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REPORT OF INVESTIGATIONS

No. 5.

SOME CRETACEOUS FORAMINIFERA

OF

SOUTH DAKOTA

By

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## SOME CRETACEOUS FORAMINIFERA OF SOUTH DAKOTA

The investigation on which this paper is based was begun with the purpose of determining the number and kind of Foraminifera which occur in the Greenhorn and Niobrara formations of the Cretaceous of South Dakota. Species and their relative abundance were tabulated to determine whether or not micro fossils can be used to distinguish these two important formations.

Three important contributions to our knowledge of the foraminifera of the Greenhorn and Niobrara formations have been published. The first of these was published by the Minnesota Geological Survey in a report entitled "The Microscopic Fauna of the Cretaceous of Minnesota with additions from Nebraska and Illinois," by Woodward and Thomas. It contains descriptions of specimens of foraminifera from the Niobrara chalk (probably from Yankton) sent them by Dr. Swezey of Doane College in Nebraska. Foraminifera from the Niobrara of South Dakota and from the Greenhorn of north western Iowa were figured and described by Samuel Calvin in Volume III of the Iowa Geological Survey under the title "Composition and Origin of Iowa Chalk." Calvin, however, did not differentiate the two formations as he believed them to be the same horizon. Niobrara foraminifera from Kansas were also described and figured by E.C. McClurg. Most of the specimens obtained from South Dakota chalk were described and figured by these early workers.

### METHODS

Two methods were used to separate the fossils from the matrix of chalk. It was found that by the use of a brush having short, stiff bristles the chalk could be readily disintegrated, brushed gently into a large beaker or other utensil of suitable size. Boiling small samples gently in beakers or test tubes in many cases has proved an effective method of disintegrating the chalk. Either method of disintegration produces a white or light colored mud or water of milky appearance resulting from the suspension of particles of considerable size range. It is desirable to remove all sizes of material larger or smaller than the shells of protozoa by washing. This was accomplished by agitating of the material in a large beaker (1000 c.c. or larger) preferably using distilled water. The material is then permitted to settle for five minutes after which the liquid is decanted or siphoned off. Washing is repeated until the liquid is clear after the settling period has elapsed. The residue is then filtered and dried.

In some cases where calcareous particles adhered to the specimens after disintegration, washing for brief periods in water made slightly acid with hydrochloric acid was an effective means of cleaning the specimens. Obviously this method is highly successful in the case of Radiolaria, whose tests are of silica (rather than of calcium carbonate).

## DESCRIPTION OF FORMATION

### Greenhorn Formation

This formation comprises a thin but very distinctive series of beds of hard, impure limestone with a thickness of about thirty feet. It consists of a basal member, eight to ten feet thick, of bluish chalky limestone, overlain by a hard impure, thin bedded limestone member, twelve feet thick, containing *Inoceramus Labiatus* in great abundance and interstratified with a chalky shale which is in turn overlain by a second chalky limestone member, four to six feet thick. The limits of the formation are commonly well marked, although in some places the limestone grades into the underlying Graneros shale and overlying Carlisle shale. In many places the limestone occurs in large blocks, divided by distinct but irregular joints. Besides *Inoceramus Labiatus*, which occurs in great abundance, the formation contains fish teeth and scales, the latter of unusually large size. It also contains shark teeth, both of the usual form and of *Ptychodus*. A chalk sample from the Greenhorn outcrop at Richland was the only one intensively studied, but another from the Greenhorn outcrop at Stone Park in Sioux City was checked against it and the two correlated closely.

### Niobrara Formation

The Niobrara formation lies above the Greenhorn with one formation, the Carlisle, intervening. The most characteristic feature of the formation is the chalk stone, but possibly a considerable thickness of shale should be considered as included in the formation. The Niobrara has a total thickness of over two hundred feet. The chalk rock of the Niobrara when weathered is a white or pale yellow, and therefore is in strong contrast with the dark color of the underlying Carlisle shale. In many places where the Niobrara is unweathered, it is a moderately dark bluish grey color.

The most abundant megascopic fossils of the Niobrara formation are small, deep cup-shaped oysters (*Ostrea Congesta* Conrad) commonly found in colonies and often attached to fragments of *Inoceramus* shell. Teeth of sharks and bones of Teleost fishes and large swimming reptiles are also found. A very small lingula is also found but is quite rare. Specimens from the outcrops at Yankton, Menno, Redfield, Chamberlain and Hot Springs were studied, thus making these studies fairly

representative of this formation in South Dakota.

### THE MICROFAUNAS

In the Microfaunas of the two formations seven genera and ten species were found. Sponge spicules and rods from oyster shells occur also, and while they are not foraminifera, they are microscopic in size and of use in differentiating localities in the same formation. The list of forms includes the following;-

Textularia agglutinans d'Orbigny  
Textularia globulosa Ehrenburg  
Radiolaria (Polycystinae)  
Globigerina cretacia d'Orbigny  
Globigerina bulloides d'Orbigny  
Arbulina universa d'Orbigny  
Lagena hispida Reuss  
Anamolina ammonoides Reuss  
Bolivina vicksburgensis Cushman  
Sponge spicules  
Rods from oyster shells

### SYSTEMATIC DESCRIPTIONS

#### Textularidae

#### Textularia Globulosa Ehrenburg

- Textularia globulosa Ehrenburg (1839) Abkand, Akad., Berlin, Pl. 4  
Textularia globulosa Ehrenburg ibid pp. 291, 438  
" " Hitchcock (1843) Asso. Geol. and Nat. (1840-1842) pp. 357, pl XV  
" " Meek (1864) Smith. Inst. Check list Cret. and Jur. Fossils, pl. 1  
" " Dawson (1874) Can. Nat. Vol. 7, page 253  
" " Woodward and Thomas 1885, 13 Ann. Report, Geol. and Nat. Hist. Sur. of Minn., p. 166, pl. III, figs. 1-5

The description of Textularia globulosa is quoted from G.M. Dawson's paper on Foraminifera of the Cretaceous Rocks of Manitoba. This is much superior to the original description by Ehrenburg.

"A stout form with globose chambers, rapidly increasing in size at each addition, and sometimes even as broad as long. The primordial chamber, and those next to it, are often bent away several degrees from the axis of symmetry of the larger part of the shell. The surface of the shell is marked with extremely minute diagonal, interrupted ridges or wrinkles."



The forms found in the Greenhorn and Niobrara differed in no conspicuous detail from this description except that the Greenhorn forms have their chambers arranged in a heterogenous manner and they are not formed in one plane.

POSITION - Niobrara, Greenhorn, Carlisle: all Cretaceous  
LOCALITY - Yankton, Menno, Redfield, Richland, Hot Springs, Chamberlain.

*Textularia agglutinans* d'Orbigny

*Textularia agglutinans* d'Orbigny, *Historie Physique, Politique et Naturelle de l'ile de Cuba, Foraminiferes*, p. 136, pl. 1, figs 17, 18 (1839)  
" " H. O. Brady, *Challenger report, Zoology*, vol. 9, p. 363, pl. 43, figs 1-2 (1884)  
" " Cushman *U.S. Nat. Hist. Mus. Bull.* 71 pt. 2, p. 9, figs. 10a (1918)  
" " Cushman, *U.S.G.S. Prof. Paper* 129, p.89. (1922)

Test elongate, large and stout, gradually tapering from the initial end, chambers nearly as high as wide, tumid, depressed sutures, early portion slightly compressed, test wall arenaceous with calcareous base, larger chambers rougher, tests arenaceous but roughly finished.

POSITION - Niobrara, Cretaceous  
LOCALITY - Menno and Redfield

*Bolivina vicksburgensis* Cushman

*Bolivina vicksburgensis* Cushman (1922) *U. S. G. S. Prof. Paper* 129, p. 126, pl. 29

Test elongate, tapering, apical and bluntly pointed, gradually increasing in width for a few chambers and then the sides are nearly parallel the remainder of its length. Chambers distinct sutures deep, lower end of chambers project slightly over the chamber directly below so as to form a wavy edge. Chambers triangular, sutures sloping towards the apical end. Surface profusely punctate, punctae arranged in rows.

The type of this specimen is an Eocene form but the Cretaceous form here described shows no differences in character.

POSITION - Niobrara, Cretaceous  
LOCALITY - Menno

Globigerinidae

Globigerina Cretacia d'Orbigny

Globigerina cretacia d'Orbigny (1842) Mem. Geol. Sci. France,  
Vol. IV, p. 34, pl. 3

Test rotaliform, much compressed, superior face convex,  
inferior concave, periphery obtuse. Five to seven chambers  
in the outer convolution. Segments relatively small, increase  
gradually and porportionally, punctuate.

Globigerina bulloides d'Orbigny

Globigerina bulloides d'Orbigny (1826) Ann. Nat. Sci., Vol.  
XIX, p. 272.

Test spiral, sub-trochoid, superior face convex, inferior  
face concave, deeply sunken umbilicus, periphery rounded,  
lobulated, four chambers form the outer convolution. Punctuate.  
A rare specimen in these formations.

POSITION - Niobrara and Greenhorn, Cretaceous  
LOCALITY - Yankton, Menno, Redfield, Chamberlain,  
Richland.

Orbulina universa d'Orbigny

Orbulina Universa d'Orbigny (1839) Foram. Canaries, p. 122.  
pl. 1.

Shell free, regular, spherical, hollow, perforated with  
a large number of very minute foramina, visible only under  
very high magnification. Septal orifice small, single, situ-  
ated on the periphery but often invisible. Calcareous tex-  
ture. Often flattened out and cracked.

POSITION - Niobrara and Greenhorn, Cretaceous  
LOCALITY - Yankton, Redfield, Menno, Chamberlain,  
Hot Springs

Lagaenaeda

Sub-family Lagaenaedae

Laegena, Walker and Boys

Laegena Hispida Reuss (1858) Zeitschr. d. deutsch geol.  
Geschellsch. vol. X, p. 434.

The arched or rounded part of the test is very variable in form but most commonly is nearly circular. Towards the top it is drawn out to form a thin, tubular beak which was never present in the forms from these two formations. The surface of the globular part is covered with closely spaced, irregularly spaced thorny tubercles. These specimens are quite rare.

POSITION - Niobrara, Cretaceous  
LOCALITY - Chamberlain

#### Sub-Family Rotalinae

##### Anamolina d'Orbigny

Anamolina Ammoinoides Reuss (1845) Verstein. boh. Kreid.,  
pt. 1, p. 36, pl. XII, fig. 66,  
pl. VIII, fig. 5

Tests much compressed and nearly equally convex on both sides. The peripheral edge is nearly round and the aperture is in the center of the median line. Early convolution visible on both dorsal and ventral sides. Coarsely punctate. Very thin test wall.

POSITION - Niobrara, Cretaceous  
LOCALITY - Menno, Redfield

#### Radiolaria

##### Radiolaria, Muller.

#### Polycystinae

An order of the Rhizopods which have a siliceous test. Tests gradually increase uniformly in size. Sutures excavated. Apical angle quite small. No surface markings.

POSITION - Niobrara, Cretaceous  
LOCALITY - Yankton

#### IDENTIFICATION OF FORMATIONS.

There are several striking differences in the faunas of the Greenhorn and Niobrara chalks.

1. The relative abundance of Orbulina. These foraminifera were much more abundant in the samples from the Greenhorn than in those from the Niobrara.

In the Greenhorn specimens from Richland and the specimens from Iowa, the Orbulinae made up about 45% of the total content of the foraminifera. In none of the Niobrara specimens did the Orbulinae exceed ten percent and often there is only a trace present. About five or six specimens out of a hundred would be the average of the Orbulinae in the Niobrara chalk.

2. Another method of separating the two formations is on the type of the *Textularia globulosa* specimens. The Greenhorn specimens are twisted and poorly symmetrical and usually quite small while the Niobrara specimens are very symmetrical. *Textularia globulosa* is the most abundant Niobrara species.

3. The relative abundance of species common to both formations as shown in the diagrams of faunal analysis which follow, appears to be a reliable criterion. These diagrams represent abundance as ascertained by counts of specimens in representative slides from different localities. The most abundant forms of the Niobrara formation as brought out in the analyses is *Textularia globulosa*, whereas *Orbulina universa* is significantly abundant in the Greenhorn.



### Faunal Analysis

Name	%	20	40	60	80	100
Textularia globulosa	45					
Globigerina cretacea	35					
Globigerina bulloides	8					
Orbulina universa	tr					
Radiolaria	15					

Slide No. I

Position-Miobrara

Locality-Yankton

Notes-This chalk is a drab color which becomes darker when wet. It has a distinct clay odor and very fine texture. Under magnification of 81.8 diameters it was still a drab gray but looked finely granular and porous.

Date-April 25, 1930

Harvey W. Anderson, Analyst

Faunal Analysis

Name	%	20	40	60	80	100
Textularia globulosa	55					
Globigerina cretacea	12					
Globigerina bulloides	tr					
Orbulina universā	10					
Radiolaria	0					
Lagena Hispida	5					
Ananolina ammonoides	0					

Slide No. II

Position-Niobrara

Locality-Chamberlain

Notes-This is another specimen of Niobrara chalk. It is a very dark grey, almost black in color. This chalk is quite hard and has small pieces of harder material in it. The foraminifera are very difficult to separate from their matrix and even when separated with the aid of chemicals, still have calcareous particles adhering to them.

Date-April 25, 1930

Harvey W. Anderson, Analyst

### Faunal Analysis

Name	%	0	20	40	60	80	100
Textularia globulosa	45						
Globigerina cretacea	26						
Globigerina bulloides	tr						
Orbulina universa	tr						
Radiolaria	0						
Lagena Hispida	0						
Anamolina ammonoides	22						

Slide No. III

Position-Niobrara

Locality-Memno

Notes-This chalk comes from Memno and belongs to the Niobrara formation. It is a verly light gray, almost white. It has a very distinct clay odor when wet. Under magnification of 81.6 it looked like a good grade of table salt, both in color and texture. Gypsum crystals were also seen in this chalk while it was under the microscope.

Date-April 25, 1930

Harvey W. Anderson, Analyst

Faunal Analysis

Name	%	20	40	60	80	100
Textularia globulosa	46					
Globigerina cretacea	35					
Globigerina bulloides	tr					
Orbulina universa	10					
Radiolaria	0					
Lagena hispida	0					
Anamolina ammonoides	14					

Slide No. IV

Position-Niobrara

Locality-Redfield

Notes-This chalk is Niobrara. It has a peculiar thin bedded cleavage that is almost as thin as the cleavage of shale. It has a tan color and no distinct odor. The microscopic fossils from this locality are hard to separate from the chalk due to the large amount of finely divided material in it.

Date-April 25, 1930

Harvey W. Anderson, Analyst

Faunal Analysis

Name	%	20	40	60	80	100
Textularia globulosa	65					
Globigerina cretacea	32					
Globigerina bulloides	0					
Orbulina universa	tr					
Radiolaria	0					
Lagena hispida	0					
Anamolina ammonoides	0					
Sponge spicules	4					

Slide No.-V

Position-Niobrara

Locality-Hot Springs

Notes-This chalk comes from the Niobrara formation where it is exposed in the Black Hills. It is a very white chalk and is composed of some colloidal material. It has a faint clay odor, becomes slightly darker when wet.

Date-April 25, 1930

Harvey W. Anderson, Analyst

Faunal Analysis

Name	%	20	40	60	80	100
Textularia globulosa	50	[shaded]				
Globigerina cretacea	16	[shaded]				
Globigerina bulloides	tr					
Orbulina universa	45	[shaded]				
Radiolaria	0					
Lagena hispida	0					
Anamolina ammonoides	0					
Sponge spicules	0					

Slide No. VI

Position-Greenhorn

Locality-Richland

Notes-This chalk comes from the chalk member of the Greenhorn limestone. This chalk is thin bedded and is coarse and granular. It is a dark tan-gray in color and has a pronounced clay odor.

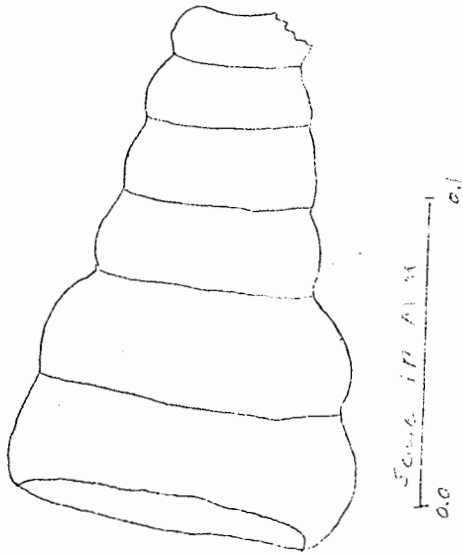
Date-April 25, 1930

Harvey W. Anderson, Analyst

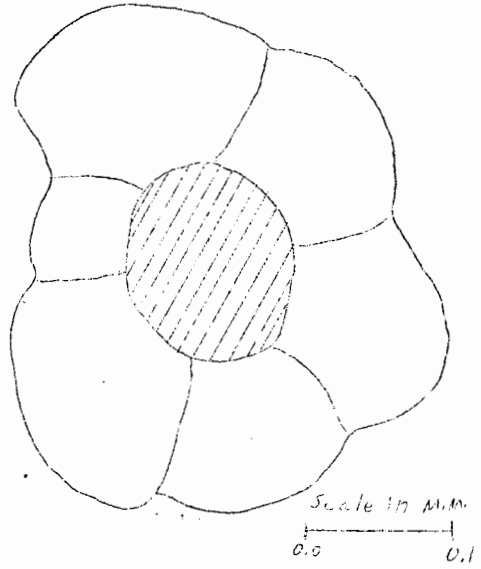


YANKTON FORAMINIFERA

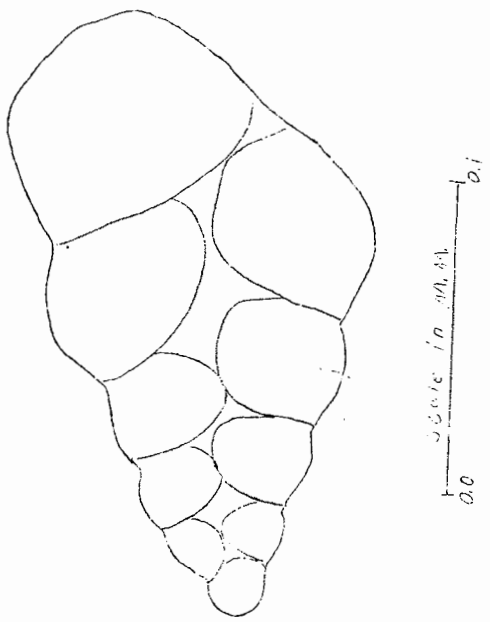
Radiolaria sp.



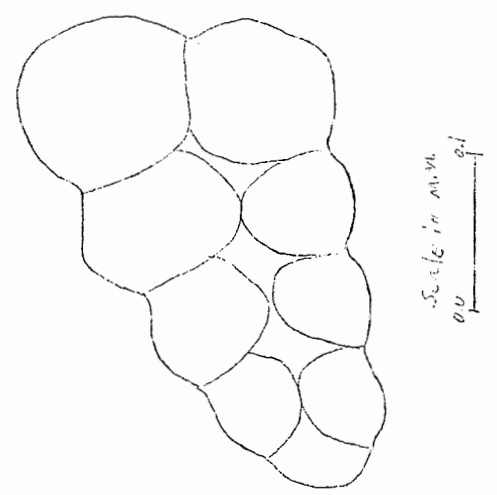
Globigerina cretacea d'Orbigny



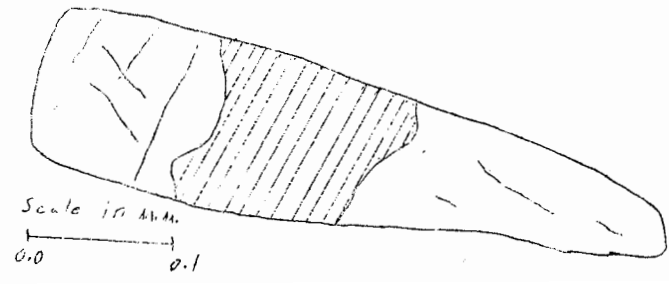
Textularia globulosa Ehrenburg



Textularia agglutinans d'Orbigny

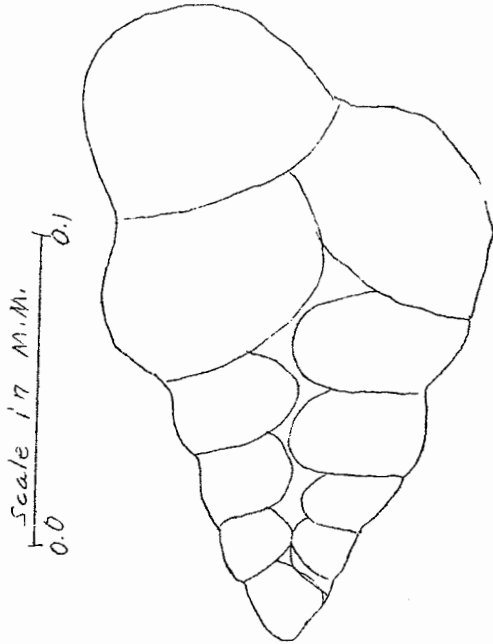


Sponge spicule

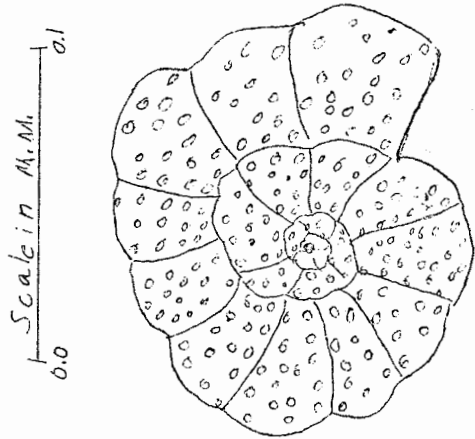


MENNO FORAMINIFERA

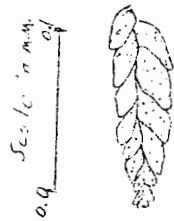
*Textularia globulosa* Ehrenburg



*Anamolina ammonoides* Reuss

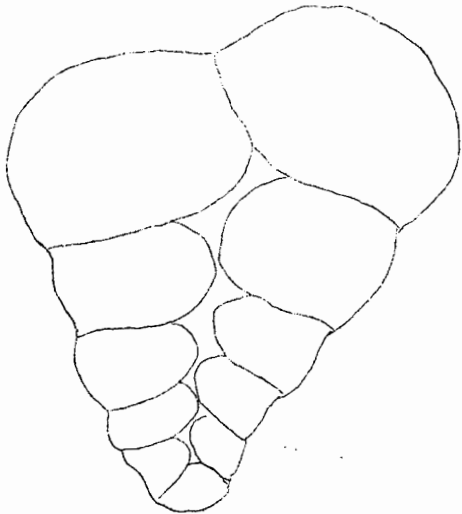


*Bolivina vicksburgensis* Cushman



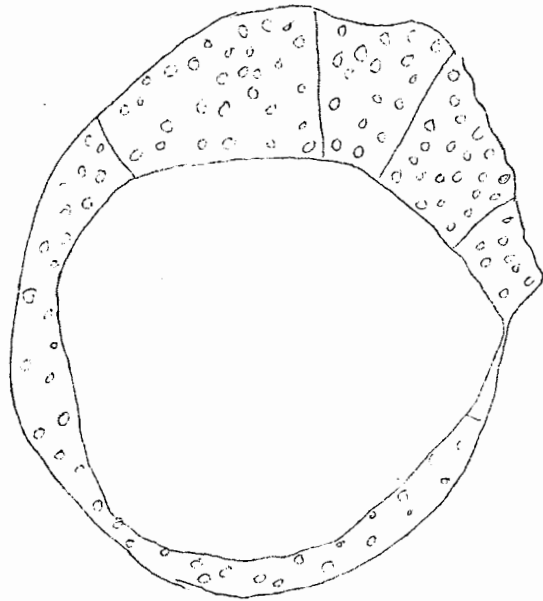
CHAMBERLAIN FORAMINIFERA

*Textularia globulosa* Ehrenburg



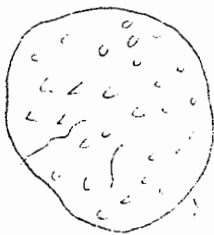
Scale in m.m.  
0.0. 0.1

*Anamolina ammonoides* Reuss



Scale in m.m.  
0.0 0.1

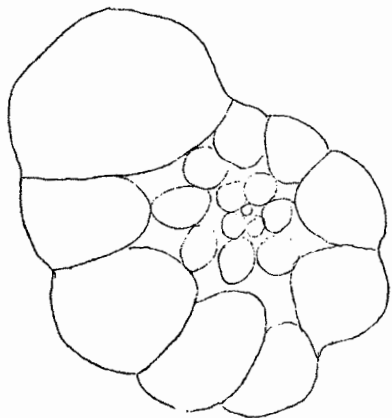
*Orbulina universa* d'Orbigny



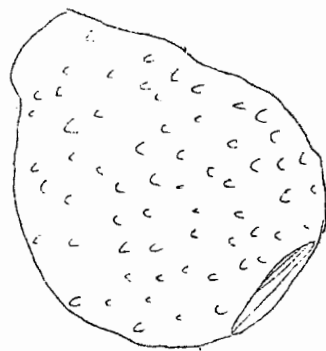
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GREENHORN FORAMINIFERA

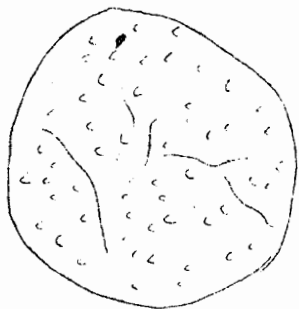
*Globigerina cretacea* d'Orbigny



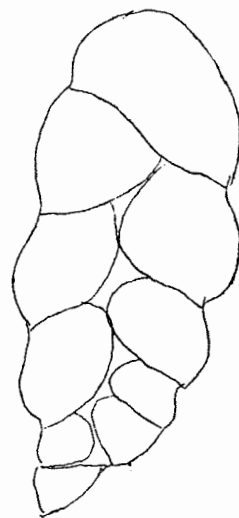
*Lagena hispida* Reuss



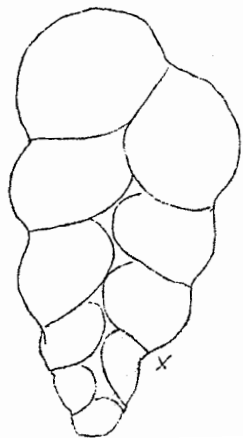
*Orbulina universa* d'Orbigny



*Textularia globulosa* Ehrenburg



*Textularia globulosa* Ehrenburg



Scale in mm.

