Masonville and Monticello there grew the small, solitary *Paleocyclus peracutus* Lonsdale, and the large robust *Zaphrentis stokesi* Edwards & Haime. With the latter were mingled the delicate coralla of *Streptelasma patula* Rominger (plate II, figure 1), *S. spongaxis* Rominger, and *S. calycula* Hall. Of the cup corals there also flourished here in great abundance *Ptychophyllum expansum* Owen (plate II, figures 3, 4), an undescribed species of the same genus, *Amplexus shumardi* Edwards & Haime, and in lesser numbers the smaller form *Cyathophyllum radicula* Rominger. The colony forming members of this family were even more conspicuous. At this time coralla of *Diphyphyllum multicaule* Hall attained a diameter of several feet. The genus Strombodes was represented by a number of species among which were *Strombodes mamillare* Owen (plate II, figure 8), *S. gigas* Owen, *S. pentagonus* Goldfuss, and *S. pygmaeus* Rominger. Here also grew occasional coralla of *Cystophorolites major* Rom., and *C. minor* Rom., and more

*Calvin: Geology of Delaware county, p. 155.

numerous individuals of *Cystiphyllum niagarense* Hall (plate II, figure 6). The curious little four-sided, pyramid-shaped coral *Goniophyllum pyramidale* Hisinger also lived at this time.

If representatives of the Tetracoralla were present in large numbers in the seas of this age, the members of the Hexacoralla flourished in even greater profusion. The honey-comb corals expanded into a number of species among which *Favosites favosus* Goldfuss (plate II, figure 7) was the largest and most abundant. *F. niagarensis* Hall, *F. hispidus* Rominger, and *F. hisingeri* Ed. & H. (plate II, figure 5) were also quite numerous, while *F. alveolaris* Goldfuss and *F. obliquus* Rominger were not rare. The remains of the closely allied species *Alveolites undosus* Miller, *Thecia major* Rom., and *Cladopora laqueata* Rom. were left mingled with those of the above mentioned Favosites. Compound corals differing from Favosites in the fact that the adjacent corallites were united, only at intervals, by hollow connecting processes were *Syringopora verticillata* Goldfuss, *S. tenella* Rominger, *S. fibrata* Rom. (plate II, figure 2) and *S. annulata* Rom. Associated in abundance with the typical corals of this age was the interesting chain-coral *Halysites catenulatus* Linnaeus. In this species the tubular corallites were built in chain-like series and disposed in such a manner as to surround irregular, vacant spaces. Sometimes the colonies were small and the corallites exceedingly tiny and delicate. In other places the coralla of this species attained the remarkable dimensions of several feet, and the individual corallites are many times the diameter of those of the smaller type.

During this time the genus Heliolites was represented by the species *H. interstinctus* Linn., *H. megastoma* McCoy, *H. pyriformis* Hall, and *H. subtubulatus* McCoy. The related species *Plasmopora follis* Edwards & Haime, *Lyellia americana* Ed. & H., and *L. decipiens* Rominger were not less abundant. Among the more distant coral

relatives were present *Cannapora junciformis* Hall, *C. annulata* Nicholson & Hinde, a few species of Stromatoporoids, and the enigmatical fossil *Cerionites dactylioides* Owen.

All of the Niagara corals mentioned above occur in the deposits of the Delaware stage, in the counties of Jones, Dubuque and Delaware. The rocks of this stage are preeminently the coral-bearing beds. As these ledges slowly disintegrated under the influence of the air and sun and showers, the hard, silicified coralla which they contained were frequently left in great numbers, free and entire, among the residual cherts and debris that mantle the tops of the cliffs. Few species of corals are encountered in the rocks of the later stages of the Niagara series, and of these the individuals occur only at very rare intervals.

Toward the close of the Niagara epoch there was an upward movement of that part of the earth's crust which embraced what is now the eastern portion of Iowa. This elevation shifted the shore-line further westward over that area, and produced a change in the conditions of sedimentation. The forms of life that peopled the sea during the Devonian period were the lineal descendants of Niagara types. The family features of the Niagara corals can be recognized in the facies of many of the later Devonian species. Under the influence of changing conditions, then as always, the progress of time was marked by migrations as well as the gradual but constant changes in the structure of the living forms. So profoundly were the corals modified that not a single one of the Niagara species persisted in the Devonian strata of Iowa. Even the genera of the Devonian are mostly new.

If the life in the Niagara sea was segregated in particularly favorable localities, it was widely and quite uniformly distributed over the more shallow portions of the ocean's bottom during the time of deposition of the Devonian sediments. At certain horizons corals grew in such abundance that their remains form well marked reefs of coral limestone.

During the Cedar Valley age in Iowa the members of the group Tetracoralla reached their highest development. Near the base of the deposits of this age corals are the characteristic fossils. In the counties of Buchanan and Johnson there occur large and beautiful coralla of *Phillipsastrea billingsi* Calvin, and the smaller but not less elegant species *Acervularia profunda* Hall (plate III, figure 3). These two species are not excelled in elegance among the fossils the world around. The latter species together with *Cystiphyllum americanum* Ed. & Haime (plate II, figure 6), and an undescribed species of Cyathophyllum are common near the base of the Cedar Valley limestones. Intermingled with coralla of the above were left the remains of *Favosites placenta* Rominger (plate III, figure 7), *Alveolites goldfussi* Billings (plate III, figure 4) and *Cladopora magna* Hall. A few feet above the zone of *Acervularia profunda* the simple coralla of *Aulocophyllum princeps* Hall and the larger species *Cyathophyllum robustum* Hall are abundant in some localities. From fifteen to twenty feet above the base of the Cedar Valley stage, and only a few feet above the zone of *Acervularia profunda*, the *Acervularia davidsoni* coral reef is encountered. The development of the reef is constant at this horizon from Howard county in the north to Muscatine county in the south. It outcrops in practically all of the counties that are touched by the winding channel of the Cedar river. The zone is so conspicuous and the contained coral species are so readily recognized that it makes the corellation of the layers of Devonian rocks in these counties comparatively easy.

Among the corals whose remains were left promiscuously intermingled in this coral reef, large and beautiful coralla of *Acervularia davidsoni* Ed. & Haime (plate III, figure 8) occur in great abundance. Indeed, the remains of the above species predominate in this zone to such an extent that the horizon is referred to in the geological literature of

the state as the *Acervularia davidsoni* coral reef. (See plate I, figure 2.) This reef is well exposed near Iowa City, Shellsburg, Vinton, Independence, Littleton, Waterloo, and at many other points in that portion of the state in which the rocks of Cedar Valley age appear at the surface.

In this zone the simple coralla of *Ptychophyllum versiforme* Hall (plate III, figure 1), *Heliophyllum halli* Ed. & Haime (plate III, figure 2), *Cystiphyllum americanum* Ed. & H. (plate III, figure 6), and *C. conifolle* Hall are numerous. With the above forms there are present of the Hexacoralla, *Favosites alpenensis* Winchell (plate III, figure 9), *F. emmonsi* Rominger, *Cladopora iowensis* Owen, and an undetermined species of *Pachypora*.

In addition to the corals enumerated above, and which are almost universally present at this horizon, there occur in the bed of a small stream near Littleton, in Buchanan county, *Acervularia profunda* Hall, an undescribed species of *Chonophyllum*, two undetermined species of *Favosites*, *Cladopora dichotoma* Hall, *C. palmata* H. & W., and *C. prolifica* Hall. There are also found here two undescribed species of *Syringopora* and several species of *Stromatopora*. This exposure near Littleton is one of the best coral-collecting grounds in the state. The coralla have weathered out, clean and perfect, from the soft shaly material in which they were originally imbedded, and pave the bottom of a small stream for a distance of several rods.

At no great distance from the coral reef there are encountered, in some localities, coralla of *Craspedophyllum strictum* Edwards & Haime, and *Alveolites roemeri* Billings.

In the white limestone near the top of the Cedar Valley stage there occurs a reef composed largely of masses of Stromatoporoids. This coral zone has a greater thickness, and is scarcely less extensive than that of the *Acervularia davidsoni* reef at a lower horizon. It outcrops in the counties of Worth, Mitchell, Cerro Gordo, Floyd, Blackhawk,

Benton, Johnson and others over the Devonian area. The forms whose skeletons make up this bed mostly belong to the group Hydrozoa. They include species of *Idiostroma*, *Actinostroma*, *Stromatoporella* and *Stromatopora*.

During the Lime Creek age, which succeeded the Cedar Valley, that portion of the Paleozoic sea which included what is now Floyd and Cerro Gordo counties supported a rich variety of coral life. Modified descendants of *Acervularia davidsoni* persisted at this time in the species *Acervularia inequalis* Hall & Whitfield. With this type were associated beautiful compound coralla of *Pachyphyllum woodmani* White (plate III, figure 5), and the small solitary species *P. solitarium* Hall & Whitfield, and *Campophyllum nanum* Hall & Whitfield. *Ptychophyllum ellipticum* H. & W., *Cyathophyllum solidum* H. & W., and *Cystiphyllum mundulum* H. & W. were the later Devonian representatives of the species of these genera that flourished during the Cedar Valley age. *Strombodes johannis* H. & W., and *S. multiradiatum* H. & W. also left their remains in the soft shales of the Lime Creek stage together with those of *Alveolites rockfordensis* H. & W., *Aulopora iowensis* H. & W., and *A. saxivadum* H. & W. Among the coralloid Hydrozoa there were present species of *Idiostroma*, *Stromatoporella incrustans* H. & W., *S. solidula* H. & W., and *Parallelopora planulata* H. & W.

Before the close of the Devonian period the corals began to decline and they never again occurred in such variety and abundance in the ancient mediterranean sea whose waters washed the shores of Iowa. In the later portion of the Devonian system there is a long break in the continuity of deposition recorded in the rocks of our state. The Upper Devonian series is represented in Iowa by the rocks of the State Quarry stage. Of these there are known to be preserved only a few small, disconnected areas in Johnson county. These isolated beds occupy depressions formed by erosion in the limestones of Cedar Valley age. They have yielded few well preserved coral remains.

In the rocks of the Lower Carboniferous series, which generally succeed those of the Middle Devonian in Iowa, there is another abrupt change in the coral species which are encountered. The Carboniferous period supported no crowded seas which teemed with coral life, nor do there occur within our state any reefs of coral remains in the rocks of this later system. The deposits of the Augusta stage are best developed in the region embraced by the counties of Henry, Van Buren, Lee, Des Moines and Louisa. During this time the members of the group Tetracoralla greatly predominated. The old-fashioned types of the Hexacoralla had waned almost to extinction. Of the representatives of the former group there were present at different points over the above mentioned area the short, simple coral *Hadrophyllum glans* White, together with several species of Zaphrentis, including: *Zaphrentis centralis* Worthen, *Z. dalei* Edwards & Haime (plate IV, figure 4), *Z. elliptica* White, *Z. illinoisensis* Worthen, *Z. spergenensis* Worthen, *Z. varsoviensis* Worthen, and *Z. calceola* White & Whitfield. Besides the above there flourished *Amplexus fragilis* White & St. John, and *A. blairi* Miller; corals which differed from Zaphrentis in bearing more highly developed tabulæ and shorter septa.

Among the Hexacoralla this age produced the curious coral *Palaeacis obtusa* Meek & Worthen, *Striatopora carbonaria* White, *Aulopora gracilis* Keyes and a species of *Syringopora*.

During the Saint Louis age, which succeeded the Augusta, there lived the largest and most elegant compound coral which the Carboniferous period produced, *Lithostrotion canadense* Castlenau (plate IV, figure 5). This beautiful form marks a definite horizon in the rocks near the base of the Saint Louis stage. The large compound coralla of this species are usually found silicified. They occur in masses from a few inches to several feet in diameter, the largest of which frequently weigh several hundred pounds.

They are found in great abundance near the towns of Salem and Mount Pleasant, in Henry county. In some localities, notably near Winfield, this compact form gives place to a less closely-growing species, *L. proliferum* Hall. Associated with the latter there grew in abundance a small, slender coral the surface of which was beset with spines, *Zaphrentis spinulosa* Edwards & Haime. Near the close of this age in Iowa the latter species of Zaphrentis was replaced by a larger type which was much more widely distributed, *Z. pellaensis* Worthen (plate IV, figures 1 and 2).

The only known representative of the Hexacoralla which flourished in Iowa during this age was an undescribed species of *Syringopora.*

With the advent of the Upper Carboniferous series the coral fauna had still more perceptibly waned both as regards numbers and the size of the coralla. The deposits of this epoch are encountered over an area, triangular in shape, the apex of which is formed by Webster county and the base by the southern border of the State. During the Missourian age there grew of the Tetracoralla the small simple species *Axophyllum rude* White & St. John, and *Lophophyllum proliferum* McChesney, and the much larger form, *Campophyllum torquin* Owen (plate IV, figure 3). The members of the Hexacoralla were represented by *Michelinia eugeneae* White, and a species of *Syringopora.*

With the close of the Paleozoic era the types of corals which constitute the ancient Tetracoralla passed away. During succeeding ages the descendants of some of these forms became more and more modified until their line seems to have culminated in the group Aporosa of the modern Hexacoralla, which is represented by the reef building corals of the present day.

The old-fashioned Tabulata of the Hexacoralla, whose members formed so conspicuous a part of the coral life in the Paleozoic seas, have long since disappeared and left no modern progeny.

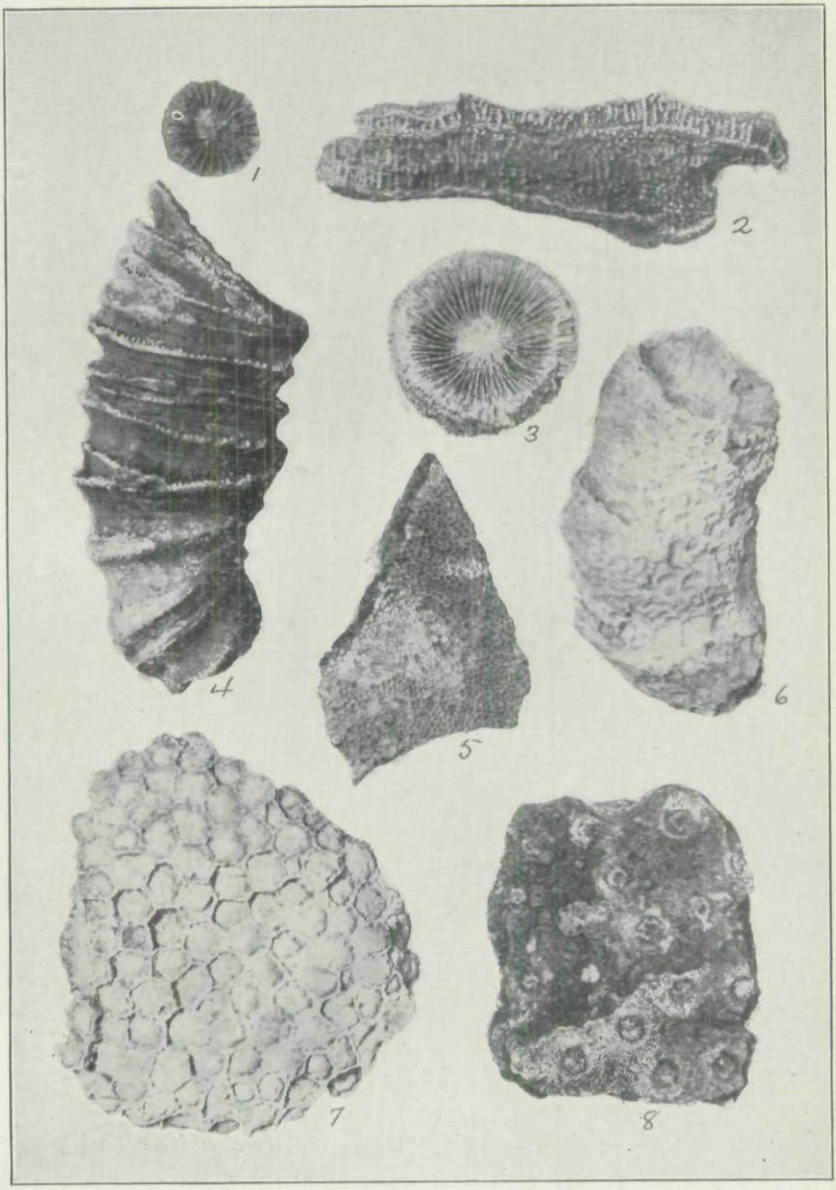

PLATE II.

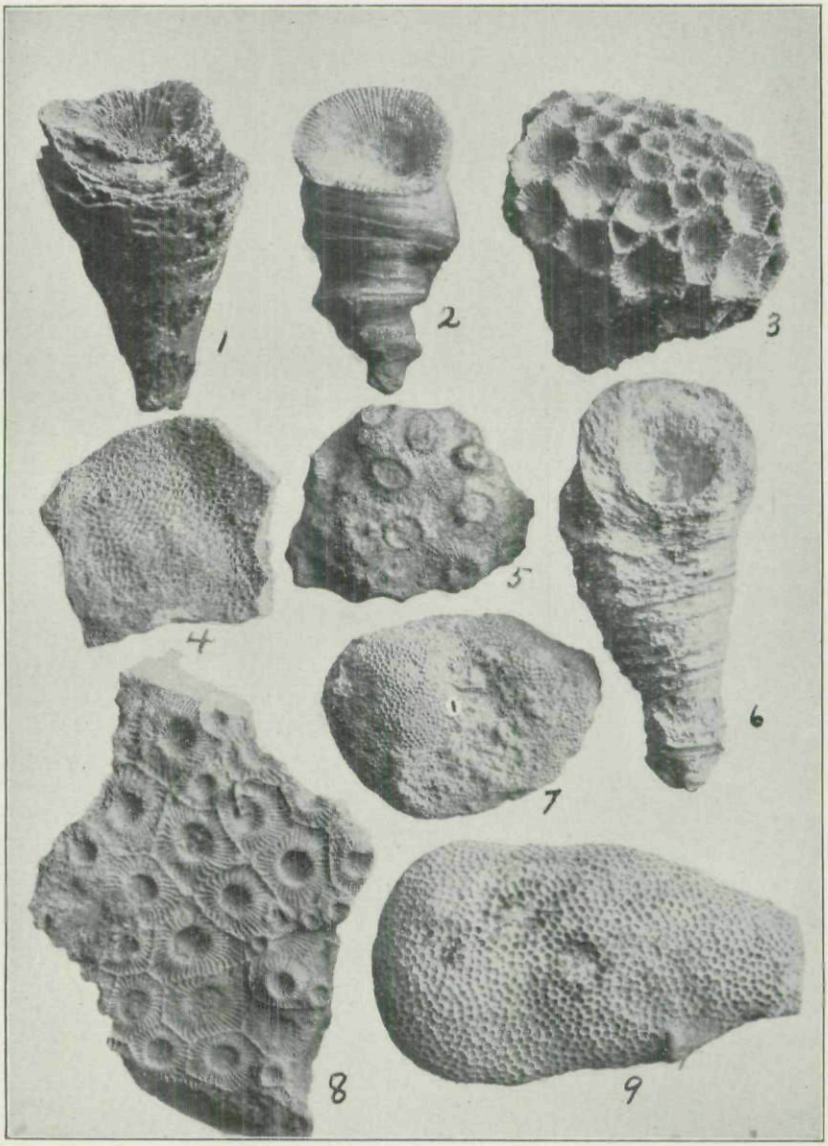

PLATE III.

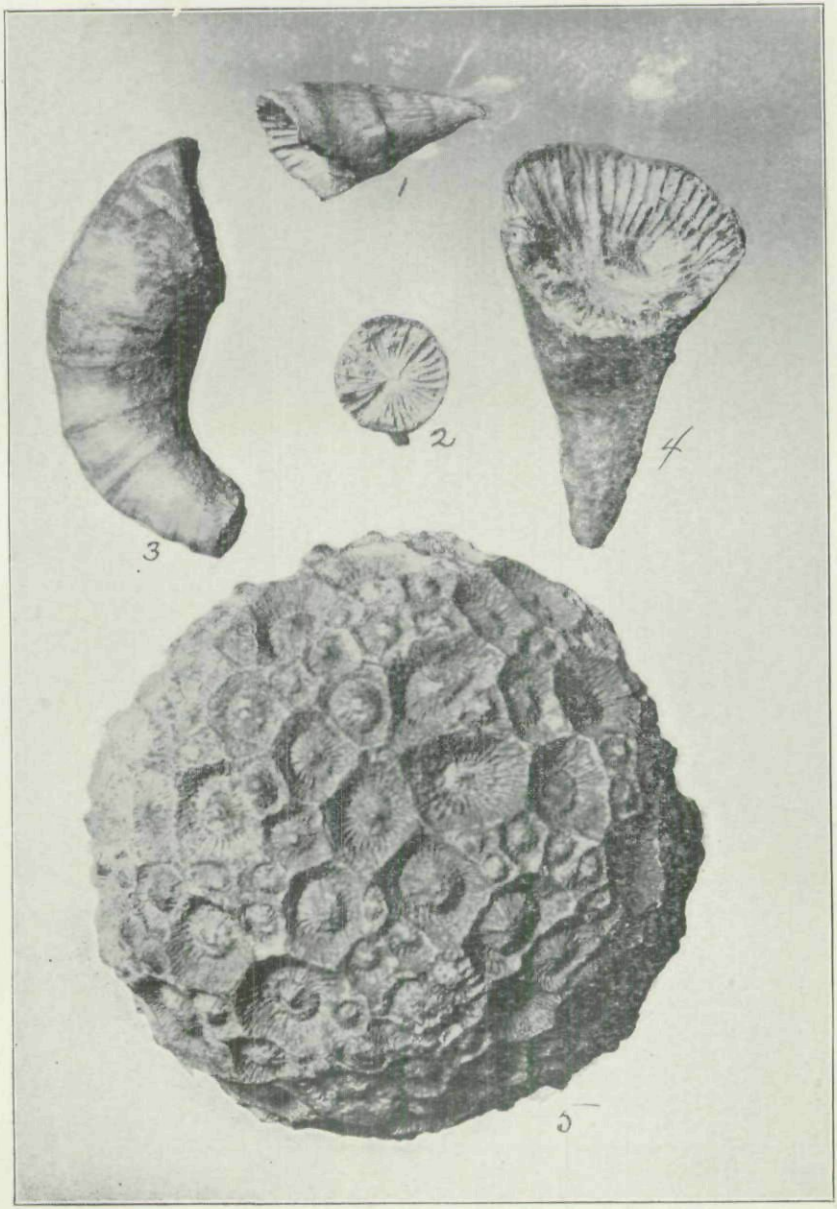

PLATE IV.

These coral skeletons are more than curious relics of ages long removed. They are freighted with the story of the past and vocal with a message to the present. They tell us of time's lapses inconceivable. They show us many of the forms that have appeared and played their part upon life's stage, and disappeared beneath the dim horizon of the past. They witness to the plastic nature of life's substance, and to the laws of adaptation and growth which govern all its creatures. They disclose the massive masonry on which our state is built, whose giant courses were laid deep on the ocean's floor. They constitute some of the letters by which is spelled out the varied and eventful story of the earth and of its life. They help to make intelligible the past, and to reveal the meaning of the present, and thus in no mean measure they contribute to the intellectual life of man.

EXPLANATION OF PLATE II.

Types of Niagara Corals.

Fig. 1. Streptelasma patula Rominger.
Fig. 2. Syringopora fibrata Rominger.
Figs. 3 and 4. Ptychophyllum expansum Owen.
Fig. 5. Favosites hisingeri Edwards and Haime.
Fig. 6. Cystiphyllum niagarense Hall.
Fig. 7. Favosites favosus Goldfuss.
Fig. 8. Strombodes mamillare Owen.

EXPLANATION OF PLATE III.

Types of Devonian Corals.

Fig. 1. Ptychophyllum versiforme Hall.
Fig. 2. Heliophyllum halli Edwards and Haime.
Fig. 3. Acervularia profunda Hall.
Fig. 4. Alveolites goldfussi Billings.
Fig. 5. Pachyphyllum woodmani White.
Fig. 6. Cystiphyllum americanum Edwards and Haime.
Fig. 7. Favosites placenta Rominger.
Fig. 8. Acervularia davidsoni Edwards and Haime.
Fig. 9. Favosites alpenensis Winchell.

NOTE: The individuals from which figures 2, 6 and 7 were photographed were not collected in Iowa, but these species are not rare in the state.

EXPLANATION OF PLATE IV.

Types of Carboniferous Corals.

Figs. 1 and 2. Zaphrentis pellaensis Worthen.
Fig. 3. Campophyllum torquin Owen.
Fig. 4. Zaphrentis dalei Edwards and Haime.
Fig. 5. Lithostrotion canadense Castlenau.