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LOWER CRETACEOUS ARENACEOUS FORAMINIFERA OF AUSTRALIA

BY

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SUMMARY

Arenaceous Foraminifera dominate the foraminiferal assemblages in the Lower Cretaceous sediments of Australia. The majority of species described in this Bulletin come from surface and subsurface sections within the Queensland part of the Great Artesian Basin, and their occurrences, for the most part, are referred to stratigraphical formations in the Basin. In addition, species have been described from samples from northern New South Wales and parts of South Australia and Western Australia. Well-known Lower Cretaceous megafossils give a clue to the stratigraphical position of many of the samples from which the foraminifera have been obtained.

Seventy-five species of arenaceous foraminifera are discussed; they belong to twenty-six genera. Twenty-three new species are described, eight of which belong to the genus *Ammobaculites.*

Many of the arenaceous forms show a close relationship with species described from the Lower Cretaceous deposits of northern Alaska, western Canada, and parts of the United States of America.

INTRODUCTION

Geological and palaeontological investigations of both surface and subsurface sediments as part of the Bureau of Mineral Resources programme of regional mapping, and stimulated by the intensified search for oil in Australia, and also aided by the continuous search for water, have allowed more satisfactory regional correlation of Lower Cretaceous rocks. Foraminiferal assemblages in these rocks are dominated by arenaceous tests. Characteristically, large numbers of these tests are poorly preserved—many are deflated, crushed, or distorted, making accurate specific and, at times, generic determination almost impossible. Nevertheless, in the absence of other diagnostic fossils, their presence does give some evidence of conditions of sedimentation at the time the rocks were deposited.

During regional mapping of the Lower Cretaceous, however, some collections of large numbers of very well preserved arenaceous Foraminifera have been made. The object of this Bulletin is to describe some of these forms, and thereby to facilitate the difficult task of correlation.

Little taxonomic investigation has been undertaken on the Lower Cretaceous Foraminifera in Australia, and no descriptive work has appeared since a publication by Crespin in 1953 on the Lower Cretaceous Foraminifera of the Great Artesian Basin. The earliest record of Lower Cretaceous Foraminifera in Australia was given by Charles Moore, who, in 1870, found species in beds at Wallumbilla, 24 miles east of Roma, Queensland. Howchin identified Foraminifera from bores in northern South Australia in 1884 and 1895. No further work was done until Crespin published a short paper on Lower Cretaceous Foraminifera from northern New South Wales in 1944. With the increased number of well-preserved specimens available for examination since 1953, some revision of the original descriptions given by Crespin in 1944 and 1953 has been necessary. Further observations are included in the present descriptions.

The arenaceous Foraminifera described in this Bulletin have been found in shales, siltstones, sandy siltstones, and sandstones collected by geologists of the Bureau of Mineral Resources, of State Geological Surveys, of the Water Conservation and Irrigation Commission of New South Wales, and of private companies engaged in the search for oil. The species are, as far as possible, referred to the formations in which they have been found, and no attempt has been made to correlate them with the European stages Aptian and Albian. The formation names used in this Bulletin and their relations are shown in Table 1.

TABLE 1

Correlation of Lower Cretaceous Formations referred to in text

Subdivisions			Great Artesian Basin					Western Australia
			Eastern		Western		Northern	
			Whitehouse (1955)		Casey (1959)	Reynolds (1960)	Laing & Power (1959, a, b); Laing (1960)	Belford (1958); Brunnschweiler (1959)
Cretaceous	Upper	Rolling Downs Group	Winton Fm.		Wilgunya	Winton Fm.		Upper Gearle Siltstone
Cretaceous	Lower	Rolling Downs Group	Tambo Fm.*		Wilgunya	upper Wilgunya* Formation	Normanton Fm.*	
Cretaceous	Lower	Rolling Downs Group	Tambo Fm.*	Coquina	Toolebuc Member	Toolebuc Member	Kamileroi Limestone	
Cretaceous	Lower	Rolling Downs Group	Non-sequence		Formation*	lower Wilgunya* Formation	Blackdown Fm.*	Windalia Radiolarite
Cretaceous	Lower	Blythesdale Group	Roma Fm.*		Formation*	lower Wilgunya* Formation	Blackdown Fm.*	Muderong Shale*
Cretaceous	Lower	Blythesdale Group	Transition Beds		(upper part)* Longsight Sandstone	(upper part)* Longsight Sandstone	Wrotham Park Sandstone Gilbert River Formation	Birdrong Sandstone
Upper Jurassic		Blythesdale Group	Transition Beds		(upper part)* Longsight Sandstone	(upper part)* Longsight Sandstone	Wrotham Park Sandstone Gilbert River Formation	Birdrong Sandstone

* Formations from which foraminifera have been described.

Whitehouse (1926, 1955), on the basis of ammonites, has given the Roma Formation an Aptian age and suggested a non-sequence between the Roma and Tambo Formations; he states that the Tambo Formation is mainly upper Albian, with a basal middle Albian coquina. Referring to samples from the Queensland part of the Great Artesian Basin from which many of the foraminifera were obtained, Dickins (1960) distinguished two faunas—a Roma Formation type and a Tambo Formation type; he did not, however, make any finer subdivisions. Subdivisions may be possible when more detailed work has been done. Ludbrook (1961), in the well completion report on Innamincka No. 1 Well, South Australia, has subdivided the Cretaceous into Winton Formation (Cenomanian), upper, middle and ?lower Albian rocks, Roma Formation equivalents (Aptian), and Aptian-Neocomian rocks. This subdivision was made after her work in Santos Oodnadatta No. 1 Bore, which yielded 960 feet of continuous core with megafossils; unfortunately the results of this work have not yet been published. For the time being, therefore, it is not possible to assign any ages other than 'Lower Cretaceous' to the species described in this Bulletin.

Brunnschweiler (1959), on the basis of the ammonites, gave an Aptian age for the Muderong Shale of the Carnarvon Basin, Western Australia, and Belford (1958), on the evidence of the microfossils, supported an Albian age for the lower part of the Gearle Siltstone.

Some specimens are also described from core 9 in BMR 4 Wallal Bore, Canning Basin. The age of these beds has not been definitely determined, but the affinities of the Foraminifera are with the Lower Cretaceous. However, the reference to age in this bulletin is given as Upper Jurassic or Lower Cretaceous.

All type and figured specimens are designated with the prefix CPC and are housed in the Commonwealth Palaeontological Collection, Canberra.

STRATIGRAPHICAL NOTES

The majority of the arenaceous Foraminifera described in this work came from the Lower Cretaceous sediments of the Great Artesian Basin in Queensland (Crespin, 1960, 1961). The relationships of the formations from which samples came are shown in Table 1.

Great Artesian Basin—eastern side

Roma Formation

The type locality of the Roma Formation is along Bungeworgorai Creek, 5 miles west of Roma and on both the north and south sides of the Great Western railway line (Whitehouse, 1955). The height of the cliffs ranges up to 30 feet. The sediments consist of blue shale, sandy siltstone, sandstone, and concretionary limestone, and contain microfossils. Carbonaceous fragments and some glauconite are usually present. Extensive collections of rocks were made by the writer in 1948 and 1949 from all available sections along the banks of Bungeworgorai Creek, and its tributary Clerk Creek, the sampling being done in measured intervals up the cliff faces. Only arenaceous foraminifera were found. Genera and species are few, but specimens are numerous; the assemblage is dominated by two species, *Ammobaculoides romaensis* and *A. pitmani.* Typical species are:

Ammobaculites australis (Howchin)
Ammobaculites subcretaceus Cushman & Alexander
Ammobaculoides pitmani Crespin
Ammobaculoides romaensis Crespin
Bigenerina loeblichae Crespin
Bimonilina variana Eicher
Haplophragmoides chapmani Crespin .
Haplophragmoides dickinsoni Crespin
Pelosina lagenoides Crespin
Spiroplectammina cushmani Crespin
Trochammina raggatti Crespin.

As regards the megafossils from the Roma area, recent material examined by Dickins (1960) yielded the following species of pelecypods: *Fissilunula clarkei, Maccoyella umbonalis, 'Natica' variabilis, Pseudavicula anomala,* and *Tatella aptiana.* This assemblage is similar to that found by Whitehouse (1955), who also records some ammonites, *Australiceras, Tropaeum, Aconoceras, Sanmartinoceras,* and belemnites, *Peratobelus* and *Tetrabelus.* R. Day of the University of Queensland is making a detailed study of the megafauna from the type Roma area, the results of which should be of considerable importance.

Tambo Formation

The area to which Whitehouse (1955) probably refers as the type area is now part of Jynoomah Station, which adjoins Minnie Downs on its northern boundary. According to Dickins (1960), megafossils found in this area include the pelecypods *Aucellina, Cyrenopsis, Grammatodon, Inoceramus, Maccoyella, Natica, Nucula, Trigonia,* and *'Yoldia'*; the ammonites *Beudantoceras,* cf. *Falciferella, Prohysteroceras*?; the belemnite *Dimitobelus*; scaphopods, fish scales, teeth, bone fragments, and fossil wood. Many of these forms are similar to those listed by Whitehouse (1955); he also records *Myloceras, Labeceras,* and *Hamites.*

The Foraminifera in the Tambo Formation include many calcareous species and only a few arenaceous forms. The latter are represented by:

Ammobaculites subcretaceus Cushman & Alexander
Haplophragmoides sp.
Hyperammina sp.
Trochammina minuta Crespin
Verneuilinoides kansasensis Loeblich & Tappan.

Great Artesian Basin—north-western margin

Upper Longsight Sandstone

The type area for the Longsight Sandstone is on Alderley Station north of Boulia, Lat. 22°17'S, Long. 140°17'E (Casey, 1959). The formation occurs as sporadic outcrops around the north-west edge of the Great Artesian Basin, but is more continuous within the Basin (Reynolds, 1960). The upper part of the formation is represented by a fossiliferous sandstone; the age is considered to be Lower Cretaceous and the beds equivalent to the Transition Beds of the Blythesdale Group. Recorded species of megafossils include *Fissilunula clarkei* and *Mytilus inflatus*, also *Maccoyella, Syncyclonema, Cyrenopsis*, and *Natica*, and belemnite moulds (Hill, 1960; Dickins, 1960).

Numerous well-preserved arenaceous Foraminifera were found in samples from Dribbling Bore on Sandringham Station and several new forms were recognized. The samples are from beds thought to be equivalent to the upper Longsight Sandstone.

The following Foraminifera have been recognized:

- *Ammobaculites exertus* sp. nov.
- *Ammobaculites implanus* sp. nov.
- *Ammobaculites australis* (Howchin)
- *Ammobaculites irregulariformis* Bartenstein & Brand
- *Ammobaculites subcretaceus* Cushman & Alexander
- *Ammobaculoides romaensis* Crespin
- *Bigenerina loeblichae* Crespin
- *Bimonilina variana* Eicher
- *Haplophragmoides chapmani* Crespin
- *Haplophragmoides gigas* Cushman
- *Dorothia grandis* sp. nov.
- *Psammosphaera parva* sp. nov.
- *Spiroplectammina cushmani* Crespin
- *Spiroplectammina enodis* sp. nov.
- *Trochammina minuta* Crespin
- *Trochammina raggatti* Crespin.

Wilgunya Formation

The type area for the Wilgunya Formation is 8 miles north-east of Dover Homestead, Lat. 22°32′S, Long. 140°50′E (Casey, 1959). Reynolds (1960) divided the formation into an upper part, which included the Toolebuc Limestone Member at or near its base, and a lower part. The lithology, mainly grey siltstone, does not vary much between the upper and lower parts, but the assemblages of megafossils are quite different.

The lower part contains ?*Cyrenopsis, Fissilunula, Maccoyella, 'Mytilus'*, ?*Thracia, Syncyclonema* (Hill, 1960; Dickins, 1960)—forms common in the Roma Formation. Arenaceous tests, excellently preserved, dominate the foraminiferal assemblage found in the lower Wilgunya. Species including several new forms:

- *Ammobaculites fisheri* Crespin
- *Ammobaculites goodlandensis* Cushman & Alexander
- *Ammobaculites australis* (Howchin)
- *Ammobaculites minimus* Crespin
- *Ammobaculites erectus* sp. nov.

Ammobaculites subcretaceus Cushman & Alexander
Ammobaculites torosus Loeblich & Tappan
Ammodiscus cretaceus (Reuss)
Ammodiscus glabratus Cushman
Bimonilina variana Eicher
Flabellammina alexanderi Cushman
Flabellammina reynoldsi sp. nov.
Flabellammina vitrea sp. nov.
Glomospirella gaultina (Berthelin)
Haplophragmoides arenatus sp. nov.
Haplophragmoides chapmani Crespin
Haplophragmoides cushmani Loeblich & Tappan
Haplophragmoides dickinsoni Crespin
Haplophragmoides gigas Cushman
Haplophragmoides wilgunyaensis sp. nov.
Pelosina lagenoides Crespin
Reophax deckeri Tappan
Saccammina globosa sp. nov.
Saccammina aff. *lagenaria* (Berthelin)
Spiroplectammina cushmani Crespin
Spiroplectammina aequabilis sp. nov.
Spiroplectammina edgelli Crespin
Textularia anacooraensis Crespin
Textularia wilgunyaensis sp. nov.
Triplasia australiae sp. nov.
Trochammina depressa Lozo
Trochammina minuta Crespin
Trochammina raggatti Crespin
Verneuilina howchini Crespin
Verneuilinoides asperulus sp. nov.

In the upper part of the Wilgunya Formation, the megafossils *Beudanticeras,* cf. *Falciferella, Labeceras, Myloceras, Aucellina, Grammatodon, Inoceramus, 'Yoldia'* (Dickins, 1960), have been found: an assemblage similar to that in the Tambo Formation. Foraminifera are not common in the upper part of the Wilgunya Formation. The following arenaceous species have been recognized:

Ammobaculites subcretaceus Cushman & Alexander
Ammodiscus sp.
Haplophragmoides spp.
Hyperammina sp.
Trochammina delicatula sp. nov.
Trochamminoides coronus Loeblich & Tappan
Verneuilinoides kansasensis Loeblich & Tappan

The Toolebuc Limestone Member occurs near the base of the upper part of the Wilgunya Formation. It is a laminated and thin-bedded sandy calcarenite, calcareous siltstone, and coquinite lens containing calcareous concretions (Casey, 1959). It occurs in a belt one to eight miles wide along the east side of the Hamilton River from Toolebuc Station in the north-east to the junction of the Hamilton and Georgina Rivers. The ammonites listed above from the upper part of the Wilgunya Formation are also present in the Toolebuc Limestone and are associated with large numbers of *Inoceramus* and *Aucellina* and plentiful fish remains. The microfauna is a pelagic one in which the planktonic genus *Globigerina* (*G. planispira* Tappan and *G. infracretacea* Glaessner) is usually abundant.

Great Artesian Basin—Carpentaria Sub-basin

Formations in the Carpentaria Sub-basin were subdivided and named by Laing & Power (1959 a, b). Laing later (1960) prepared a generalized section of their formations as shown in Table 1 of this report; their subdivisions are correlated with other subdivisions on the basis of lithological and megafossil assemblage similarities.

The relationship of the formations in ZCL No. 1 Bore, Weipa, FBH No. 1, Wyaaba Well, and AAO No. 8, Karumba Well, is shown in Table 2. This Table is adapted from Plate 2 of Laing's (1960) report on the Karumba AAO No. 8 Bore, northern Queensland, of Associated Australian Oilfields N.L. It shows the well correlations used by Associated Australian Oilfields for the Carpentaria Sub-basin, along the east shore of the Gulf of Carpentaria from Karumba in the south to Weipa in the north. Depths on the table are in feet, and are marked "a" where estimated from Plate 2 of Laing (1960).

The various formations are considered briefly below. Microfossils have been placed into formations on the basis of the subdivisions of Laing (1960) given in Table 2.

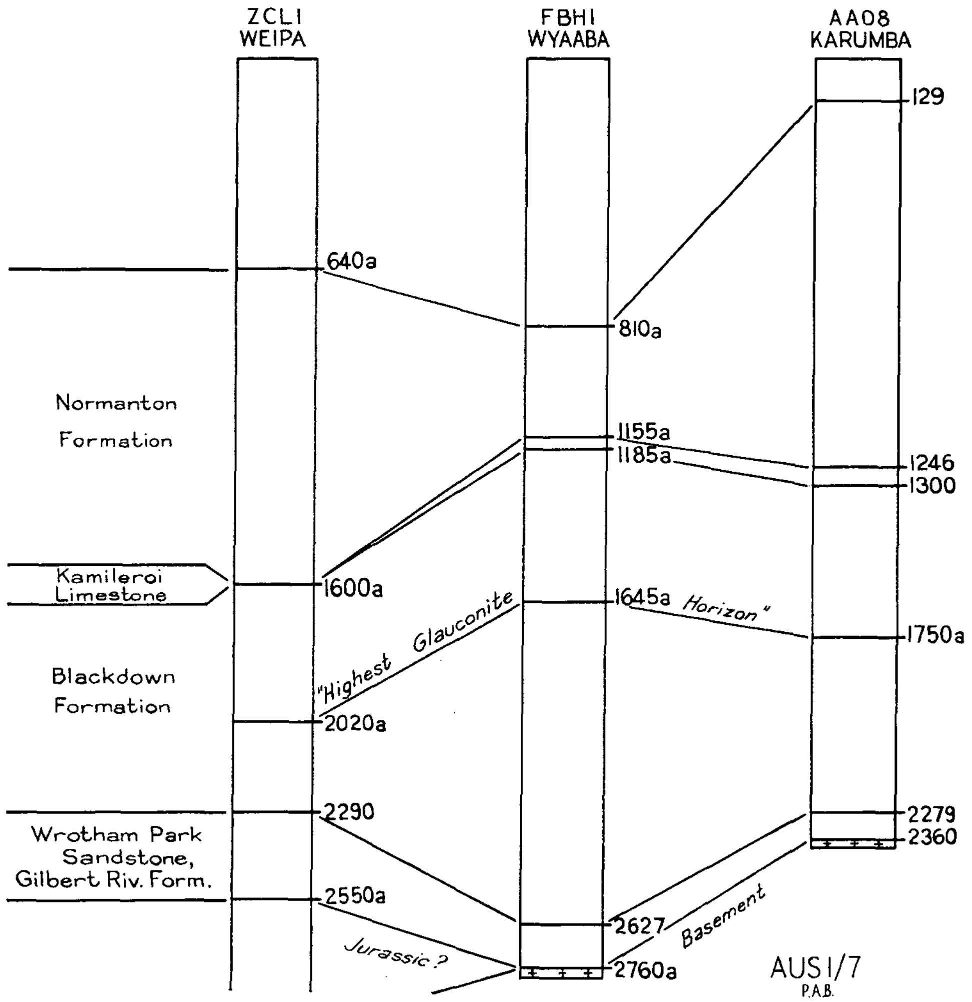

TABLE 2

Well correlations used by Associated Australian Oilfields, N.L., for Carpentaria Sub-basin. Depths in feet, marked "a" where estimated from Plate 2 of Laing (1960).

Wrotham Park Sandstone

The type area is eight miles south of Wrotham Park Homestead on the Chillagoe road. The rocks are red current-bedded feldspathic sandstone, partly conglomeratic. No fossils have been found.

The Gilbert River Formation, regarded by Laing (1960) as equivalent to the Wrotham Park Sandstone, has its type area 18 miles east of Croydon on the Georgetown road. It consists of interbedded conglomerate, grit, sandstone, and siltstone. Fossils include *Rhynchonella, Maccoyella, Peratobelus*; and plant remains, *Ptilophyllum, Elatocladus*, and *Williamsonia.*

Blackdown Formation

The type area is Elizabeth Creek, from the road and telegraph crossing to the Walsh River. The formation consists mainly of grey shale with calcareous concretionary bands and minor fine lithic sandstone, and some glauconitic fine sandstone in the bottom part. Megafossils identified by Whitehouse (in Laing, 1960) include *Pachydomella, Australiceras, Cinula, Dentalium, Macrocallista,* and *'Cyrenopsis'.* Crespin (1956) identified the following arenaceous foraminifera from Elizabeth Creek, near Wrotham Park Station:

Ammomarginulina sp.
Ammobaculites fisheri Crespin
Ammobaculites minimus Crespin
Ammodiscus cretaceus (Reuss)
Haplophragmoides sp. nov.
Pelosina lagenoides Crespin
Trochammina minuta Crespin
Trochammina raggatti Crespin.

Kamileroi Limestone

The type area is near Kamileroi Homestead, south part of Carpentaria Sub-basin. The rocks consist of grey to pink limestone up to 20 feet thick, rich in fossils such as *Inoceramus, Dimitobelus,* and vertebrate fragments.

Normanton Formation

The type area is at Normanton and the Little Bynoe Crossing at Magoura in the southern part of Carpentaria Sub-basin. The formation, the top of which is lateritized at Normanton, consists of grey lithic sandstone, and dark grey siltstone and shale, with hard calcareous concretionary bands mainly in sandstone. Whitehouse (in Laing, 1960) identified the following megafossils: *Cyrenopsis*?, *Cymatoceras, Beudanticeras, Cophinoceras*?, *Myloceras*, and *Appurdiceras.*

Great Artesian Basin—northern New South Wales

Although the depths of the samples from the four bores from which arenaceous Foraminifera described in this work are known (Crespin, 1955a), stratigraphic sections were not obtained. These species cannot, therefore, be correlated with any of the known formations in the Lower Cretaceous. However, the recognition of characteristic Roma species, *Ammobaculoides romaensis* Crespin and *A. pitmani* Crespin, in Water Conservation and Irrigation Commission bores Nos. 8264, 6763, and 8271 (Crespin, 1956), and the new species *Ammobaculites exertus* described later in this work, suggests that the beds may be low in the Lower Cretaceous sequence. The following arenaceous Foraminifera are identified from the bores:

Ammomarginulina sp.
Ammobaculites australis (Howchin)
Ammobaculites exertus sp. nov.
Ammobaculites fisheri Crespin
Ammobaculites minimus Crespin
Ammobaculites succinctus sp. nov.
Ammobaculoides pitmani Crespin
Ammobaculoides romaensis Crespin
Ammodiscus cretaceus (Reuss)
Glomospirella cf. *gaultina* (Berthelin)
Haplophragmoides chapmani Crespin
Haplophragmoides dickinsoni Crespin
Haplophragmoides sp. *A*
Hyperammina sp.
Miliammina sproulei Nauss var. *gigantea* Mellon & Wall
Spiroplectammina cushmani Crespin
Spiroplectammina edgelli Crespin
Textularia anacooraensis Crespin
Trochammina minuta Crespin
Trochammina raggatti Crespin
Verneuilina howchini Crespin
Verneuilinoides kansasensis Loeblich & Tappan.

Great Artesian Basin—north-east South Australia and southern Northern Territory

Divisions of Lower Cretaceous formations in the Great Artesian Basin in South Australia have been based on Whitehouse's (1955) subdivisions in the Queensland part of the basin (G.S.A., 1958). The sample at 1907 feet from the Koppera-manna Bore, according to Sprigg and others (G.S.A., 1958), may be equivalent of the Tambo Formation; Foraminifera from this bore were previously listed by Crespin (1949).

The Anacoora Bore is in southern Northern Territory. According to lithology in which artesian water was obtained at 1127 feet (Ward, 1946)—'fine grained siliceous sand'—it is possible that the samples from 830-840 feet were in beds equivalent to the Roma Formation; but the evidence is not sufficient to assign the samples to any formation. Crespin (1946) has listed Foraminifera from the Anacoora Bore.

Eucla Basin, South Australia

The Cook Bore in the Eucla Basin yielded Lower Cretaceous Foraminifera at 423 and 604 feet (Crespin, 1955b). Lower Cretaceous shales in the Eucla Basin may be equivalent to the Tambo Formation (G.S.A., 1958), but not enough is known to assign the above samples to any formation.

Western Australia

Muderong Shale

The type section for the Muderong Shale is in a scoured gully on the northern slope of an isolated hill at Lat. 24°08'S, Long. 114°45¾'E, one mile south-west of Muderong Bore, Carnarvon Basin (Condon, 1954). The rock varies from silty sandstone to silty shale. The age is regarded as Aptian (Brunnschweiler, 1959). Few Foraminifera have been found. The species described in this work come from a silty sandstone at a locality (MG. 224, 18 miles south of Middalya) not far from the type section.

Lower Gearle Siltstone

The type section of the Gearle Siltstone is in the upper part of C. Y. Creek on the western limb of the Giralia Anticline, at Lat. 22°54'S, Long. 114°09'E, Carnarvon Basin (Condon, 1954). In subsurface sections in WAPET wells at Rough Range a great thickness of sediments was referred to this formation and it is possible that only the lower part of the subsurface section is to be correlated with the outcrop: the Foraminifera recorded from the upper beds in the subsurface sections are not known from the outcrop section.

Bore BMR 4 *Wallal, Canning Basin, Core* 9 *at* 888-898 *feet*

A rich assemblage of arenaceous Foraminifera was found in core 9 from BMR 4 Wallal. Whether the beds are basal Lower Cretaceous or uppermost Jurassic has not yet been satisfactorily determined, but the affinities of the foraminiferal assemblage are with the Lower Cretaceous. Some of the foraminifera recognized in this assemblage are as follows:

Ammobaculites fisheri Crespin
Ammobaculites minimus Crespin
Ammobaculites wallalensis sp. nov.
Reophax deckeri Tappan
Reophax torus sp. nov.
Reophax sp.
Haplophragmoides spp.
Hyperammina sp.
Psammosphaera cf. *parva* sp. nov.
Psamminopelta cf. *bowsheri* Tappan.

SUGGESTED FORAMINIFERAL ENVIRONMENTS

Observations given here on the probable depositional environments which controlled the microfaunal assemblages in the Lower Cretaceous rocks of the Great Artesian Basin are based primarily on evidence from the examination of extensive collections of rocks made by geologists of the Bureau of Mineral Resources field parties from localities within the 1:250,000 Sheet areas covering Boulia, Springvale, Glenormiston, Gilberton, and Mount Whelan, and the Tambo and Roma areas. Samples from wells drilled for oil by private companies and from water bores by Mines Departments and Water Commissions of the States in the northern, southern, and south-western portions of the Basin have also been examined.

The environments in Lower Cretaceous times in Australia fit well into the three divisions given by Tappan (1960, p. 277) in her work on the Cretaceous of Northern Alaska. The close similarity of depositional environments found in the Lower Cretaceous of northern Alaska, Central and Western Canada, and parts of Northern United States, as in Wyoming, with those found in Australia is most striking.

The three divisions relating to 'Offshore facies' are:

1. Inner sublittoral environment.
2. Outer sublittoral environment.
3. Open sea environment.

Inner sublittoral environment. This environment is indicated by the predominance of arenaceous Foraminifera, as found in surface and some subsurface samples from beds equivalent to the Roma Formation and the lower part of the Wilgunya Formation. It is an environment of high turbidity and considerable turbulence with low salinity, with the result that calcareous foraminifera are rare or absent. Megafossils found associated with this arenaceous assemblage include cephalopods and pelecypods. The microfauna is typical of turbidity facies, with large and robust forms predominant. Stainforth (1952) pointed out that the families characteristic of this environment include the Rhizamminidae, Reophacidae, Ammodiscidae, Lituolidae, Textulariidae, Verneuilinidae and Valvulinidae. All these are represented in the beds of the Roma Formation and the lower Wilgunya Formation of the Great Artesian Basin. Probably similar conditions of environment existed in parts of the Carnarvon Basin, especially during the deposition of the Aptian Muderong Shale, in which coarse arenaceous foraminiferal tests are characteristic.

Outer sublittoral environment. In some subsurface sections throughout the Great Artesian Basin, in certain beds equivalent to the Roma and the lower part of the Wilgunya Formations, the foraminiferal assemblage is more diversified, and calcareous and arenaceous foraminifera occur in nearly equal abundance. This aspect is especially noticeable in bores in the north, south, and south-western portions of the Basin. There are indications of decreasing turbidity and increasing salinity in the presence of calcareous forms belonging to the Nodosariidae, Buliminidae, Virgulinidae, and some Rotalinidae.

Open-sea environment. A striking change in environment is noticeable in the faunas of the overlying Tambo Formation and the upper part of the Wilgunya Formation. The change to open-sea conditions has brought about a considerable lessening of turbidity and increase of salinity. Typical megafossils include ammonites, *Inoceramus*, fish bone fragments. In the Toolebuc Limestone Member of the Wilgunya Formation and its equivalents in northern and south-western Queensland, the foraminiferal assemblage is dominated entirely by minute to small tests of the planktonic genus *Globigerina.* This open-sea environment extends northward from localities in the Boulia area to the northern margin of the Great Artesian Basin. Along the southern and eastern edge of the Gulf of Carpentaria, this influx of Globigerinids forms a characteristic horizon in some of the bores in that region.

Eicher (1960, p. 45) commented that assemblages of entirely arenaceous species, such as are found in the *Haplophragmoides gigas* zone of the Lower Cretaceous Thermopolis Shale of Wyoming, 'are uncommon and one so large as the *H. gigas* fauna is most unusual'. He recorded 24 species of arenaceous Foraminifera throughout the upper shale. Stelck & Wall (1956, p. 17) recorded 17 species from the *Haplophragmoides gigas* zone in the Middle Albian of Western Canada. *H. gigas* is found in the lower part of the Wilgunya Formation in western Queensland in association with 20 species, but it does not occur in such abundance and with such persistance as to be of zonal importance.

SYSTEMATIC DESCRIPTIONS

Family RHIZAMMINIDAE

Genus RHIZAMMINA H. B. Brady, 1879

RHIZAMMINA sp.

(Pl. 1, Figs. 2, 3)

The specimens referred to the genus *Rhizammina* consist of a flattened tube with a chitinous lining to which is attached grains of angular quartz and other material.

Occurrence: Figured specimens A, B (CPC 4406, 4407) from Coogiebung Tank, Marion Downs, western Queensland (W. 26).

Formation: lower Wilgunya.

Genus BATHYSIPHON M. Sars, 1872

BATHYSIPHON sp.

(Pl. 1, Fig. 1)

This form, with its long slender tubular chamber which is covered with a few transverse growth wrinkles, closely resembles *Bathysiphon brosgei* Tappan (1957) from the Albian beds of northern Alaska. Many fragments have been found in beds referable to the lower Wilgunya Formation of western Queensland, but none are complete enough for definite specific determination.

Occurrence: Figured specimen (CPC 4408) from Coogiebung Tank, Marion Downs, western Queensland (W. 26).

Formation: lower Wilgunya.

Genus PSAMMOSPHAERA Schultze, 1879

PSAMMOSPHAERA PARVA sp. nov.

(Pl. 1, Figs. 4-9)

Diagnosis: A small compressed oval to rounded finely arenaceous test consisting of one chamber with a small slit-like aperture at one end.

Description: Test small, compressed, oval to rounded in outline depending on amount of compression during fossilization, consisting of one chamber with a small slit-like apertural opening at one end. Wall thick, composed entirely of very fine siliceous material. Surface smooth. Slit-like aperture surrounded by a thickened lip in some specimens.

Dimensions (in mm.):

	Max. width	Length
Holotype	0·57	0·51
Paratype A	0·53	0·55
Paratype B	0·63	0·61
Paratype C	1·09	0·75

Thickness of wall in Paratype D, 0·09 mm.

Remarks: The tests of this small species vary in size and in the amount and direction of compression. The direction of compression in Paratype C has revealed a thickened lip surrounding the aperture.

Occurrence: Holotype (CPC 4409) and paratypes A,B,C,D (CPC 4410, 4411, 4412, 4413) from Dribbling Bore, Sandringham, western Queensland, at 470-489 feet.

Formation: upper Longsight Sandstone.

Family SACCAMMINIDAE

Genus SACCAMMINA M. Sars 1869

SACCAMMINA ALEXANDERI (Loeblich & Tappan), 1950

(Pl. 1, Fig. 10-12)

Proteonina alexanderi Loeblich & Tappan, 1950, *Univ. Kansas, paleont. Contr.*, Art. 3, p. 5, pl. 1, figs. 1*a, b*; 2*a, b*.

Saccammina alexanderi (Loeblich & Tappan), Eicher, 1960, *Peabody Mus. nat. Hist. Bull.* 15, p. 55, pl. 3, figs. 1, 2.

Description: Test free, consisting of a single flask-shaped chamber, apertural end extending into a neck; some specimens compressed. Wall thick, coarsely arenaceous, the sand grains at times covering the apertural neck. Surface rough. Aperture terminal, rounded.

Remarks: The figured specimens closely resemble *Saccammina alexanderi* (Loeblich & Tappan). The very coarse arenaceous test is a distinctive character not strongly represented in the figures given by Eicher (1960). Loeblich &

Tappan (1955) indicated that the genus *Proteonina* is no longer valid; consequently the most appropriate genus to which this form can be referred is *Saccammina* M. Sars, 1869.

Occurrence: Hypotypes A and B (CPC 4414, 4415) from WAPET Rough Range No. 4 Well, Carnarvon Basin, W.A., core 12, at 3640 feet. Hypotype C (CPC 4416) from Netting Bore, Paton Downs, western Queensland.

Formations: Muderong Shale; lower Wilgunya.

SACCAMMINA GLOBOSA sp. nov.

(Pl. 1, Fig. 13-17)

Diagnosis: Test lageniform in shape, composed of one large globular chamber with an apertural neck. Wall coarsely arenaceous, sand grains continuing up apertural neck. Aperture round.

Description: Test lageniform, consisting of one globular chamber, at times compressed, with an apertural neck. Wall coarsely arenaceous, composed of fine to coarse angular to subangular quartz grains in siliceous cement, extending up apertural neck. Surface rough. Aperture round, opening at end of neck which is in some specimens lined with chitinous material.

Dimensions (in mm.):	Length	Max. width
Holotype	1·27	1·07
Paratype A	0·80	0·61
Paratype B	1·19	1·00
Paratype C	1·09	1·04

Remarks: *Saccammina globosa*, with its very coarse globular test, cannot be compared with any described species from the Lower Cretaceous. Its coarse texture somewhat resembles that of *S. arenosa* (Crespin) from the Permian. Its globular shape separates it from *S. alexanderi* Loeblich & Tappan. The species has hitherto only been found in the lower part of the Wilgunya Formation of western Queensland.

Occurrence: Holotype (CPC 4417) and paratype B (CPC 4419), from Coogiebung Tank, Marion Downs, western Queensland (W. 26). Paratype A (CPC 4418), west of Momedah Anticline near track, south side of Momedah Creek, 4 miles north-north-west of Little Bore, St Lucia, western Queensland (B. 705c). Paratype C (CPC 4420), Mount Whelan, western Queensland (W. 40).

Formation: lower Wilgunya.

SACCAMMINA sp. aff. LAGENARIA (Berthelin), 1880

(Pl. 1, Fig. 18)

Haplophragmium lagenarium Berthelin, 1880, *Mém. Soc. géol. France,* 3 (1), 5, p. 21, pl. 1, figs. 2*a, b.*

This coarsely arenaceous, flask-shaped test resembles in shape and texture the species described by Berthelin from the Albian.

Occurrence: Figured specimen (CPC 4421) from 11 miles south-west of 8 mile Yard, near track to Whitewood Tank on Herbert Downs, western Queensland (W. 206.)

Formation: lower Wilgunya.

Genus PELOSINA H. B. Brady, 1879

PELOSINA LAGENOIDES Crespin, 1953

(Pl. 1, Figs. 19, 20)

Pelosina lagenoides Crespin, 1953, *Contr. Cushm. Fdn foram. Res.,* 4 (1), p. 28, pl. 5, fig. 1.

This small compressed, flask-shaped species with its finely arenaceous test is widely distributed in the Lower Cretaceous in Australia. Although the genus *Pelosina* is defined as having a chitinous inner layer, this layer is often not observed in fossil specimens.

Occurrence: Hypotype A (CPC 4422) from FBH No. 1 Bore, Wyaaba, north Queensland, Core 3 at 2229 feet. Hypotype B (CPC 4423) Broken Dam Bore, Canary Station, western Queensland, at 51-53 feet.

Formations: Blackdown; lower Wilgunya.

Genus SACCULINELLA Crespin, 1958

SACCULINELLA sp.

(Pl. 1, Figs. 21, 22)

This small, finely arenaceous, compressed and sack-shaped test is referred to the genus *Sacculinella*, described by Crespin (1958) from the Permian of Western Australia. The test of the Lower Cretaceous form is covered with irregular ridges running parallel with the short axis. The genus has not been recognized previously in beds younger than the Permian.

Occurrence: Figured specimen (CPC 4423) from 1 Mile Creek, 7 miles west-south-west along fence from Rocky Waterhole on Sherbrook (Jewlery) Creek, western Queensland (W. 69).

Formation: lower Wilgunya.

Family HYPERAMMINIDAE

Genus HYPERAMMINA Cushman, 1928

HYPERAMMINA cf. BARKSDALEI (Tappan), 1957

(Pl. 2, Fig. 5)

Hyperamminoides barksdalei Tappan, 1957, *U.S. nat. Mus. Bull.* 215, p. 202, pl. 65, figs. 6-12.

This species with its flattened, elongate, somewhat flaring, wrinkled, undivided tubular chamber, closely resembles Tappan's figure 12 of *H. barksdalei* from the Albian of northern Alaska. The figured specimen (CPC 4425) was found in the Kopperammana Bore, north-east South Australia, at the depth of 1907 feet (equivalent of Roma or Tambo Formation).

HYPERAMMINA sp. A

(Pl. 2, Fig. 1)

A single specimen of this form, with its thin wall, rapidly expanding chamber, and broad apertural opening, resembles the Permian species *H. hadzeli* Crespin, 1958. The figured specimen (CPC 4426) was found in a sample from Union-Kern-AOG Cabawin No. 1 Well, Queensland, at the depth of 700-710 feet, in beds referable to the top part of the Aptian Roma Formation.

HYPERAMMINA sp. B

(Pl. 2, Figs. 2, 3)

Two specimens of *Hyperammina*, with gently tapering tests and thick walls, show no resemblance to any species described from the Lower Cretaceous. The figured specimens (CPC 4427, 4428) were found in FBH No. 1 Wyaaba Well, north Queensland, in core 3 at 2229 feet, in beds equivalent to Blackdown Formation.

HYPERAMMINA sp. C

(Pl. 2, Fig. 4)

This long, tapering, thin-walled test shows some resemblance to *H. elegans* (Cushman & Alexander) 1928, from the Permian of Texas. The figured specimen (CPC 4429) came from FBH No. 1 Wyaaba Well, north Queensland, core 3, at 2232 feet, in beds equivalent to the Blackdown Formation.

Family REOPHACIDAE

Genus REOPHAX Montfort, 1808

REOPHAX DECKERI Tappan, 1940

(Pl. 3, Figs. 1-10)

Reophax deckeri Tappan, 1940, *J. Paleont.*, 14 (2), p. 94, pl. 14, figs. 3*a*, *b*.

Reophax eckernex Vieaux, 1941, *J. Paleont.*, 15 (6), p. 625, pl. 10, fig. 1.

Reophax deckeri Tappan, Tappan, 1943, *J. Paleont.*, 17 (5), p. 479, pl. 77, fig. 3.

Reophax scorpiurus Bartenstein & Brand, 1951 (*non* Montfort, 1808), *Abh. senck. naturf. Ges.*, 485, p. 266, pl. 1, figs. 9-11.

Reophax deckeri Tappan, Frizzell, 1954, *Texas Bur. econ. Geol. Rep. Invest.*, 22, p. 57, pl. 1, figs. 7*a*, *b*.

Reophax eckernex Vieaux, Frizzell, 1954, *Texas Bur. econ. Geol. Rep. Invest.*, 22, p. 57, pl. 1, fig. 9.

Description: Test free, medium sized, elongate, consisting of a linear series of chambers followed by a well developed apertural neck. Chambers 2 to 4, in some specimens increasing rapidly in size, with the last chamber generally much larger than preceding one. Well preserved specimens round in cross section. Sutures straight, distinct, depressed. Wall coarsely arenaceous, consisting usually of large angular to subangular quartz grains in siliceous cement, the quartz grains extending up wall of neck in some specimens. Aperture circular opening at end of neck.

Dimensions (in mm.):

	Length	Max. width	Width of smallest chamber
Hypotype A	1·24	0·60	0·35
Hypotype B	0·93	0·41	0·32
Hypotype C	0·97	0·46	0·29
Hypotype D	1·28	0·36	0·24
Hypotype E	1·40	0·63	—
Hypotype F	1·65	0·80	0·47
Hypotype G	1·24	0·73	0·32
Hypotype H	1·07	0·51	0·20
Hypotype I	1·37	0·77	0·39
Hypotype J	0·92	0·41	0·27

Several hypotypes are figured to show the wide variation within the species. The specimen shown on Plate 3, Figure 4, is more regular in shape, but when compared with Tappan's figures of the species, there is little doubt that this form comes within it.

Occurrence: Hypotypes A, B, E (CPC 4430, 4431, 4434) from Coogiebung Tank, Marion Downs, western Queensland (W. 26). Hypotype C (CPC 4432) from Peanungra Well, Glenormiston, western Queensland. Hypotype D (CPC 4433) from 12 Mile Tank, Marion Downs, western Queensland, 0-4 feet above base (GAB. 304a). Hypotype F (CPC 4435) from WAPET Rough Range No. 4 Well, Carnarvon Basin, Western Australia, core 12, at 3440 feet. Hypotypes G, H, I, J (CPC 4436, 4437, 4438, 4439) from BMR 4 Wallal Bore, Canning Basin, Western Australia, from core 9 at 888-898 feet.

Formations: lower Wilgunya; Muderong Shale. Age of Hypotypes G-J, Upper Jurassic or Lower Cretaceous.

REOPHAX TORUS sp. nov.
(Pl. 4, Figs. 1-7)

Diagnosis: Test is stout, straight, gently tapering or with sides almost parallel. It consists of three chambers, the initial end of the test being a group of quartz grains, followed by two inflated chambers, the third or last formed chamber subpyriform. The wall is composed of large quartz grains in much cement.

Description: Test medium sized, straight, stout, elongate, gently tapering or with sides almost parallel, consisting of initial end followed by three chambers usually inflated and almost rounded in cross section. Initial end a group of quartz grains followed by two chambers which increase in height but little in width, the third or last formed chamber large, globular, and subpyriform in shape with greatest width through central portion. Sutures distinct, depressed, usually straight. Wall coarsely arenaceous, with large rounded to angular quartz grains embedded in much siliceous cement. Surface rough. Aperture simple rounded, terminal, central in last-formed chamber.

Dimensions (in mm.):

	Length	Width at initial end	Width at apertural end
Holotype	1·47	0·31	0·64
Paratype A	1·89	0·83	0·53
Paratype B	2·35	0·93	0·93
Paratype C	1·71	—	0·67
Paratype D	1·35	0·40	0·53
Paratype E	0·88	—	0·43
Paratype F	0·73	0·35	0·33

The figured specimens show the variation within the species. However, the subpyriform shape of the apertural chamber, with its greatest width at about the centre of the chamber, remains constant. The specific name is taken from the Latin *torus*, meaning bulge, protuberance.

Occurrence: Holotype (CPC 4440) and paratypes A and B (CPC 4441, 4442) from Middalya Station, 18 miles south of Homestead and 19½ miles north-easterly from Hill Springs Homestead, Carnarvon Basin, Western Australia, Lat. 24°09′24″ S, Long. 114°45′45″ E (MG. 224). Paratype C (CPC 4443) from WAPET Rough Range No. 4 Well, Carnarvon Basin, Western Australia, core 17 at 3715 feet. Paratype D (CPC 4444) from Coogiebung Tank, Marion Downs, western Queensland (W. 26). Paratypes E and F (CPC 4445, 4446) from BMR 4 Wallal Bore, Canning Basin, Western Australia, core 9 at 888-898 feet.

Formations: Muderong Shale; lower Wilgunya. Age of paratypes E and F, Upper Jurassic or Lower Cretaceous.

REOPHAX sp. A

(Pl. 4, Fig. 8)

This small form, with its curved and finely arenaceous test consisting of five chambers gradually increasing in height, does not resemble any described species of *Reophax* from the lower Cretaceous.

Occurrence: Figured specimen (CPC 4447) W.C. and I.C. Bore 8271, northern New South Wales, at 1000 feet.

Age: Lower Cretaceous.

Reophax sp. B

(Pl. 4, Figs. 9, 10)

This small delicate form of *Reophax* consists of four linear chambers which may taper gradually or sharply. The variation is shown in the two figured specimens.

Occurrence: Figured specimens A and B (CPC 4448, 4449) from Coogiebung Tank, Marion Downs, western Queensland (W. 26).

Formation: lower Wilgunya.

Reophax sp. C

(Pl. 4, Figs. 11, 12)

This unusually coarse arenaceous species of *Reophax* shows no indication of chambers. It may represent a coarse-grained variety of *R. deckeri*.

Occurrence: Figured specimens A and B (CPC 4450, 4451) from BMR 4 Wallal Bore, Canning Basin, Western Australia, core 9 at 888-898 feet.

Age: Upper Jurassic or Lower Cretaceous.

Family Ammodiscidae

Genus Ammodiscus Reuss, 1861

Ammodiscus cretaceus (Reuss), 1845

(Pl. 2, Figs. 6, 7)

Operculina cretacea Reuss, 1845, *Verst. böhm. Kreide.*, 1, p. 35, pl. 13, figs. 64-65.

Cornuspira cretacea (Reuss), Reuss, 1860, *Akad. Wiss. Wien, math.-naturwiss. Kl.*, 40, p. 177, pl. 1, fig. 1.

Ammodiscus cretaceus (Reuss), Cushman, 1946, *U.S. geol. Surv., prof. Pap.* 206, p. 17, pl. 1, fig. 34.

Ammodiscus rotalarius Crespin, 1953, (*non* Loeblich & Tappan, 1949), *Contr. Cushm. Fdn foram. Res.*, 4 (1), p. 29, pl. 5, fig. 2.

Involutina cretacea (Reuss), Belford, 1960. *Bur. Min. Resour. Aust. Bull.* 57, p. 22, pl. 6, fig. 1.

Involutina cretacea (Reuss), Takayanagi, 1960, *Sci. Rep. Tohoku Univ., 2nd ser. (Geol.)*, 32 (1), p. 67, pl. 1, figs. 10*a*-12.

Well preserved specimens of *A. cretaceus* are difficult to obtain; most are crushed or distorted. Variation in size of tests can be seen within one sample. *A. rotalarius* Loeblich & Tappan, 1949, with its finely arenaceous wall composed of considerable cement, its rounded periphery, and the regular coiling of the tubular second chamber, may be synonomous with *A. cretaceus.*

A. cretaceus, although described from the Upper Cretaceous, is widely distributed throughout the Cretaceous. It is recorded from the Lower Cretaceous Gault of Europe.

Occurrence: Hypotype A (CPC 4452) from small section of blue gypsiferous clay, 3 miles south of Carlo Springs, Glenormiston Station, western Queensland, (W. 32). Hypotype B (CPC 4453) 4 miles north-west of Kidman's Bore, Marion Downs, western Queensland (W. 80).

Formation: lower Wilgunya.

Ammodiscus glabratus Cushman & Jarvis, 1928

(Pl. 2, Figs. 8, 9)

Ammodiscus glabratus Cushman & Jarvis, 1928, *Contr. Cushm. Lab. foram. Res.*, 4 (4), p. 86, pl. 12, figs. 6, 6*a*.
Ammodiscus glabratus Cushman & Jarvis, Cushman & Jarvis, 1932, *Proc. U.S. nat. Mus.*, 80 (2914), p. 8, pl. 2, fig. 1.
Ammodiscus glabratus Cushman & Jarvis, Cushman, 1946, *U.S. geol. Surv. prof. Pap.* 206, p. 7, pl. 1, fig. 32.

This distinctive species with its smooth and polished surface, its tubular second chamber very gradually and uniformly increasing in size, with the thin wall composed almost entirely of cement and the base of the coil almost pure cement and translucent, occurs in many samples from the Great Artesian Basin; the majority of tests are crushed or distorted. The Australian occurrences of *A. glabratus* in the Lower Cretaceous seem to be the first from beds of that age.

Occurrence: Hypotypes A and B (CPC 4454, 4455) from 12 Mile Tank, Marion Downs, western Queensland, 0-4 feet above base. (GAB. 304a).

Formation: lower Wilgunya.

Genus Glomospirella Plummer, 1945

Glomospirella gaultina (Berthelin), 1880

(Pl. 2, Fig. 10)

Ammodiscus gaultinus Berthelin, 1880, *Mém. Soc. géol. France,* (1) 5, p. 19, pl. 1 (24), figs. 3*a, b*.
Ammodiscus gaultinus Berthelin, Egger, 1899, *Abh. bayer. Akad. Wiss.*, 2, 21, p. 16, pl. 1, figs. 1-3, 8-9, 30-31.
Ammodiscus gaultinus Berthelin, Tappan, 1940, *J. Paleont.*, 14 (2), p. 95, pl. 14, figs. 6*a-c*.
Ammodiscus gaultinus Berthelin, Tappan, 1943, *J. Paleont.*, 17 (5), p. 481, pl. 77, figs. 6*a, b*.
Ammodiscus gaultinus Berthelin, Bartenstein, 1954, *Senckenb. Lethaea,* 35, p. 38, pl. 1, figs. 17-20.
Glomospirella gaultina (Berthelin), Tappan, 1960, *Bull. Amer. Assoc. Petrol. Geol.,* 4 (3), p. 288.
Involutina gaultina (Berthelin), Takayanagi, 1960, *Sci. Rep. Tohoku Univ., 2nd ser. (Geol.)*, 32 (1), p. 67, pl. 1, figs. 13*a*-14*b*.

The *Glomospira*-type of coiling by the tubular second chamber in its early portion was noted by Berthelin (1880) in his original description of the species from the Albian of Montcley, France, and subsequent authors who have recognized the species have commented on this characteristic feature. Tappan (1960), in her work on the Cretaceous of Northern Alaska, placed the form in the genus *Glomospirella* Plummer, 1945. The white colour of the test is another characteristic feature noted in all its recorded occurrences.

Occurrence: Hypotype (CPC 4456) from Gaffney's Tank No. 1, Herbert Downs, western Queensland, 2-3 feet above base (G. 159b).

Formation: lower Wilgunya.

Family LITUOLIDAE

Genus TROCHAMMINOIDES Cushman, 1910

TROCHAMMINOIDES CORONUS Loeblich & Tappan, 1946
(Pl. 2, Figs. 11-15)

Trochamminoides coronus Loeblich & Tappan, 1946, *J. Paleont.*, 20 (3), p. 243, pl. 35, figs. 3*a-c*.

Trochamminoides coronus Loeblich & Tappan, Loeblich & Tappan, 1949, *J. Paleont.*, 23 (3), p. 248, pl. 46, figs. 2*a, b*.

A few small planispirally coiled and evolute specimens which are referred to *T. coronus* were found in the upper Wilgunya beds in western Queensland and in the Carnarvon Basin, Western Australia. Three complete whorls can be seen, the small chambers very gradually increasing in size; 16 chambers are present in the last whorls; the wall of many of them has collapsed and formed concave areas. The species was described from the Washita Group of southern Oklahoma.

Occurrence: Hypotype A (CPC 4457) about 4 miles north-east of northernmost of the Three Sisters (Breadalbane), western Queensland (GAB. 66a). Hypotypes B and C (CPC 4458, 4459) WAPET Rough Range No. 7 Well, Carnarvon Basin, Western Australia, core 1 at 2360-2375 feet. Hypotypes D and E (CPC 4460, 4461) from ZCL Weipa No. 1 Bore, north Queensland, core 2 at 998-1005 feet.

Formations: upper Wilgunya: lower Gearle; Normanton.

Genus HAPLOPHRAGMOIDES Cushman, 1910

HAPLOPHRAGMOIDES ARENATUS sp. nov.
(Pl. 5, Figs. 1-4)

Diagnosis: The medium-sized, closely coiled, coarsely arenaceous test is almost completely involute and deeply umbilicate and has a rounded periphery. The last-formed whorl contains seven chambers, which increase rapidly in size and are lobate along the peripheral edge. Sutures are depressed and straight; the aperture is a gently arched slit at the base of the last-formed chamber.

Description: Test medium-sized, closely coiled, almost completely involute, slightly compressed, deeply umbilicate, periphery rounded. Seven chambers in last-formed whorl, increasing rapidly in size as added and roughly triangular in outline, lobate along peripheral edge, inner edge around umbilicus rough. Last-formed chamber tends to overlap previous whorl, giving test an evolute appearance. Sutures depressed, straight radiate. Wall thin, coarsely arenaceous with rounded to sub-angular grains of clear quartz in little cement. Surface rough. Aperture a gently arched slit at base of apertural face of last-formed chamber.

Dimensions (in mm.):

	Max. diameter	Max. thickness
Holotype	0·96	0·35
Paratype A	0·91	0·39
Paratype B	0·97	0·31

H. arenatus shows some resemblance to *H. rugosus* Cushman from the Upper Cretaceous of Texas, but the Queensland species has fewer chambers, is not so coarsely textured, and is slightly more regularly compressed. Well preserved specimens of this striking species are few, although many tests are present in samples from localities covered by the Mount Whelan 1:250,000 Sheet.

Occurrence: Holotype (CPC 4462), Mount Whelan, western Queensland (W. 40). Paratype A (CPC 4463) 11 miles south-west of 8 Mile Yard near track to Whitewood Tank on Herbert Downs, western Queensland (W. 206a). Paratype B (CPC 4464) Netting Bore, Paton Downs, western Queensland, at 0-5 feet.

Formation: lower Wilgunya.

HAPLOPHRAGMOIDES CHAPMANI Crespin, 1944
(Pl. 5, Figs. 5-16)

Haplophragmoides chapmani Crespin, 1944, *J. Roy. Soc. N.S.W.*, 78, p. 19, pl. 1, figs. 2*a*, *b*; 3.
Haplophragmoides chapmani Crespin, Crespin, 1953, *Contr. Cushm. Fdn foram. Res.*, 4 (1), p. 29, pl. 5, fig. 5.

Description: Test medium sized, closely coiled, compressed, involute with some tests showing tendency to become evolute in last-formed chambers, deeply umbilicate. Periphery gently rounded. Seven to nine chambers in last-formed whorl, with five to six in juvenile tests. Chambers roughly triangular in outline, some of the later chambers slightly lobate along peripheral margin. Sutures straight, depressed, in places thickened and almost even with surface. Wall finely arenaceous, with fine quartz grains arranged closely in fine siliceous cement. Surface usually smooth. Aperture an arched slit at base of septal face of last-formed chamber and with a distinct lip present in well preserved specimens.

Dimensions (in mm.):

	Max. diameter	Max. thickness
Hypotype A	1·39	0·47
Hypotype B	0·96	0·35
Hypotype C	1·05	0·47
Hypotype D	1·47	0·53
Hypotype E	1·00	0·36
Hypotype F	1·01	—
Hypotype G	0·89	0·32

Remarks: Variation in preservation of tests of *H. chapmani* tends to misinterpretation of the species, but the number and shape of the chambers and the deep umbilicus appear to remain consistent. Well preserved specimens with their inflated chambers resemble *H. rota* Nauss, 1947, from the Vermilion area, Alberta, Canada, and that species may prove to be synonymous with *H. chapmani*. At times distorted tests of the species resemble *H. concavus* (Chapman), 1892, from the Gault of England, the type figure of which is of a distorted specimen. Some specimens previously referred to that species by the writer in unpublished reports are most probably distorted tests of *H. chapmani.* The figure given by Geroch (1959) as *H.* cf. *chapmani* Crespin bears little resemblance to that species and shows a closer relationship with *H. globosa* Lozo, 1944. *H.* sp. D. of Stelck, Wall, Bahan, & Martin (1956, pl. 5, fig. 2) resembles *H. chapmani.*

H. chapmani is widely distributed in surface and subsurface sediments of Lower Cretaceous age in the Great Artesian Basin and in Western Australia.

Occurrence: Hypotype A (CPC 4465), hills about 16 miles west of Marion Downs Homestead, western Queensland (S. 156). Hypotype B, C, D (CPC 4466, 4467, 4468), 1 mile west of gate along fence 5 miles north-west of Hilary Dam, Marion Downs, western Queensland (W. 261). Hypotype E (CPC 4469), Bungeworgorai Creek, 5 miles west of Roma, Queensland, on south side of Great Western railway line. Hypotype F (CPC 4470) W.C. and I.C. Bore 6763, northern New South Wales, at 265-275 feet. Hypotype G (CPC 4471) W.C. and I.C. Bore 8302, northern New South Wales, at 750 feet.

Formations: lower Wilgunya; Roma. Age of hypotypes F and G, Lower Cretaceous.

HAPLOPHRAGMOIDES cf. CONCAVUS (Chapman), 1892
(Pl. 6, Figs. 3, 4)

Trochammina concava Chapman, 1892, *J. Roy. microsc. Soc.*, 2, p. 327, p. 6, fig. 14.
Haplophragmoides concava (Chapman), Tappan, 1940, *J. Paleont.*, 14 (2), p. 95, pl. 15, figs. 7*a-c*.
Haplophragmoides concava (Chapman), Tappan, 1943, *J. Paleont.*, 17 (5), p. 481, pl. 77, figs. 7*a, b*.
Haplophragmoides concavus (Chapman), Bartenstein & Brand, 1951, *Abh. senck. naturf. Ges.*, 485, p. 268, pl. 1, figs. 24, 25.

The side view of the figured specimen closely resembles Chapman's figure of *H. concavus* and those given of that species by Bartenstein & Brand. However, it is difficult to reconcile these figures with those of Tappan (1940, 1943).

Occurrence: Figured specimen (CPC 4472) 11 miles south-west of 8 Mile Yard, near track to Whitewood Tank on Herbert Downs, western Queensland (W. 206a).

Formation: lower Wilgunya.

HAPLOPHRAGMOIDES CUSHMANI Loeblich & Tappan, 1946
(Pl. 6, Figs. 1, 2)

Haplophragmoides cushmani Loeblich & Tappan, 1946, *J. Paleont.*, 20 (3), p. 244, pl. 35, figs. 4*a, b*.
Haplophragmoides cushmani Loeblich & Tappan, Bartenstein & Brand, 1951, *Abh. senck. naturf. Ges.*, 485, p. 268, pl. 1, figs. 23*a, b*.

A few well preserved tests of *H. cushmani* are identical with those figured by Loeblich & Tappan from the lower part of the Washita Group of northern Texas and by Bartenstein & Brand (1951) from the Valendian of north-west Germany. It is distinguished from *H. globosa* Lozo and *H. dickinsoni* Crespin by its few inflated chambers, which increase rapidly in size as added.

Occurrence: Hypotype (CPC 4473) 11 miles south-west of 8 Mile Yard near track to Whitewood Tank on Herbert Downs, western Queensland (W. 206a).

Formation: lower Wilgunya.

HAPLOPHRAGMOIDES DICKINSONI Crespin, 1953
(Pl. 6, Figs. 5-8)

Haplophragmoides dickinsoni Crespin, 1953, *Contr. Cushm. Fdn foram. Res.*, 4 (1), p. 29, pl. 5, fig. 6.

Description: Test small, planispiral, closely coiled, completely involute, periphery broadly rounded, shallow umbilicus. Six to eight chambers in last-formed whorl, slightly inflated. Sutures straight, distinct, depressed. Wall finely arenaceous, with fine quartz grains embedded in much cement; surface chiefly smooth. Aperture a low arch at base of face of last-formed chamber.

Dimensions (in mm.):

	Max. diameter	Max. thickness
Hypotype A	0·83	0·43
Hypotype B	0·53	0·33
Hypotype C	0·80	0·35

Remarks: This small compact species shows some resemblance to *H. globosa* Lozo, 1944, in its robust shape, but it has fewer chambers and is completely involute. The form figured as *H.* sp. C. by Stelck et al. (1956, pl. 4, figs. 25, 26), which they compare with *H. dickinsoni*, is most probably this species.

H. dickinsoni is widely distributed in the Lower Cretaceous of Australia.

Occurrence: Hypotype A (CPC 4474) 4 miles north-north-west of Kidman's Bore, Marion Downs, western Queensland (W. 80). Hypotype B (CPC 4475) Coogiebung Tank, Marion Downs, western Queensland (W. 26). Hypotype C (CPC 4476), hills about 16 miles north-west of Marion Downs Homestead, western Queensland (S. 156).

Formation: lower Wilgunya.

HAPLOPHRAGMOIDES GIGAS Cushman, 1927
(Pl. 6, Figs. 9-17)

Haplophragmoides gigas Cushman, 1927, *Trans. Roy. Soc. Can.*, 21 (4), p. 129, pl. 1, fig. 5.
Haplophragmoides gigas Cushman, Stelck & Wall, 1956, *Res. Coun., Alberta, Rep.* 75, p. 36, pl. 5, fig. 1.
Haplophragmoides gigas Cushman, Eicher, 1960, *Bull. Peabody Mus.*, 15, p. 58, pl. 3, fig. 16.

Description: Test large, compressed, involute, becoming slightly evolute in later stages, and with a deep umbilicus. Periphery narrowly to broadly rounded, depending on the amount of compression. Ten to fourteen chambers in last whorl, the inner edges tending to be lobate around the umbilical area. Sutures distinct, at times sigmoidal, especially in the more crushed specimens. Wall finely arenaceous, with a large amount of cement; surface chiefly smooth. Aperture a low slit at base of apertural face, with a thickened lip which is more obvious in crushed specimens.

Dimensions (in mm.):

	Max. diameter	Max. thickness
Hypotype A	1·55	—
Hypotype B	1·47	0·55
Hypotype C	1·63	—
Hypotype D	1·65	—
Hypotype E	1·93	—
Hypotype F	1·13	0·51
Hypotype G	2·13(estimated)	0·47

Remarks: This large species of *Haplophragmoides,* with its characteristic apertural lip and lobate edge of chambers surrounding the umbilical area, is certainly referable to *H. gigas* Cushman, 1927, described from a bore section in Alberta in beds now considered to be Albian. All figured specimens of *H. gigas* appear to be crushed and Cushman in his type description comments that 'this is a very large and striking species but by the somewhat flexible character of the test often distorted in the samples studied'. Stelck et al. (1956) and Eicher (1960) remark on the commonness of crushed specimens. However, an uncrushed but slightly broken specimen, Hypotype F, from Queensland, with a broadly rounded periphery, deep umbilical area, and distinct apertural lip, is shown on Plate 6, Figure 15. Stelck et al. (1956) have a well defined zone, the *Haplophragmoides gigas* zone, in outcrop in the Middle Albian of western Canada, where it is associated with a small macrofauna of ammonites and *Inoceramus.* In the Great Artesian Basin in Queensland the species is associated with Roma-type (Aptian) macrofossils in the upper Longsight Sandstone and in the lower Wilgunya Formation.

Occurrence: Hypotypes A, B, C, F (CPC 4477, 4478, 4479, 4482) from Dribbling Bore, Sandringham, western Queensland, at 470-489 feet. Hypotypes D and E (CPC 4480, 4481) from hills 16 miles north-west of Marion Downs Homestead, western Queensland (S. 156). Hypotype G (CPC 4483) from 1 mile west of gate along fence, 5 miles north-west of Hilary Dam, Marion Downs (W. 261).

Formations: upper Longsight Sandstone; lower Wilgunya.

HAPLOPHRAGMOIDES WILGUNYAENSIS sp. nov.
(Pl. 7, Figs. 1-10)

Diagnosis: A medium-sized, finely arenaceous test which is planispiral, closely coiled, and completely involute, and has a rounded periphery and deep umbilicus. There are twelve to fourteen chambers in the last-formed whorl, the final one tending to overlap the early ones of the preceding whorl. Sutures are thick and straight, and the aperture is a low arched slit at the base of the last-formed chamber.

Description: Test medium-sized, compressed, closely coiled, planispiral, completely involute, deeply umbilicate. Periphery rounded. Twelve to fourteen chambers in last-formed whorl, increasing very gradually in width and rather rapidly in height, the last-formed chamber tending to overlap the early chambers of the preceding whorl. Inner margin of chambers around umbilicus slightly lobate. Face of last-formed chamber slightly rounded but depressed around apertural area. Sutures straight, thickened, distinct, flush with surface of test. Wall arenaceous with fine quartz grains in siliceous cement. Surface smooth and slightly polished. Aperture a low arched slit at base of last-formed chamber.

Dimensions (in mm.):

	Max. diameter	Max. thickness
Holotype	0·83	0·27
Paratype A	1·20	0·40
Paratype B	0·88	—
Paratype C	1·07	—
Paratype D	0·72	0·24

Remarks: This species, with its numerous chambers, deep umbilicus and thickened sutures flush with the surface of the test, is a distinctive one. The type specimen is only very slightly distorted; the paratypes are either a little distorted or crushed. *H. wilgunyaensis* shows some resemblance to *H. sluzari* Mellon & Wall, 1956, from the lower part of the middle Albian in Alberta. Both species have thickened sutures flush with the surface, but the Queensland species is deeply umbilicate and completely involute. The species is very common in beds of the lower Wilgunya Formation of western Queensland.

Occurrence: Holotype (CPC 4484) and Paratype B (CPC 4486) from Marion Downs Homestead, side of track 4 miles south of junction with track between Bucket Creek Bore and Whitewood Tank, western Queensland (W. 285). Paratype A (CPC 4485) from 12 Mile Tank, Marion Downs, western Queensland, 0-4 feet above base (GAB. 304a). Paratypes C and D (CPC 4487, 4488), Batavia Downs Station Well, north Queensland.

Formations: lower Wilgunya: Blackdown.

HAPLOPHRAGMOIDES sp. A
(Pl. 7, Figs. 11, 12)

This very small species, with a smooth surface, few chambers, which are slightly inflated near the umbilical region, and rather acute periphery, has been found in several bores in northern New South Wales. The length of specimen A is 0.55 mm. and of specimen B 0.69 mm.

Ocurrence: Figured specimens A and B (CPC 4489, 4490)from W.C. and I.C. Bore 8302, northern New South Wales, at 700 feet.

Age: Lower Cretaceous.

Haplophragmoides sp. B
(Pl. 7, Figs. 13, 14)

This small, slightly compressed species, with few chambers and distinct sutures of transparent silica, is present in samples from localities within the Springvale 1:250,000 Sheet.

Occurrence: Figured specimens A and B (CPC 4491, 4492) from hills about 16 miles north-west of Marion Downs Homestead, western Queensland (S. 156).

Formation: lower Wilgunya.

Genus Ammomarginulina Wiesner, 1931

Ammomarginulina sp.
(Pl. 7, Fig. 16)

This large, flattened, coarsely arenaceous test shows a proloculus followed by about four chambers in the coiled portion and three in the uniserial portion, the last chamber present being broken. The aperture is present as an elongate slit. Only one specimen of this genus has been found.

Occurrence: Figured specimen (CPC 4493), ROB. No. 2 Bore, Mount Bassett, 7 miles north-east of Roma, Queensland, at 357-425 feet.

Formation: Roma.

Genus Ammobaculites Cushman, 1910

Ammobaculites abnormalis sp. nov.
(Pl. 8, Figs. 1-8)

Diagnosis: The test is elongate ovate, with a rounded periphery, three inflated and lobate chambers in the coiled portion, followed by two or three chambers in the uniserial portion, the last-formed one being large and inflated and about one third of the total length of the test.

Description: Test free, elongate ovate in outline, consisting of coiled portion followed by uniserial portion, periphery rounded. Three inflated chambers with lobate peripheral margin in coiled portion, followed by two or three chambers in uniserial portion, the last-formed one being large and almost rounded in cross section and about one third the length of the whole test. In juvenile tests, number of chambers in coiled portion irregular, three on dorsal side and three or four on ventral side, uniserial chamber large and about one third size of test. The apparent fourth chamber later becomes part of the uniserial portion. Sutures distinct and depressed. Wall arenaceous, composed of small quartz grains in much cement. Surface somewhat roughened. Aperture rounded opening to side of last-formed chamber, and surrounded by thickened lip. In many juvenile tests, opening on ventral margin of chamber, where it is surrounded by fine quartz grains.

Dimensions (in mm.):

	Length	Max. width	Width of last chamber
Holotype	2·11	0·73	0·80
Paratype A	1·13	0·52	0·80
Paratype B	1·48	0·57	0·87
Paratype C	1·04	0·60	0·80

Remarks: *Ammobaculites abnormalis,* with its unusual method of coiling in the early portion and its large apertural chamber, shows some resemblance to *A. eocretaceus* Bartenstein & Brand (1951) from the Lower Cretaceous of northwest Germany. It differs from that form in being more robust, with a more gently curved surface on the dorsal side of the juvenile forms, and in the more pronounced globular last-formed chamber in the adult test, this chamber being about one third the length of the test rather than half the length as in *A. eocretaceus.* The aperture is distinctly rounded in the majority of juvenile tests and perfectly so in adult forms. A complete series of growth stages from the juvenile to the adult form has been available for study from cores from WAPET Rough Range No. 4 Well, Western Australia.

The adult test of *A. abnormalis* also resembles *A. subaequalis* Myatliuk, 1939, from the Upper Jurassic of the middle Volga region, USSR. However, the last chamber in the Western Australian species is only one third the length of the whole test and the aperture, though prominent, is not at the end of a short neck.

The specific name is from the Latin *abnormalis,* departing from the rules.

Occurrence: Holotype (CPC 4494) from WAPET Rough Range No. 4 Well, Carnarvon Basin, W.A., core 17, at 3715 feet. Paratype A (CPC 4495) from same bore, core 12, at 3640 feet. Paratypes B and C (CPC 4496, 4497) from same bore, core 14, at 3670 feet.

Formation: Muderong Shale.

AMMOBACULITES AUSTRALIS (Howchin), 1895

(Pl. 7, Figs. 17, 18)

Haplophragmium australis Howchin, 1895, *Trans. Roy. Soc. S. Aust.,* 19, p. 198, pl. 10, figs. 1, 2.

Ammobaculites australe (Howchin), Crespin, 1944, *J. Roy. Soc. N.S.W.,* 78, p. 18, pl. 1, fig. 1.

Ammobaculites australe (Howchin), Crespin, 1953, *Contr. Cushm. Fdn foram. Res.,* 4 (1), p. 29, pl. 5, fig. 7.

This species was described by Howchin from No. 1 Bore, Hergott Township (now Marree), in northern South Australia. It is not common but is widely distributed in the Great Artesian Basin in beds equivalent to the Roma and Tambo Formations.

Occurrence: Hypotype A (CPC 4498), Bungeworgorai Creek section, south of Great Western railway line, 5 miles west of Roma, Queensland. Hypotype B (CPC 4499), Kopperammana Bore, north-east of Adelaide, South Australia, at 1907 feet.

Formations: Roma; equivalent of Roma or Tambo.

AMMOBACULITES DISPARILIS sp. nov.

(Pl. 11, Figs. 11-14)

Diagnosis: The test is large, consisting of few chambers, the early ones coarsely arenaceous and the last-formed one smooth and composed almost entirely of fine quartz grains in siliceous cement. The aperture is a central opening in the last-formed chamber, surrounded by a smooth-edged, thickened lip.

Description: Test large, elongate, sides almost parallel, the holotype slightly crushed, consisting of few chambers in both coiled and uniserial portions. Periphery rounded. Three chambers in coiled portion, large and slightly lobate, followed by three uniserial ones, two fairly regular in size, width greater than height; last-formed chamber large, somewhat rounded, and usually white. Sutures distinct, depressed. Wall of coiled chambers and the following two uniserial ones coarsely arenaceous, composed of large angular quartz grains. Wall of last-formed chamber thin, composed entirely of fine quartz grains in siliceous cement. Surface of early chambers rough, of last one smooth. Aperture terminal, a large round opening in centre of last-formed chamber, surrounded by a smooth but thickened lip.

Dimensions: Length of holotype, 1.49 mm.; width of last-formed chamber, 0.77 mm. Length of paratype, 1.31 mm.

Remarks: This unusual form of *Ammobaculites* cannot be compared with any described species of the genus. *A. disparilis* is at present restricted to the Roma Formation and its equivalents in the Great Artesian Basin in Queensland.

The specific name is taken from the Latin *disparilis*, different, referring to the differences in the wall texture.

Occurrence: Holotype (CPC 4500) from Dribbling Bore, Sandringham, western Queensland at 470-489 feet. Paratype (CPC 4501) from Union-Kern-AOG Cabawin No. 1 Well, Queensland, at 1090-1099 feet.

Formations: upper Longsight Sandstone; Roma.

AMMOBACULITES ERECTUS sp. nov.

(Pl. 8, Figs. 9-12)

Diagnosis: The test is erect in the uniserial portion, with chambers rounded in cross section and roughly quadrate in side view. Sutures are distinct. The aperture is terminal at the end of a pyriform-shaped chamber and surrounded by a rim of angular quartz grains.

Description: Test small, elongate, erect, rarely curved, consisting of probably three or more depressed closely coiled chambers in planispiral portion and of four to five chambers in uniserial portion. These are roughly quadrate in side view but rounded in cross section, increasing very gradually in height as added and slightly inflated with greatest width immediately above preceding suture; last-formed chamber pyriform, broadest at base and tapering towards apertural opening. Wall coarsely arenaceous, composed of angular to rounded grains of clear quartz in siliceous cement. Surface somewhat roughened. Aperture terminal, rounded, surrounded by a rim of angular quartz grains.

Dimensions (in mm.):

	Length	Max. width of apertural chamber	Max. width of coiled chambers
Holotype	1·16	0·33	0·35
Paratype A	1·13	0·32	0·29
Paratype B	0·84	0·27	0·23
Paratype C (crushed) ...	0·87	—	—

Remarks: *A. erectus* is distinguished from *A. fisheri* Crespin by its larger and stouter test, by the more regular shape of the chambers in the uniserial portion, and by its few chambers and indistinct sutures in the planispiral portion. The species is common in some of the samples of the lower Wilgunya Formation of western Queensland.

The specific name is taken from the Latin *erectus*, upright.

Occurrence: Holotype (CPC 4502) and Paratype A (CPC 4503) from Coogiebung Tank, Marion Downs, western Queensland (W. 26). Paratype B (CPC 4504) from Netting Bore, Paton Downs, western Queensland. Paratype C (CPC 4505) from 12 Mile Tank, Marion Downs, western Queensland, 0-4 feet above base (GAB. 304a).

Formation: lower Wilgunya.

AMMOBACULITES EXERTUS sp. nov.

(Pl. 8, Figs. 13-16)

Diagnosis: The test is roughly quadrate in outline, with the aperture protruding from the peripheral edge of the last-formed chamber.

Description: Test roughly quadrate, compressed, with minute chamber in early coil followed by six to eight chambers in closely coiled final whorl. Periphery rounded. Chambers roughly triangular, increase in size as added, last-formed one being almost a complete triangle. Sutures straight, radial. Wall coarsely to finely arenaceous; wall of holotype composed of angular quartz grains and rounded grains of black mineral (ilmenite) set in much cement; wall of paratypes finely arenaceous and partly infilled with pyrite. Surface rough to moderately smooth. Aperture simple, protruding from peripheral margin of last-formed chamber.

Dimensions: Length of holotype, 0.96 mm.; max. thickness, 0.37 mm. Length of paratype A, 0.73 mm.; max. thickness, 0.31 mm. Length of paratype B, 0.81 mm.; max. thickness, 0.27 mm.

Remarks: This form has the shape of the genus *Haplophragmoides,* but it is distinguished from it by the position of the aperture, which protrudes from the periphery of the last-formed chamber. The wall of the test varies from coarsely to finely arenaceous, both types being found in the one sample in the Dribbling Bore, Sandringham, western Queensland. *A. exertus* shows some resemblance to *A. spiritensis* Stelck & Wall, 1955, from the Cenomanian of Alberta. It differs in its less angulate outline and less compression.

The specific name is the Latin *exertus,* projecting.

Occurrence: Holotype (CPC 4506) and paratype A (CPC 4507) from Dribbling Bore, Sandringham, western Queensland, at 470-489 feet. Paratype B (CPC 4508) from W.C. and I.C. Bore 8271, northern New South Wales, at 1000 feet. Also in Union-Kern-AOG Cabawin No. 1 Well, Queensland, at 1090-1099 feet.

Formation: upper Longsight Sandstone. Age of Paratype B—Lower Cretaceous.

AMMOBACULITES FISHERI Crespin, 1953
(Pl. 11, Figs. 8-10)

Ammobaculites fisheri Crespin, 1953, *Contr. Cushm. Fdn foram. Res.*, 4 (1), p. 29, pl. 5, figs. 4, 5.

Description: Test free, small, straight, elongate, coiled portion compressed, uniserial portion almost round in cross section. Coiled portion consisting of three to five chambers, usually five chambers in uniserial portion, early ones very gradually increasing in size and slightly inflated, with greatest width towards middle of chamber. Last-formed chamber subpyriform, becoming extended in direction of apertural opening with greatest width in lower third. Sutures distinct, depressed. Wall arenaceous consisting of small quartz grains in siliceous cement. Surface rather rough. Aperture terminal rounded to elliptical, surrounded by a slight lip of siliceous material.

Dimensions: Length of hypotype A, 0.6 mm.; hypotype B, 0.66 mm.; hypotype C, 0.88 mm.

Remarks: *A. tyrrelli* Nauss var. *jolifouensis* Stelck et al., 1956, from the Middle Albian of Central Alberta, resembles *A. fisheri* in its well defined chambers in both the planispiral and uniserial portions of the test and in the short protruding apertural neck, but has fewer chambers. *A. fisheri* is widely distributed in Lower Cretaceous rocks of the Great Artesian Basin and in Western Australia, where it is known to range up to the basal Upper Cretaceous (Cenomanian).

Occurrence: Hypotype A (CPC 4509) 1 mile west of gate along fence, 5 miles north-west of Hilary Dam, Marion Downs, western Queensland (W. 261). Hypotype B (CPC 4510), hills about 16 miles north-west of Marion Downs Homestead (S. 156). Hypotype C (CPC 4511) Anacoora Bore, southern Northern Territory, at 830-840 feet.

Formations: lower Wilgunya; equivalent of Roma?

AMMOBACULITES FRAGMENTARIUS Cushman, 1927
(Pl. 7, Fig. 15)

Ammobaculites fragmentaria Cushman, 1927, *Trans. Roy. Soc. Can.*, 21 (4), p. 130, pl. 1, fig. 8.
Ammobaculites fragmentarius Cushman, Frizzell, 1954, *Texas Bur. econ. Geol., Rep. Invest.*, 22, p. 62, pl. 2, figs. 16, 17, 18*a*, *b*.
Ammobaculites fragmentarius Cushman, Stelck & Wall, 1956, *Res. Coun. Alberta, Rep.* 75, p. 21, pl. 5, fig. 18.

The figured specimen, with its rapidly tapering test and its five uniserial chambers which are wider than high and gradually increase in width as added, closely resembles Cushman's type figure of the species from Alberta.

Occurrence: Hypotype (CPC 4512), Dry Bore Creek Tank, Marion Downs, western Queensland (GAB. 23).

Formation: lower Wilgunya.

AMMOBACULITES GOODLANDENSIS Cushman & Alexander, 1930
(Pl. 9, Figs. 1-4)

Ammobaculites goodlandensis Cushman & Alexander, 1930, *Contr. Cushm. Lab. foram. Res.*, 6 (1), p. 8, pl. 2, figs. 7, 8.
Ammobaculites goodlandensis Cushman & Alexander, Tappan, 1940, *J. Paleont.*, 14 (2), p. 96, pl. 14, figs. 8*a*, *b*; 9.
Ammobaculites goodlandensis Cushman & Alexander, Tappan, 1943, *J. Paleont.*, 17 (5), p. 481, pl. 77, figs. 9*a*, *b*.
Ammobaculites goodlandensis Cushman & Alexander, Lozo, 1944, *Amer. Mid. Nat.*, 31 (3), p. 537, pl. 14, fig. 4.
Ammobaculites goodlandensis Cushman & Alexander, Loeblich & Tappan, 1946, *J. Paleont.*, 23 (3), p. 250, pl. 46, figs. 14*a*, *b*.
Ammobaculites goodlandensis Cushman & Alexander, Bartenstein & Brand, 1951, *Abh. senck. naturf. Ges.*, 485, p. 271, pl. 3, fig. 49.
Ammobaculites goodlandensis Cushman & Alexander, Frizzell, 1954, *Texas Bur. econ. Geol. Rep. Invest.*, 22, p. 62, pl. 2, figs. 20*a*, *b*.

Description: Test free, large, stout, early portion closely coiled with central area strongly depressed and umbilicate; uniserial portion short; periphery broad and truncate. Five chambers in coiled portion becoming nodose. One or two chambers in uniserial portion. Peripheral edge of chambers broad and often raised above general surface of test. Sutures indistinct but often marked by deep depression between chambers. Wall composed of coarse, angular quartz grains with considerable cement. Aperture terminal, elliptical.

Dimensions: Diameter of coiled portion of hypotype A, 0.92 mm.; length of test, 1.44 mm. Diameter of coiled portion of hypotype B, 1.13 mm. Diameter of coiled portion of hypotype C, 1.17 mm.; length of test, 1.61 mm.

Remarks: The figured specimens referred to *A. goodlandensis* are almost identical with those figured by Cushman & Alexander (1930) from the Lower Cretaceous of Texas. These authors remarked that the species is a distinctive one and commented on the rarity of uncoiled specimens. Several uncoiled tests are present amongst the many specimens available for study from the lower Wilgunya beds of the Great Artesian Basin.

Occurrence: Hypotype A (CPC 4513), Marion Downs Homestead, western Queensland, side of track 4 miles south of junction with track between Bucket Creek Bore and Whitewood Tank (W. 285). Hypotype B (CPC 4514), from hills about 16 miles north-west of Marion Downs Homestead (S. 156). Hypotype C (CPC 4515), Kopperamanna Bore, north-east South Australia, at 1907 feet.

Formations: lower Wilgunya; equivalent of Roma or Tambo.

AMMOBACULITES GROSSUS sp. nov.

(Pl. 9, Figs. 5-10)

Diagnosis: The test is large, erect or gently curved, slightly compressed except in the apertural chamber, which is pyriform, with a rounded cross-section. Three slightly inflated chambers in the coiled portion are followed by two to four uniserial ones. The aperture is a central circular opening surrounded by a lip, and the wall is composed of coarse quartz grains.

Description: Test large, elongate, slightly compressed, rounded periphery. Early chambers coiled, uniserial portion erect or slightly curved. Coiled portion of three or four inflated chambers, lobate and rounded on peripheral margin. Uniserial portion of two to four chambers, the early ones broader than high; apertural chamber inflated, pyriform, and twice as high as preceding one, rounded in cross-section with greatest width in lower third of chamber. Sutures indistinct, depressed, straight, those in coiled portion converging to centre of base of following uniserial chamber. Wall very coarsely arenaceous with large angular to rounded grains of clear quartz in much cement. Surface rough. Aperture a circular opening, central, projecting, surrounded by lip composed of quartz grains or of thickened siliceous cement.

Dimensions (in mm.):

	Length	Width of apertural chamber	Height of apertural chamber
Holotype	2·32	0·88	1·00
Paratype A	3·87	1·07	1·07
Paratype B	1·27	max. width 0·64	

Remarks: *A. grossus,* with its coarse-grained large test, seems to be distinctive amongst species of *Ammobaculites* from the Lower Cretaceous. The figures given show the variation within the species, all specimens coming from the one sample of Muderong Shale in the Carnarvon Basin, Western Australia.

A. grossus shows some resemblance to *A. reophacoides* Bartenstein, 1952, from the Upper Barremian and Upper Neocomian of Germany, with its coarse texture and three chambers in the coiled portion, but differs in its large size, in the circular apertural opening in the last-formed chamber, and in its usually few chambers in the uniserial portion. *A. grossus* also shows some resemblance to *A. pacalis* Stelck & Wall, 1954, from the Cenomanian of Alberta, in its three-chambered coiled portion and two to four chambers in the uniserial portion, but it differs from that species in the consistently large size of the test and the circular aperture. The length of the holotype of *A. pacalis* is given as 0.64 mm., whereas the Western Australian form averages about 4 mm. in length. *A. grossus* appears to be restricted to the Aptian Muderong Shale of the Carnarvon Basin, Western Australia.

The species name is taken from the Latin *grossus,* big, coarse.

Occurrence: Holotype (CPC 4516) and Paratypes A, B, C (CPC 4517, 4518, 4519) from Middalya Station, 18 miles south of Homestead and 19½ miles north-easterly from Hill Springs Homestead, Carnarvon Basin, Western Australia (MG. 224).

Formation: Muderong Shale.

AMMOBACULITES IMPLANUS sp. nov.

(Pl. 9, Figs. 11-18)

Diagnosis: A large, robust, compressed, coarsely arenaceous test with five chambers in loosely coiled portion, at times umbilicate. The uniserial portion is short and may be erect or curved. The surface is rough and the aperture a slit-like opening.

Description: Test robust, compressed, rather large, early portion loosely coiled and often umbilicate, followed by a short uniserial portion which may be erect or curved. Periphery rounded. Five slightly inflated chambers in planispiral portion, two or three in the uniserial portion, with final chamber produced towards apertural opening and becoming pyriform. Sutures indistinct, straight and radial in coiled portion, straight and horizontal in uniserial portion. Wall coarsely arenaceous, composed of large rounded quartz grains, with an occasional rounded grain of ilmenite in fine siliceous cement. Surface rough. Aperture terminal, elongated slit.

Dimensions (in mm.):

	Length	Thickness	Length of uniserial portion
Holotype	1·24	0·47	0·40
Paratype A	1·16	0·49	0·53
Paratype B	1·00	0·24	0·40
Paratype C	0·81	0·25	0·28
Paratype D	0·93	0·24	0·28
Paratype E	1·00	0·35	0·40
Paratype F	1·07	0·31	0·53

Remarks: *A. implanus* is a striking species with its roughened, loosely coiled, frequently umbilicate portion of the test and the straight to curved uniserial portion.

The species shows some resemblance to *A. barrowensis* Tappan, 1955, from the Lower Jurassic of Alaska, in its occasionally curved uniserial chambers, but the Lower Cretaceous form has fewer chambers in that portion of the test.

The specific name is taken from the Latin *implanus,* uneven, rough.

Occurrence: Holotype (CPC 4520) and Paratypes A, E, F (CPC 4521, 4525, 4526) from Dribbling Bore, Sandringham, western Queensland, at 470-489 feet. Paratypes B, C, D (CPC 4522, 4523, 4524), Mount Whelan, western Queensland (W. 40).

Formations: upper Longsight Sandstone; lower Wilgunya.

AMMOBACULITES IRREGULARIFORMIS Bartenstein & Brand, 1951
(Pl. 10, Figs. 1-3)

Ammobaculites irregulariformis Bartenstein & Brand, 1951, *Abh. senck. naturf. Ges.,* 485, p. 270, pl. 2, figs. 41-44.
Ammobaculites irregulariformis Bartenstein & Brand, Bartenstein, 1952, *Senckenbergiana,* 33 (4/6), p. 319, pl. 7, fig. 12.

The specimens figured on Plate 10, with their irregular shape, are closely comparable with *A. irregulariformis* from the Valendian (Neocomian) of North-west Germany. The Queensland specimens have about four irregularly-shaped chambers in the coiled portion and three or four in the uniserial portion. The wall is composed of small irregular-shaped quartz grains in fine cement. The aperture is terminal and an elongated slit.

Occurrence: Hypotype A (CPC 4527) from Dribbling Bore, Sandringham, Queensland, at 470-489 feet. Hypotypes B and C (CPC 4528, 4529), from Union-Kern-AOG Cabawin No. 1 Well, Queensland, at 1090-1099 feet.

Formations: Roma; upper Longsight Sandstone.

AMMOBACULITES LAEVIGATUS LOZO, 1944
(Pl. 10, Figs. 4-9)

Ammobaculites laevigatus Lozo, 1944, *Amer. Mid. Nat.,* 31 (3), pl. 2, figs. 2, 3; text-figs. 14*a-h*.
Ammobaculites laevigatus Lozo, Bartenstein, 1952, *Senckenbergiana,* 33 (4/6), pl. 7, fig. 15.
Ammobaculites laevigatus Lozo, Frizzell, 1954, *Texas Bur. econ. Geol. Rep. Invest.,* 22, p. 62, pl. 2, figs. 19*a, b*.

Description: Test medium sized, compressed, closely coiled in early portion, completely involute, followed by short uniserial portion, umbilicate, periphery broadly rounded. Eight to twelve chambers in coiled portion, depending on maturity of test. Chambers triangular in most of coiled portion, later ones almost quadrate, especially in mature specimens. Two chambers in uniserial portion of mature specimens, rectangular in side view, with width at least twice the height. Immature specimens in which uniserial portion not developed shaped like

Haplophragmoides. Sutures thickened, clearly visible, slightly curved towards final chamber of involute portion; straight in uniserial portion, and at right angles to long axis of test. Wall thick, uniformly finely granular, composed of small siliceous particles with much cement. Surface smooth, polished. Aperture, in mature specimen, a long central slit running parallel with sides of last-formed chamber, the edge of which is rounded and smooth. In immature specimens, aperture almost a rounded central opening in last-formed chamber.

Dimensions (in mm.):

	Length	Width	Greatest Thickness
Hypotype A	1·20	0·76	0·40
Hypotype B	0·99	0·72	0·47

Remarks: This distinctive species of *Ammobaculites* was described by Lozo from the Goodland Formation of North Texas. As far as is known it has only been recorded in Australia in the Aptian Muderong Shale in bores in Rough Range, Carnarvon Basin, Western Australia.

Occurrence: Hypotype A (CPC 4530) from WAPET Rough Range No. 4 Well, Carnarvon Basin, Western Australia, in core 18 at 3725 feet. Hypotype B (CPC 4531) from same well, core 12, at 3640 feet. Hypotype C (CPC 4532) from same well, core 17, at 3715 feet.

Formation: Muderong Shale.

AMMOBACULITES MINIMUS Crespin, 1953
(Pl. 10, Figs. 10-12)

Ammobaculites minimus Crespin, 1953, *Contr. Cushm. Fdn foram. Res.*, 4 (1), p. 30, pl. 5, fig. 8.

This small compressed species with four closely coiled chambers followed by three or four uniserial ones is found throughout the Great Artesian Basin, but its occurrence is rare in the Lower Cretaceous of Western Australia.

Occurrence: Hypotype A (CPC 4533) 11½ miles south-west of 8 Mile Yard near track to Whitewood Tank on Herbert Downs, western Queensland (W. 206a). Hypotype B (CPC 4534) Dry Bore Creek Tank, Marion Downs, western Queensland (GAB. 23). Hypotype C (CPC 4535) from BMR 4 Wallal Bore, Canning Basin, Western Australia, core 9, at 888-898 feet.

Formation: lower Wilgunya. Age of hypotype C, Upper Jurassic or Lower Cretaceous.

AMMOBACULITES SUBCRETACEUS Cushman & Alexander, 1930
(Pl. 10, Figs. 13, 14)

Ammobaculites subcretacea Cushman & Alexander, 1930, *Contr. Cushm. Lab. foram. Res.*, 6 (1), p. 6, pl. 2, figs. 9, 10.

Ammobaculites subcretaceus Cushman & Alexander, Lozo, 1944, *Amer. Mid. Nat.*, 33 (3), p. 538, pl. 4, figs. 2, 3.

Ammobaculites subcretaceus Cushman & Alexander, Loeblich & Tappan, 1949, *J. Paleont.*, 23 (3), p. 251, pl. 46, figs. 9-13.

Ammobaculites subcretaceus Cushman & Alexander, Bartenstein, 1952, *Senckenbergiana*, 33 (4/6), p. 319, pl. 1, fig. 8; pl. 2, figs. 1-9; pl. 7, fig. 11.

Ammobaculites subcretaceus Cushman & Alexander, Skolnick, 1958, *J. Paleont.*, 32 (2), p. 282, pl. 37, figs. 4*a-c*.

Ammobaculites subcretaceus Cushman & Alexander, Eicher, 1960, *Bull. Peabody Mus. nat. Hist.*, 15, p. 63, pl. 4, fig. 3.

A. subcretaceus shows some variation in shape and in number of uniserial chambers, but the specimens figured here closely resemble the type figures from the Lower Cretaceous of Texas. The species is widely distributed in the lower Wilgunya Formation and less commonly in the Roma Formation of the Great Artesian Basin. In Texas it ranges from the Lower Albian to basal Upper Cretaceous.

Occurrence: Hypotypes A and B (CPC 4536, 4537) from Dribbling Bore, Sandringham, western Queensland, at 470-489 feet.

Formation: upper Longsight Sandstone.

AMMOBACULITES SUCCINCTUS sp. nov.
(Pl. 10, Figs. 15-17)

Diagnosis: The test is medium sized, with five chambers in the involute coiled portion and one to three in the uniserial portion, which is rounded in cross section. The aperture is rounded and slightly protruding.

Description: Test medium-sized, free, early chambers coiled, involute, later chambers becoming uniserial and slightly lobate, periphery rounded. Coiled portion large, about twice width of uniserial portion and consisting of five chambers of uniform size. Uniserial portion short, either straight or curved, consisting of one to three chambers, sides almost parallel; chambers as broad as long, last-formed one pyriform, tapering towards apertural opening. Sutures distinct in coiled portion, depressed in uniserial portion. Wall arenaceous, composed of small angular to rounded quartz grains and a few mica flakes, in much cement. Surface rough to moderately smooth, texture varying with amount of cement. Aperture terminal, rounded, slightly protruding.

Dimensions (in mm.):

	Length	Diameter of coil	Length of uniserial portion
Holotype	0·83	0·53	0·33
Paratype A	0·66	0·48	0·27
Paratype B	0·99	0·60	0·47

Remarks: This species shows some resemblance to figure 46c of *A. irregulariformis* of Bartenstein & Brand (1951), in its broad coiled portion and its erect and short uniserial portion. However, it differs in having fewer chambers in the planispiral portion, which is also more closely coiled.

The specific name is taken from the Latin *succinctus*, brief, short.

Occurrence: Holotype (CPC 4538) and Paratypes A and B (CPC 4539, 4540), from W.C. and I.C. Bore 8264, northern New South Wales, at 1000 feet.

Age: Lower Cretaceous.

AMMOBACULITES TOROSUS Loeblich & Tappan, 1949
(Pl. 11, Figs. 6, 7)

Ammobaculites torosus Loeblich & Tappan, 1949, *J. Paleont.*, 33 (3), p. 251, pl. 46, figs. 6*a*, *b*; 7.

Ammobaculites torosus Loeblich & Tappan, Frizzell, 1954, *Texas Bur. econ. Geol. Rep. Invest.*, 22, p. 62, pl. 2, figs. 20*a*, *b*.

Ammobaculites torosus Loeblich & Tappan, Skolnick, 1958, *J. Paleont.*, 32 (2), p. 282, pl. 37, figs. 1*a-d*.

The figured specimens, with the parallel sides of the uniserial chambers and the large subpyriform last-formed chambers which finishes in a short apertural neck, closely resemble *A. torosus,* described from the Walnut Clay (Middle Albian) of Texas. Bartenstein (1952) records it from the Albian of Middle Europe.

Occurrence: Hypotype A (CPC 4541), Broken Dam Bore, Canary Station, western Queensland, at 51-53 feet. Hypotype B (CPC 4542), AAO No. 8 Well, Karumba, north Queensland, at 2218-2223 feet.

Formations: lower Wilgunya; Blackdown.

AMMOBACULITES WALLALENSIS sp. nov.
(Pl. 11, Figs. 1-5)

Diagnosis: This elongate, gently curved to straight, tapering species has a rounded test, with a few inflated chambers in the coiled portion and seven to ten in the uniserial portion. The surface is smooth, with an occasional large quartz grain in the more finely arenaceous wall.

Description: Test elongate, medium sized, tapering, straight or gently curved, early portion closely coiled, almost globular, uniserial portion with numerous chambers rounded in cross section, periphery rounded. Early portion consisting of about four small inflated chambers, followed by seven to ten uniserial chambers broader than high and increasing gradually in size with last-formed chamber large and subpyriform. Sutures straight, depressed, distinct. Wall arenaceous with small quartz grains in fine cement and with an occasional large grain. Surface smooth, except for occasional large quartz grain, and slightly polished; tests partly infilled with pyrite. Aperture terminal, rounded opening surrounded by a few small angular quartz grains.

Dimensions: Length of holotype, 1.15 mm.; max. diameter of coiled portion, 0.19 mm.; max. diameter of uniserial portion, 0.36 mm.; min. diameter of uniserial portion, 0.16 mm.

Remarks: *A. wallalensis* shows little resemblance to any described species of *Ammobaculites*. Specimens are common in Core 9 of the Wallal Bore.

Occurrence: Holotype (CPC 4543) and Paratypes A, B, C (CPC 4544, 4545, 4546), from BMR 4 Wallal Bore, Canning Basin, Western Australia, core 9, at 888-898 feet.

Age: Upper Jurassic or Lower Cretaceous.

Genus FLABELLAMMINA Cushman, 1928

FLABELLAMMINA ALEXANDERI Cushman, 1928

(Pl. 12, Figs. 5-7)

Flabellammina alexanderi Cushman, 1928, *Contr. Cushm. Lab. foram. Res.*, 4 (1), p. 1, pl. 1, figs. 3, 4.

Flabellammina alexanderi Cushman, Loeblich & Tappan, 1949, *J. Paleont.*, 23 (3), p. 252, pl. 46, fig. 16.

Flabellammina alexanderi Cushman, Frizzell, 1954, *Texas Bur. econ. Geol. Rep. Invest.*, 22, p. 63, pl. 3, figs. 5-7.

The specimens referred to *F. alexanderi* are large, roughly ovate in outline, and flattened, with the early portion coiled, later chambers becoming uniserial, and with the sutures chevron-shaped in the uniserial portion. Cushman described the species from the Lower Cretaceous (Albian) of Texas. *F. alexanderi* occurs in both surface and subsurface samples in the Great Artesian Basin in western Queensland.

Occurrence: Hypotypes A, B, C (CPC 4547, 4548, 4549), from Broken Dam Bore, Canary Station, western Queensland, at 45-51 feet.

Formation: lower Wilgunya.

FLABELLAMMINA REYNOLDSI sp. nov.

(Pl. 12, Figs. 8-11)

Diagnosis: A large rather coarsely arenaceous compressed test with flat surfaces and rounded periphery. There are three inflated chambers in the coiled portion and one to four in the uniserial portion, the chambers being arched along the central line.

Description: Test large, free, compressed, elongate, early portion coiled, later portion uniserial, surfaces flat, periphery rounded. A small proloculus surrounded by three inflated, almost globular chambers in coiled portion. Four chambers in well developed specimens in uniserial portion, one to two in juvenile tests, second and third chambers gradually increasing in height and width, slightly inflated and gently arched in central portion; width of second and third chambers in holotype somewhat abnormal along peripheral margin. Last-formed chamber large and inflated. Sutures distinct, depressed, chevron-shaped. Wall coarsely arenaceous, composed of angular quartz grains in siliceous cement. Surface rough. Aperture terminal, central, narrow elongate slit.

Dimensions (in mm.):

	Length	Width of last chamber	Width ot coiled portion
Holotype	2·08	0·80	0·56
Paratype A	1·19	0·75	0·80
Paratype B	1·00	0·80	0·84
Paratype C	1·44	0·73	0·48

Remarks: *F. reynoldsi* is fairly common in samples from the lower part of the Wilgunya Formation of western Queensland and the variation in the growth stages of the test is illustrated, the stages passing from one chamber in the uniserial portion of some tests to four in the holotype. One specimen (Pl. 12, Fig. 11) shows the coiled portion slightly to one side of the test. Tappan (1941) figures similar variation in *F. denisoniensis* from the basal Upper Cretaceous of Texas. The fewer chambers in the adult test, the three well developed chambers in the coiled portion, and the rough surface distinguish *F. reynoldsi* from *F. denisoniensis*.

The species is named after Mr M. A. Reynolds of the Bureau of Mineral Resources, whose geological investigations in the Lower Cretaceous beds of the Great Artesian Basin in Queensland have formed a basis for this present work.

Occurrence: Holotype (CPC 4550) and Paratypes A and B (CPC 4551, 4552), from Coogiebung Tank, Marion Downs, western Queensland (W. 26). Paratype C (CPC 4553), from Mount Whelan (W. 40).

Formation: lower Wilgunya.

FLABELLAMMINA VITREA sp. nov.

(Pl. 12, Figs. 12-16)

Diagnosis: A small, stout, compressed, test with flat faces, a rounded periphery, a lobate peripheral margin and a glassy surface. Three small inflated chambers surround a small depressed proloculus in the coiled portion, three to five chambers in the uniserial portion, with the last chamber tending to be subpyriform.

Description: Test small, stout, compressed, surfaces flat, periphery rounded; early portion coiled, later portion uniserial. Small depressed proloculus, surrounded by three small inflated chambers in coiled portion which very gradually increase in size. Usually three chambers in uniserial portion (five in one specimen), gradually increasing in width and height, becoming arched in central portion. Greatest width in two early chambers central, but lower third of last-formed chamber large and inflated and subpyriform, this being more obvious in slightly compressed tests. Sutures arched in central portion, distinct, depressed, constricted to make peripheral margin lobate. Wall arenaceous, composed of small grains of clear quartz in fine cement, giving the smooth surface a glassy appearance. Aperture terminal, elliptical.

Dimensions (in mm.):

	Length	Width of coil	Max. width of test
Holotype	0·87	0·43	0·41
Paratype A	0·89	0·43	0·43
Paratype B	0·80	0·48	0·49
Paratype C	1·35	0·47	0·49
Paratype D	0·95	0·43	0·44

Remarks: The small test, the inflated coiled chambers, the lobate peripheral margin, the subpyriform shape of the last-formed chamber, and the glassy texture, make *F. vitrea* a distinctive species of the genus from the Lower Cretaceous. It is restricted to the lower part of the Wilgunya Formation.

The specific name is taken from the Latin *vitrea*—glassy.

Occurrence: Holotype (CPC 4554) from hills about 6 miles north-west of Marion Downs Homestead, western Queensland (S. 156). Paratypes A, B, C, D (CPC 4555, 4556, 4557, 4558), near Marion Downs Homestead, side of track, 4 miles south of junction with track between Bucket Creek Bore and Whitewood Tank, Marion Downs Homestead (W. 285).

Formation: lower Wilgunya.

Genus TRIPLASIA Reuss, 1854

TRIPLASIA AUSTRALIAE sp. nov.

(Pl. 12, Figs. 1-4)

Diagnosis: This coarsely arenaceous species has three large, inflated chambers in the planispiral portion followed by four uniserial ones which become triradiate, giving a triangular cross-section. Sutures are arched on the faces of the test and curve gently downwards at the angles.

Description: Test free, medium-sized, elongate, planispiral in early portion, later becoming uniserial and triangular in cross-section. Three large inflated chambers in planispiral portion, followed by four uniserial chambers, early ones *Flabellammina*-like, becoming triradiate after second or not becoming angulate until third. Chambers gradually increasing in size, last strongly rounded with triradiate angle less prominent. Sutures distinct, depressed, arched on faces of test and curving very gently downwards at angles. Wall coarsely arenaceous, with small angular to subangular quartz grains in fine siliceous cement. Surface rough. Aperture terminal, rounded, in centre of last-formed chamber.

Dimensions: Length of holotype, 1.53 mm.; greatest width, 0.72 mm. Length of paratype, 1.24 mm.; greatest width, 0.60 mm.

Remarks: *Triplasia australiae* cannot be compared with any species described from the Lower Cretaceous. However, it shows some resemblance to *T. kingakensis* Loeblich & Tappan (1952, pl. 1, fig. 6), from the Upper Jurassic of Alaska, in its well developed coil but differs in the fewer chambers in the coiled portion. A slight resemblance is also shown in the uniserial portion of *T. commutata* Loeblich & Tappan (1952, pl. 1, fig. 12a) from the Upper Jurassic of Wyoming. The genus *Triplasia* is rare in the Lower Cretaceous of Australia.

Occurrence: Holotype (CPC 4559) from 4 miles north-west of Kidman's Bore, Marion Downs, western Queensland (W. 80). Paratype (CPC 4560) from 11 miles south-west of 8 Mile Yard near track to Whitewood Tank on Herbert Downs, western Queensland (W. 206).

Formation: lower Wilgunya.

Family TEXTULARIIDAE

Genus SPIROPLECTAMMINA Cushman, 1927

SPIROPLECTAMMINA AEQUABILIS sp. nov.

(Pl. 13, Figs. 1-4)

Diagnosis: The test is small, compressed, with the sides usually parallel, and numerous chambers in both coiled and biserial portions. The sutures are strongly oblique.

Description: Test small, elongate, compressed, with surfaces almost flattened, sides parallel for almost entire length, rarely tapering, coiled in early portion then becoming biserial. Chambers numerous, five or six in coiled portion and five to six pairs in biserial portion, the biserial chambers being almost uniform in width and height, with the last pair of chambers larger. In tapering specimen, the chambers very gradually increase in size as added. Sutures distinct, oblique in biserial portion with an angle of approximately 90 degrees to the horizontal, slightly depressed and constricted at peripheral edge giving a somewhat lobate margin. Wall thin, finely arenaceous, with small clear quartz grains in considerable siliceous cement. Surface smooth with a polished appearance. Aperture an arched opening at base of last-formed chamber.

Dimensions (in mm.):

	Length	Width at coiled end	Width of last biserial chambers
Holotype	0·95	0·27	0·33
Paratype A	0·88	0·29	0·31
Paratype B	0·76	0·19	0·33
Paratype C	0·73	0·24	0·28

Remarks: *S. aequabilis* shows some resemblance to *S. ammovitrea* Tappan, 1940, from the Grayson Formation of Texas in its smooth test and almost parallel sides; the writer in some unpublished reports has referred it to *S. ammovitrea*. *S. aequabilis*, however, differs from *S. ammovitrea* in the strong oblique sutures and the compressed test. It also resembles *S. longa* Lalicker (1935) from the Lower Cretaceous of Texas in its oblique sutures, but these in the Australian form are at a much greater angle, the test is more compressed, and the sides almost parallel. At present *S. aequabilis* appears to be restricted to the lower part of the Wilgunya Formation of western Queensland.

The specific name is the Latin *aequabilis,* consistent, equal.

Occurrence: Holotype (CPC 4561) and Paratypes A and B (CPC 4562, 4563) from near Marion Downs Homestead, western Queensland, at side of track 4 miles south of junction with track between Bucket Creek Bore and Whitewood Tank (W. 285). Paratype C (CPC 4564) from hills about 16 miles north-west of Marion Downs Homestead (S. 156).

Formation: lower Wilgunya.

SPIROPLECTAMMINA CUSHMANI Crespin, 1944
(Pl. 13, Figs. 5-7)

Spiroplectammina cushmani Crespin, 1944, *J. Roy. Soc. N.S.W.*, 78, p. 19, pl. 1, fig. 7.
Spiroplectammina cushmani Crespin, Crespin, 1953, *Contr. Cushm. Fdn foram. Res.*, 4 (1), p. 30, pl. 5, fig. 9.

Description: Test small, elongate, tapering, with greatest width in last-formed chambers. Early chambers planispiral, later biserial. Coiled portion in megalospheric form consisting of about four small indistinct chambers followed by five or six pairs of slightly inflated chambers, gradually increasing in size, the last pair almost twice the size of the preceding ones. Coiled portion in microspheric form minute, followed by numerous biserially arranged chambers, the early ones small, then gradually increasing in size. Wall finely arenaceous, usually composed of quartz grains in fine cement, some tests adding other minerals such as ilmenite. Sutures oblique, slightly depressed. Aperture narrow slit in base of face of last-formed chamber.

Dimensions: Length of hypotype A, 0.73 mm.; max. width, 0.21 mm. Length of hypotype B, 0.61 mm.; max. width, 0.20 mm. Length of hypotype C, 0.77 mm.; max. width, 0.21 mm.

Remarks: *S. cushmani* is widely distributed in the Lower Cretaceous and is especially common in beds of the Roma Formation and its equivalents.

Occurrence: Hypotypes A, B, C (CPC 4565, 4566, 4567), from Union-Kern-AOG Cabawin No. 1 Well, Queensland, at 1090-1099 feet.

Formation: Roma.

SPIROPLECTAMMINA EDGELLI Crespin, 1953
(Pl. 13, Figs. 8-12)

Spiroplectammina edgelli Crespin, 1953, *Contr. Cushm. Fdn foram. Res.*, 4 (1), p. 30, pl. 5, fig. 10.

Description: Test small, elongate, compressed, early chambers closely coiled, later ones biserial, gradually increasing in width, with the last pair of chambers usually increasing more rapidly in height and width. Four to five chambers in coiled portion followed by four pairs in biserial portion. Periphery slightly rounded, lobate. Sutures distinct in coiled portion, oblique and less distinct in biserial portion. Wall coarsely arenaceous, composed of grains of clear quartz in much cement. Surface somewhat roughened. Aperture slit-like at base of last-formed chamber.

Dimensions: Length of hypotype A, 0.84 mm.; max. width, 0.41 mm. Length of hypotype B, 0.97 mm.; max. width, 0.52 mm. Length of hypotype C, 0.65 mm.; max. width, 0.40 mm.

Remarks: This small species is widely but not commonly distributed in the Lower Cretaceous of Australia.

Occurrence: Hypotype A (CPC 4568), Netting Bore, Paton Downs, western Queensland. Hypotypes B and C (CPC 4569, 4570) from 12 Mile Tank, Marion Downs, western Queensland, at 0-4 feet from base (GAB. 304A). Hypotype D (CPC 4571) from Broken Dam Bore, Canary Station, western Queensland, at 45-50 feet. Hypotype E (CPC 4572) from Coogiebung Tank, Marion Downs (W. 26).

Formation: lower Wilgunya.

SPIROPLECTAMMINA ENODIS sp. nov.

(Pl. 13, Figs. 13-16)

Diagnosis: The test of the megalospheric form is small, stout, tapering, with a rounded periphery, four chambers in the coiled portion, and three pairs in the biserial. The microspheric test is large, with numerous chambers. The surface is smooth.

Description: Test elongate, tapering, coiled in early portion, later becoming biserial, periphery rounded. Megalospheric test small, stout, with four small chambers in coiled portion followed by three pairs in biserial portion, chambers increasing rather rapidly in size with last pair large. Microspheric test large, at least twice length of megalospheric one, tapering, with numerous chambers, gradually increasing in size. Sutures straight, distinct. Wall arenaceous. Surface generally smooth with polished appearance. Aperture elongate opening at base of face of last-formed chamber. Colour brown, with last-formed chamber white.

Dimensions (in mm.):

	Length	Width at initial end	Max. width
Holotype	1·05	0·16	0·35
Paratype A	1·44	0·13	0·36
Paratype B	1·67	—	—
Paratype C	0·84	0·23	0·40

Remarks: The most striking feature of *S. enodis* is the large size of the microspheric form compared with the megalospheric one. The holotype is slightly distorted, but all essential characters are distinct. As in many of the foraminiferal tests from the Aptian Roma Formation of the Great Artesian Basin, most of the test is brown, and the last-formed chamber white.

The name is taken from the Latin *enodis*, smooth, no knobs.

Occurrence: Holotype (CPC 4573) and Paratype A (CPC 4574) from Dribbling Bore, Sandringham, western Queensland, at 460-489 feet. Paratypes B and C (CPC 4575, 4576), from Union-Kern-AOG Cabawin No. 1 Well, Queensland, at 1090-1099 feet.

Formations: upper Longsight Sandstone; Roma.

Genus AMMOBACULOIDES Plummer, 1932

AMMOBACULOIDES PITMANI Crespin, 1953

(Pl. 16, Figs. 5-7)

Ammobaculoides pitmani Crespin, 1953, *Contr. Cushm. Fdn foram. Res.*, 4 (1), p. 30, pl. 5, fig. 12.

This small species of *Ammobaculoides* does not occur as commonly in the beds of the Roma Formation as *A. romaensis*. It has also been found in beds stratigraphically higher than the Roma Formation.

Occurrence: Hypotypes A, B, C (CPC 4577, 4578, 4579), Bungeworgorai Creek, 5 miles west of Roma, Queensland, south side of Great Western Railway line.

Formation: Roma.

AMMOBACULOIDES ROMAENSIS Crespin, 1953

(Pl. 16, Figs. 1-4)

Ammobaculoides romaensis Crespin, 1953, *Contr. Cushm. Fdn foram. Res.*, 4 (1), p. 31, pl. 5, figs. 13, 14.

This large species of *Ammobaculoides* is characteristic of the beds of the Roma Formation, not only at the type locality for the formation at Bungeworgorai Creek, Roma, but in bores in the Roma area.

Occurrence: Hypotypes A, B, C (CPC 4580, 4581, 4582), from Bungeworgorai Creek, 5 miles west of Roma, Queensland, on south side of Great Western railway line. Hypotype D (CPC 4583) from Union-Kern-AOG Cabawin No. 1 Well, Queensland, at 800-810 feet.

Formation: Roma.

Genus TEXTULARIA Defrance, 1824

TEXTULARIA ANACOORAENSIS Crespin, 1953

(Pl. 14, Figs. 1-4)

Textularia anacooraensis Crespin, 1953, *Contr. Cushm. Fdn foram. Res.*, 4 (1), p. 31, pl. 5, fig. 15.

Description: Test small, elongate, tapering, narrow throughout, biserial, chambers numerous, periphery narrowly rounded. Minute proloculus followed by seven to nine pairs of biserially arranged chambers, very gradually increasing in size.

Suture oblique, distinct, at times thickened, depending upon preservation. Wall finely arenaceous, smoothly finished. Aperture an elongate slit in face of last-formed chamber.

Dimensions (in mm.):

	Length	Max. width
Hypotype A	0·92	0·37
Hypotype B	0·69	0·24
Hypotype C	0·89	0·29
Hypotype D	0·49	0·23

Remarks: This small species does not occur commonly in Lower Cretaceous sediments, but it is widely distributed in the Great Artesian Basin. Numerous distorted and crushed tests were found in the Kingdom Bore, Boulia area, western Queensland; some of the smaller tests were similar to that figured from the Cook Bore, Eucla Basin, South Australia.

Occurrence: Hypotypes A and B (CPC 4584, 4585) from basal beds in hills south of track 5 miles from Snake Creek Bore, on track to Junction Bore, Alderley, western Queensland (G. 158). Hypotype C (CPC 4586) from Kingdom Bore, western Queensland. Hypotype D (CPC 4587) from Cook Bore, Eucla Basin, South Australia, at 422 feet.

Formation: lower Wilgunya. Age of hypotype D—Lower Cretaceous.

TEXTULARIA WILGUNYAENSIS sp. nov.
(Pl. 14, Figs. 5-11)

Diagnosis: The test is elongate, tapering, with biserial chambers increasing in width and height as added, the last-formed pair large. The periphery is rounded, at times lobate, and sutures are oblique.

Description: Test free, elongate, tapering. Megalospheric form medium-sized, microspheric form large; biserial throughout; periphery rounded. Small globular proloculus followed by four or five pairs of chambers in megalospheric form, increasing rather rapidly in width and height as added, so that test broadens rapidly; last-formed pair of chambers about twice size of previous ones, but only slightly inflated. About ten pairs of chambers in microspheric form, which may be slightly curved, last-formed pair wide and high. Sutures oblique, at angle of approximately 90 degrees to the horizontal in the initial stages of all specimens, distinct, depressed, giving a lobate peripheral margin. Wall arenaceous, composed of small grains of quartz, some angular, and occasional other minerals in siliceous cement. Aperture large, elongate, in face of last-formed chamber.

Dimensions (in mm.):

	Length	Width at apertural end
Holotype	1·01	0·45
Paratype A	1·29	0·47
Paratype B	1·15	0·53
Paratype C	2·00	0·65

Remarks: *Textularia wilgunyaensis,* with its rapidly expanding test, rounded periphery, oblique sutures, and almost glassy finish, cannot be compared with any described species from the Lower Cretaceous. Juvenile tests are always well preserved; microspheric tests become large, the maximum length observed being 2.00 mm. The species is common in some of the beds in the lower Wilgunya Formation in western Queensland, and it has been found in beds of the Roma Formation in Union-Kern-AOG Cabawin No. 1 Well, Queensland, at 1090-1099 feet.

Occurrence: Holotype (CPC 4588) and Paratype C (CPC 4591) from Dry Bore Creek Tank, Marion Downs, western Queensland (GAB. 23). Paratypes A, B, D (CPC 4589, 4590, 4591), from near Marion Downs Homestead at side of track 4 miles south of junction with track between Bucket Creek Bore and Whitewood Tank (W. 285).

Formation: lower Wilgunya.

Genus BIGENERINA d'Orbigny, 1826

BIGENERINA LOEBLICHAE Crespin, 1953

(Pl. 14, Figs. 12-14)

Bigenerina loeblichae Crespin, 1953, *Contr. Cushm. Fdn foram. Res.,* 4 (1), p. 31, pl. 5, figs. 17, 18.

The megalospheric and microspheric forms of *B. loeblichae* usually occur together in the one sample. The microspheric test has nine or more very small biserially arranged chambers in the early portion. *B. loeblichae* occurs in beds of the Roma Formation and its equivalents in western Queensland; the type was described from the Marree Bore, northern South Australia.

Occurrence: Hypotype A (CPC 4593), Belemnite Bed, Bungeworgorai Creek, five miles west of Roma, Queensland, near Old Mount Abundance Homestead. Hypotype B (CPC 4594) from Bungeworgorai Creek Section, south side of Great Western railway line, five miles west of Roma; Hypotype C (CPC 4595) from Union-Kern-AOG Cabawin No. 1 Well, Queensland, at 850-860 feet.

Formation: Roma.

Genus BIMONILINA Eicher, 1960

BIMONILINA COONANAENSIS (Crespin), 1953

(Pl. 14, Figs. 20-22)

Ammobaculoides coonanaensis Crespin, 1953, *Contr. Cushm. Fdn foram. Res.,* 4 (1), p. 30, pl. 5, fig. 11.

Description: Test free, very small, compressed, slightly distorted, sides almost parallel, rounded periphery. Bulbous proloculus followed by four pairs of biserially arranged chambers, tending to become uniserial. Chambers slightly inflated, varying in shape due to slight compression, and gradually increasing in size. Sutures distinct, slightly oblique. Wall finely arenaceous, smooth. Aperture a terminal slit surrounded by a lip.

Dimensions: Length, 0.24 mm.; greatest width, 0.09 mm.

Remarks: The description of *B. coonanaensis* is a revision of that in Crespin (1953). The re-examination confirms the suggestion by Eicher (1960, p. 66) that it belongs to his new genus *Bimonilina* rather than *Ammobaculoides*. (The species name is misspelt '*coonaensis*' by Eicher). The close coiling mentioned in the original description is really a large megalospheric proloculus, which is well shown on one side of the test. Eicher comments further that 'the distinct way in which the chambers are added, each appearing to be the initial one of a uniserial series, is particularly suggestive of *Bimonilina*'. At present, according to Eicher, the genus is known only from the Lower Cretaceous. *B. coonanaensis* has not as yet been found in the eastern part of the Great Artesian Basin.

Occurrence: Holotype (CPC 898) from Coonana Bore, 40 miles due east of Lake Callabonna, South Australia, at the depth of 1185-1310 feet.

Age: Lower Cretaceous.

BIMONILINA VARIANA Eicher, 1960
(Pl. 14, Figs. 15-19)

Bimonilina variana Eicher, 1960, *Bull. Peabody Mus. nat. Hist.*, 15, p. 67, pl. 4, figs. 15-19.

Description: Test small, elongate, tapering, biserial throughout, periphery rounded. Large bulbous proloculus in megalospheric form, followed by six biserially arranged inflated chambers, the first pair small, the following ones increasing in size quite rapidly as added. Each biserial chamber so overlaps the preceding two chambers as to suggest that at every growth stage, the last chamber appears to be terminal, becoming uniserial. Some specimens have a slight twist to the biserial rows. Initial chambers in microspheric form in a minute coil, then followed by minute biserial chambers which, above the lower third, gradually increase in size and in inflation. Apertural chamber usually large and strongly inflated. Sutures distinct, depressed. Wall finely arenaceous, smoothly finished. Aperture a terminal slit with prominent lip in well preserved specimens.

Dimensions (in mm.):

	Length	Max. width	Thickness
Hypotype A	0·83	0·33	0·23
Hypotype B	0·89	0·40	0·20
Hypotype C	0·68	0·36	0·23
Hypotype D	0·77	0·33	0·24
Hypotype E	0·91	—	—

Remarks: This interesting form has been recorded previously by the writer as *Siphotextularia*. The Australian form with its variations is almost identical with specimens of *Bimonilina variana* Eicher (1960) from the Thermopolis Shale of Wyoming. The megalospheric specimen from western Queensland (Pl. 14, Fig.

15) closely resembles that figured by Eicher (pl. 4, fig. 15). The position of the aperture in the last-formed chamber varies, but it always appears as a slit with a thickened lip. *B. variana* differs from *B. coonanaensis* in its tapering test.

B. variana is widely but not commonly distributed in the Lower Cretaceous of Australia; the genus is apparently restricted to rocks of that age. Well-preserved tests are uncommon. It is found in the Aptian Muderong Shale of the Carnarvon Basin as well as the Great Artesian Basin.

Occurrence: Hypotype A (CPC 4596) from Peanungra Well, Glenormiston, western Queensland. Hypotypes B and C (CPC 4597, 4598), basal bed in hills south of track, 5 miles from Snake Creek Bore on track to Junction Bore, Alderley, western Queensland (G. 158). Hypotype D (CPC 4599) from AAO No. 1 Well, Roma, Queensland, at 195 feet (core 3). Hypotype E (CPC 4600) Union-Kern-AOG Cabawin No. 1 Well, Queensland, at 1090-1099 feet.

Formations: lower Wilgunya; Roma.

Family VERNEUILINIDAE

Genus VERNEUILINA d'Orbigny, 1840

VERNEUILINA HOWCHINI Crespin, 1953

(Pl. 15, Figs. 1-3)

Verneuilina howchini Crespin, 1953, *Contr. Cushm. Fdn foram. Res.*, 4 (1), p. 31, pl. 5, fig. 16.

Description: Test tapering, triserial, elongate, sharply triangular in cross section, peripheral margins irregular, greatest width of test near apertural end. Sides concave, angle varying in different specimens. Initial end a group of minute quartz grains, followed by seven to nine chambers on each face, distinct and gradually increasing in size. The last-formed chamber large; in gerontic tests this chamber extends across width of test. Sutures distinct, slightly curved. Wall finely arenaceous, at times composed almost entirely of fine siliceous cement. Surface moderately smooth to rough. Aperture an opening at base of last-formed chamber, except in gerontic tests where it is round and terminal.

Dimensions: Length of holotype A, 1.31 mm.; max. width, 0.60 mm. Length of hypotype B, 1.35 mm.; max. width, 0.60 mm. Length of hypotype C, 1.52 mm.; max. width, 0.72 mm.

Remarks: *V. howchini* is common in surface samples from localities in the Great Artesian Basin, especially those within the Mount Whelan 1:250,000 Sheet; the specimens show a variety of shapes and sizes. It is also found in beds of the Roma Formation at Bungeworgorai Creek, Roma, and in Lower Cretaceous sediments in Western Australia.

Occurrence: Hypotype A (CPC 4601) from Mount Whelan, western Queensland (W. 40). Hypotypes B and C (CPC 4602, 4603) from Marion Downs Homestead, side of track 4 miles south of junction with track between Bucket Creek Bore and Whitewood Tank, western Queensland (W. 285).

Formation: lower Wilgunya.

Genus VERNEUILINOIDES Loeblich & Tappan, 1949

VERNEUILINOIDES ASPERULUS sp. nov.

(Pl. 15, Figs. 8-12)

Diagnosis: This small species has a tapering test which may be straight or gently curved. It is triserial throughout and the sides are rounded. The surface is rough, with small quartz grains in little cement.

Description: Test small, tapering, with greatest width at apertural end, straight or gently curved, sides rounded in cross section. Chambers numerous, slightly inflated, gradually increasing in size. Sutures indistinct, depressed. Wall arenaceous, consisting of small subangular to rounded quartz grains in little cement. Surface rough. Aperture low opening at base of final chamber.

Dimensions (in mm.):

	Length	Max. width
Holotype	0·66	0·28
Paratype A	0·98	0·28
Paratype C	0·59	0·24
Paratype D	0·56	0·23

Remarks: All specimens of *V. asperulus* are small and vary little in length. Species of *Verneuilinoides* with roughened surfaces are few; *V. canadensis* (Cushman) 1927 from the Cretaceous of Alberta has a rough test, but it differs from *V. asperulus* in its large size and distinct sutures. *V. borealis* Tappan, 1957, from the Lower Cretaceous of Alaska is occasionally rough. However, it differs from *V. asperulus* in its more rapidly flaring test and the more inflated chambers. At present *V. asperulus* is restricted to the lower Wilgunya Formation of the Great Artesian Basin in Queensland.

The specific name is taken from the Latin *asperulus,* rough.

Occurrence: Holotype (CPC 4604), Mount Whelan, western Queensland (W. 40). Paratype A (CPC 4605), 11 miles south-west of 8 mile Yard near track to Whitewood Tank on Herbert Downs, western Queensland (W. 206). Paratypes B and C (CPC 4606, 4608), Breadalbane No. 3 Bore, 20 miles west of Breadalbane Homestead, western Queensland (GAB. 218). Paratype D (CPC 4608), AAO No. 8 Karumba Well, northern Queensland, at 2095-2100 feet.

Formations: lower Wilgunya; Blackdown.

VERNEUILINOIDES KANSASENSIS Loeblich & Tappan, 1950

(Pl. 15, Figs. 4-7)

Verneuilinoides kansasensis Loeblich & Tappan, 1950, *Univ. Kansas, paleont. Contr.*; *Protozoa, Art.*, 3, p. 10, pl. 2, figs. 1*a, b*; 2*a, b*.

Verneuilinoides kansasensis Loeblich & Tappan, Eicher, 1960, *Bull. Peabody Mus. nat. Hist.*, 15, p. 69, pl. 5, figs. 7-10.

This small species of *Verneuilinoides* from the Great Artesian Basin is referred to *V. kansasensis* Loeblich & Tappan from the Lower Cretaceous Kiowa Shale of Kansas, where it occurs abundantly. The chambers are triserially arranged with the angles rounded, the chambers gradually increasing in size and very slightly inflated. The sutures are distinct and depressed, and the wall finely arenaceous and smoothly finished. The aperture is a low arch at the base of the last-formed chamber.

V. kansasensis is present in many bores in the Great Artesian Basin of northern New South Wales and has been recorded by the writer (Crespin, 1955) as *V. schizea* (Cushman & Alexander).

Occurrence: Hypotypes A and B (CPC 4609, 4610), W.C. and I.C. Bore 8302, Wanaaring, northern New South Wales, at 600 feet. Hypotype C (CPC 4611) from shaley beds from lowest part of No. 2 Tank, Springvale, western Queensland (S. 241). Hypotype D (CPC 4612) Jack's (New Limestone) Bore, Canary Station, western Queensland.

Formation: Hypotype C, upper Wilgunya; hypotype D, lower Wilgunya. Age of hypotypes A and B, lower Cretaceous.

Family VALVULINIDAE

Genus DOROTHIA Plummer, 1931

DOROTHIA FILIFORMIS (Berthelin), 1880
(Pl. 16, Fig. 8)

Gaudryina filiformis Berthelin, 1880, *Mém. Soc. géol. France,* 3 (1), p. 25, pl. 1 (24), figs. 8*a-d*.

Gaudryina filiformis Berthelin, Chapman, 1892, *J. Roy. microsc. Soc.*, p. 4, pl. 11, fig. 7.

Gaudryina filiformis Berthelin, Wickenden, 1932, *J. Paleont.*, p. 205, pl. 29, fig. 4.

Dorothia filiformis (Berthelin), Cushman, 1937, *Contr. Cushm. Lab., Spec. Publ.*, 8, p. 73, pl. 8, figs. 1, 2.

Dorothia filiformis (Berthelin), Bartenstein, 1954, *Senck. Leth.*, 35 (1/2), p. 39, pl. 1, figs. 14, 15.

Description: Test small, elongate, slender, gently tapering, early chambers triserial, consisting of about six chambers, followed by four pairs of biserially arranged chambers. Chambers distinct and becoming increasingly inflated as added. Sutures distinct, depressed, slightly oblique in early portion but straightening in adult. Wall finely arenaceous; surface smooth. Aperture slit at inner margin of last-formed chamber.

Dimensions: Length, 0.65 mm.; max. diam., 0.24 mm.

Remarks: A few specimens of this well-known species from the Albian of Europe were found in the lower Wilgunya Formation of western Queensland.

Occurrence: Hypotype (CPC 4613), New (1959) Bore, Etheldale, western Queensland.

Formation: Roma equivalent.

Dorothia grandis sp. nov.
(Pl. 16, Figs. 9-17)

Diagnosis: The test is large, gently tapering, straight or irregularly curved, with a rounded periphery, and oval in cross section. The early portion is rounded with chambers in a triserial arrangement; the biserial portion consists of four pairs of chambers, gradually increasing in size. The wall is composed of quartz grains and other minerals.

Description: Test free, large, elongate, gently tapering, straight or irregularly curved, oval in cross section, periphery rounded. Early portion globular with a few triserially arranged chambers, then becoming biserial, the triserial portion forming about one third of length of test. Biserial portion of four pairs of chambers, gradually increasing in width but rather more rapidly in height, last pair large and rounded. Sutures obscure in triserial portion, depressed and straight in biserial portion. Wall arenaceous, composed of angular quartz grains and sub-angular to rounded grains of black mineral (ilmenite) and pink mineral (? zircon), in fine siliceous cement. Surface chiefly rough. Aperture a broad slit in crushed specimens to an ovate opening at the base of the last-formed chamber.

Dimensions (in mm.):

	Length	Max. width	Width at initial end
Holotype	1·67	0·48	0·24
Paratype A	1·60	0·49	0·26
Paratype B	1·67	0·53	0·29
Paratype C	1·41	0·53	0·33
Paratype D	0·87	0·39	0·17
Paratype E	1·43	0·49	0·24
Paratype F	1·20	0·51	—

Remarks: *Dorothia grandis,* with its straight to somewhat irregularly shaped test, short triserial portion, and longer biserial portion, shows some resemblance to *D. chandlerensis* Tappan 1957 from the upper Aptian beds of northern Alaska. It differs in having fewer biserial chambers and a more ovate shaped test. Juvenile tests consist almost entirely of rounded triserial chambers. Irregularly shaped tests were common in a sample from Dribbling Bore, western Queensland. At present *D. grandis* is restricted to the Roma Formation equivalents in the Great Artesian Basin.

Occurrence: Holotype (CPC 4614) from Union-Kern-AOG Cabawin No. 1 Well, Queensland, at 1108 feet-1108 feet 4 inches (core 2). Paratypes A, B, C, F (CPC 4615, 4616, 4617, 4620), from Dribbling Bore, Sandringham, western Queensland, at 470-489 feet. Paratype D (CPC 4618), Union-Kern-AOG Cabawin No. 1 Well, at 1120-1130 feet. Paratype E (CPC 4619), Union-Kern-AOG Cabawin No. 1 Well, at 1109-1120 feet.

Formations: Roma; upper Longsight Sandstone.

Family Silicinidae

Genus Miliammina Heron-Allen & Earland, 1930

Miliammina sproulei Nauss var. gigantea Mellon & Wall, 1956

(Pl. 15, Figs. 13-18)

Miliammina sproulei Nauss var. *gigantea* Mellon & Wall, 1956, *Alberta Res. Counc. Rep.*, 72, p. 21, pl. 1, fig. 1.

The specimens from Murray's Bore, northern New South Wales, closely resemble *M. sproulei* var. *gigantea,* described by Mellon & Wall from the Lower Cretaceous Middle Albian beds of the McMurray Formation of Alberta, where it occurs abundantly. Several specimens were available from the New South Wales locality, but the majority were badly crushed, as were the Canadian specimens.

The figured specimens, which are compressed, vary in length from 0.88 mm. to 1.07 mm.; the holotype of the Canadian form has a length of 0.9 mm. Three tubular chambers are present on one side and four on the other. The wall is finely arenaceous. The aperture appears as a round opening at the end of the last-formed chamber on a short but distinct neck and is surrounded by a lip.

Occurrence: Hypotypes A, B, C (CPC 4621, 4622, 4623), from W.C. and I.C. Bore 6763, northern New South Wales, at 277 feet.

Age: Lower Cretaceous.

Family Rzehakinidae

Genus Psamminopelta Tappan, 1957

Psamminopelta cf. bowsheri Tappan, 1957

(Pl. 15, Figs. 19, 20)

Psamminopelta bowsheri Tappan, 1957, *U.S. nat. Mus. Bull.*, 215, p. 211, pl. 67, figs. 11-18, 22-24.

The figured specimens, with their ovate outline, flattened, finely arenaceous tests consisting of a long narrow tubular planispirally arranged chambers, each a half coil in length and only very slightly overlapping earlier coils, closely resemble *P. bowsheri,* the type species of the genus, described by Tappan from the Lower Cretaceous Grandstand Formation of northern Alaska.

Occurrence: Figured specimens A and B (CPC 4624, 4625) from BMR 4 Wallal Bore, Canning Basin, Western Australia, core 9, at 888-898 feet.

Age: Upper Jurassic or Lower Cretaceous.

Family TROCHAMMINIDAE

Genus TROCHAMMINA Parker & Jones, 1859

TROCHAMMINA DELICATULA sp. nov.

(Pl. 17, Figs. 1-10)

Diagnosis: This small finely arenaceous species consists of numerous chambers, which increase rather rapidly in size and the centre of which has usually collapsed. The peripheral margin is lobate. An umbilicus is usually present on the ventral surface and the sutures are curved.

Description: Test small, compressed, planoconvex, consisting of three whorls, dorsal surface flat, ventral surface slightly convex, periphery narrowly rounded. Chambers numerous with central portion of each usually concave, due to collapse of wall. On dorsal surface, initial chambers minute, depressed, followed by six chambers in second whorl, gradually increasing in width, more rapidly in height; ten to thirteen chambers in final whorl, also increasing rather rapidly in size. On ventral surface, ten to twelve chambers in final whorl, umbilicus deep in some specimens, plugged in others. Sutures distinct, thickened, curved, becoming more strongly so in later part of whorl, giving distinctly lobate outline to peripheral margin. Wall thin, finely arenaceous; surface smooth. Aperture on ventral margin of last-formed chamber.

Dimensions (in mm.):

	Max. diameter	Max. thickness
Holotype	0·56	0·17
Paratype A	0·51	0·13
Paratype B	0·53	0·16
Paratype C	0·56	0·15

Remarks: This small delicate species of *Trochammina*, with its numerous chambers and curved sutures, cannot be compared with any described species. It is apparently restricted to the upper Wilgunya Formation.

Occurrence: Holotype (CPC 4626) at foot of hills 100 yards west of Hilary Tank, 66 miles north of Bedourie, west Queensland (GAB. 205). Paratypes A, B, and C (CPC 4627, 4628, 4629), about 4 miles north-east of northernmost of the Three Sisters (Breadalbane), western Queensland (GAB. 66a).

Formation: upper Wilgunya.

TROCHAMMINA DEPRESSA Lozo, 1944

(Pl. 17, Figs. 11-21)

Trochammina depressa Lozo, 1944, *Amer. mid Nat.*, 31 (3), p. 552, pl. 2, figs. 4*a*, *b*; 5.
Trochammina depressa Lozo, Loeblich & Tappan, 1949, *J. Paleont.*, 23 (3), p. 256, pl. 49, figs. 1, 2.
Trochammina depressa Lozo, Bartenstein & Brand, 1951, *Abh. senck. naturf. Ges.*, 485, p. 280, pl. 4, fig. 96.
Trochammina depressa Lozo, Frizzell, *Texas Bur. econ. Geol., Rep. Invest.*, 22, p. 79, pl. 7, figs. 13*a*, *b*.

The specimens figured here closely resemble *T. depressa* Lozo from the Lower Cretaceous of northern Texas, though they are not so compressed as the type figures. They have ten chambers which increase in size as added, the last one large. The peripheral margin of the chambers has an outline of clear cement, such as is present in the figures given by Lozo. Many specimens of this delicate form, most compressed or distorted, were present in samples from the Marion Downs area in western Queensland.

Occurrence: Hypotypes A, B, C (CPC 4630, 4631, 4632), from 12 Mile Tank, Marion Downs, western Queensland, 0-4 feet above base (GAB. 304a). Hypotype D (CPC 4633), Woolshed, Jynoomah Station, Queensland.

Formations: lower Wilgunya; Tambo.

TROCHAMMINA MINUTA Crespin, 1953

(Pl. 18, Figs. 1-5)

Trochammina minuta Crespin, 1953, *Contr. Cushm. Fdn foram. Res.*, 4 (1), p. 32, pl. 5, figs. 19*a*, *b*.

This tiny species is widely distributed in the Lower Cretaceous rocks of Australia. Its broadly rounded periphery, its convex dorsal surface, and the deep umbilicus on the ventral surface are distinctive characters.

Occurrence: Hypotype A (CPC 4634), Lower Gidyea Bore, Lorna Downs, west Queensland. Hypotype B (CPC 4635), Cook Bore, Eucla Basin near Trans-Continental Railway line, South Australia, at 604 feet.

Formation: lower Wilgunya. Age of hypotype A, Lower Cretaceous.

TROCHAMMINA RAGGATTI Crespin, 1944

(Pl. 18, Figs. 6-10)

Trochammina raggatti Crespin, 1944, *J. Roy. Soc. N.S.W.*, 78, p. 20, pl. 1, figs. 4*a-c*; 5.
Trochammina raggatti Crespin, Crespin, 1953, *Contr. Cushm. Fdn foram. Res.*, 4 (1), p. 32, pl. 6, fig. 1.

Description: Test medium sized, trochoid, dorsal surface strongly convex or compressed according to preservation, ventral surface slightly concave, periphery broadly or narrowly rounded. On dorsal surface, initial chambers minute, followed by second whorl of about four or five small chambers gradually increasing in size; last whorl of six to eight chambers increasing more rapidly in size and inflated, giving a lobate peripheral margin, last-formed chamber large and broadly triangular. Five to seven chambers on ventral side, last-formed one large, expanded to form flap over umbilical area. Sutures distinct, straight, depressed. Wall thin, arenaceous, with quartz grains and other minerals in much cement. Aperture an arched slit on inner margin of last-formed chamber, extending on ventral surface from periphery almost to umbilical area.

Remarks: With the discovery of well-preserved tests of *T. raggatti* the original description of the species (Crespin, 1944) has been revised. Specimens from localities in western Queensland, especially from the upper Longsight Sandstone, which is considered to be the equivalent of the Aptian Roma Formation, are numerous and large, but many of them are crushed and distorted. *T. raggatti* is widely distributed in Lower Cretaceous sediments in Australia.

Occurrence: Hypotype A (CPC 4636) from Dribbling Bore, Sandringham, western Queensland, at 470-489 feet. Hypotypes B and C (CPC 4637, 4638), Sandy Creek Well, Herbert Downs Station, north of Badalia Homestead, west Queensland (B. 417).

Formation: upper Longsight Sandstone.

TROCHAMMINA SUBINFLATA sp. nov.

(Pl. 18, Figs. 11-19)

Diagnosis: This small species, with its flat dorsal surface and strongly convex ventral surface, has six chambers in the last whorl, which rapidly increase in size with the last one large and inflated on the ventral side.

Description: Test small, trochoid, flat on dorsal surface, strongly convex on ventral side with small umbilicus, periphery subacute, lobate on margin. On dorsal side, chambers in early whorl small and indistinct, six in last whorl, increasing rapidly in size. Six chambers on ventral surface, increasing in size, the last one large, inflated, and roughly triangular. Sutures straight, distinct, depressed. Wall arenaceous, consisting of very small quartz grains in considerable cement. Surface smooth. Aperture on ventral side at base of last-formed chamber.

Dimensions (in mm.):

	Max. diameter	Max. thickness	Max. width of last chamber
Holotype	0·80	0·35	0·45
Paratype A	0·76	0·36	0·40
Paratype B	0·63	0·29	0·40

Remarks: *T. subinflata* shows some resemblance to *T. yubarensis,* described by Takayanagi (1960) from the Lower Cretaceous of Japan, in its few chambers in the last whorl and its large last-formed chamber. However, the Australian species has more chambers in the last whorl and the last-formed chamber on the ventral side is very much inflated.

Occurrence: Holotype (CPC 4639) and Paratype B (CPC 4641) from SOE Scout Bore No. 3, Gumbla, south-west Queensland, at 1500 feet. Paratype A (CPC 4640) from W.C. and I.C. Bore 8302, Wanaaring, northern New South Wales, at 600 feet.

Age: Lower Cretaceous.

TROCHAMMINA sp. nov.

(Pl. 18, Figs. 20-22)

Description: Only one specimen of this distinctive species was found. The test is stout and gently convex on the dorsal surface with a strong umbilicus on the ventral surface. The periphery is broadly rounded. Five chambers are in the last whorl. The wall is coarsely arenaceous, with little visible cement. The test has a diameter of 1.07 mm.

Occurrence: Figured specimen (CPC 4642) from Union-Kern-AOG Cabawin No. 1 Well, Queensland, at 1120-1130 feet.

Formation: Roma.

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LOCALITIES OF DESCRIBED SPECIMENS

QUEENSLAND

AAO No. 8 (Karumba) Well, at 2095-2100 feet.
ZCL No. 1 (Weipa) Well, core 2 at 998-1005 feet.
FBH No. 1 (Wyaaba) Well, at 2229 feet.
Elizabeth Creek, Wrotham Park.
Batavia Downs Station Well, Cape York Peninsula.
Bungeworgorai Creek, north and south sides of Great Western Railway line, 5 miles west of Roma.
Belemnite Bed, Bungeworgorai Creek, Roma, near Old Mount Abundance Homestead.
Roma Oil Bore No. 2, Mount Bassett, 7 miles north-east of Roma, at 357-425 feet.
AAO No. 1 Well, Roma, core 3, at 159 feet.
Union-Kern-AOG Cabawin No. 1 Well, 80 miles south-east of Roma, between 700 feet and 1108 feet 4 inches.
Smart Oil Exploration Scout Bore No. 3, Gumbla, at 1500 feet.

Mount Whelan 1:250,000 Sheet

Dribbling Bore, Sandringham, at 470-489 feet.
Peanungra Well, Glenormiston.
Small section of blue gypsiferous clay 3 miles south of Carlo Springs, Glenormiston Station (W. 32).
Coogiebung Tank, Marion Downs (W. 26).
4 miles north-west of Kidman's Bore, Marion Downs (W. 80).
1 mile west of gate along fence 5 miles north-west of Hilary Dam, Marion Downs (W. 261).
Marion Downs Homestead, side of track 4 miles south of junction with track between Bucket Creek Bore and Whitewood Tank (W. 285).
Dry Bore Creek Tank, Marion Downs (GAB. 23).
Mount Whelan (W. 40).
1 Mile Creek, 7 miles west-south-west along fence from Rocky Waterhole on Sherbrook (Jewlery) Creek (W. 69).
11 miles south-west of 8 Mile Yard, near track to Whitewood Tank on Herbert Downs (W. 206).
Breadalbane No. 3 Bore, 20 miles west of Breadalbane Homestead (GAB. 218).
4 miles north-east of northernmost of the Three Sisters (Breadalbane) (GAB. 66a).

Springvale 1:250,000 Sheet

Lower Gidyea Bore, Lorna Downs.
Broken Dam Bore, Canary Station.
Hills about 16 miles west of Marion Downs Homestead (S. 156).
12 Mile Tank, Marion Downs, 0-4 feet above base (GAB. 304a).
At foot of hills 100 yards west of Hilary Tank, 66 miles north of Bedourie (GAB. 205).
Netting Bore, Paton Downs.

Glenormiston 1:250,000 Sheet

Basal bed in hills south of track, 5 miles from Snake Creek Bore, on track to Junctior Bore, Alderley (G. 158).
Gaffney's No. 1 Tank, Herbert Downs, 2-3 feet above base (G. 159b).

Gilberton 1:250,000 Sheet

New (1959) Bore, Etheldale, 0-50 feet.

Boulia 1:250,000 Sheet

Kingdom Bore.

Just east of Momedah Anticline, St Lucia Station, 5 miles south-west of Brighton Bore (B. 98).

West of Momedah Anticline near track on south of Momedah Creek, 4 miles north-north-west of Little Bore, St Lucia (B. 705c).

Sandy Creek Well, north of Badalia Homestead but on Herbert Downs Station (B. 417).

Tambo 1:25,000 Sheet

Woolshed, Jynoomah Station.

NEW SOUTH WALES

Water Conservation and Irrigation Commission Bores

Bore 6763. D. L. J. Murray, Goolgumble, Bourke, at 265 and 277 feet.

Bore 8264. E. W. Robinson, Womparley, Bourke, at 1000 feet.

Bore 8271. K. F. Robinson, Talyeale, Hungerford.

Bore 8302. J. J. Doohan, Yarralee, Wanaaring, at 600 and 750 feet.

SOUTH AUSTRALIA

Kopperamanna Bore, north-east South Australia, at 1,907 feet.

Coonana Bore, 40 miles due east of Lake Callabonna, at 1,186-1,300 feet.

Cook Bore, Nullarbor Plains, at 423 and 604 feet.

SOUTHERN NORTHERN TERRITORY

Anacoora Bore, at 830-840 feet.

WESTERN AUSTRALIA

Carnarvon Basin

Middalya Station, 18 miles south of Homestead and 19½ miles north-easterly from Hill Springs Homestead (MG. 224).

WAPET Rough Range No. 4 Well, core 12, at 2640 feet; core 14, at 3670 feet; core 17 at 3715 feet.

WAPET Rough Range No. 7 Well, core 1, at 2360-2375 feet.

Canning Basin

BMR 4 Wallal Bore, core 9, at 888-898 feet.

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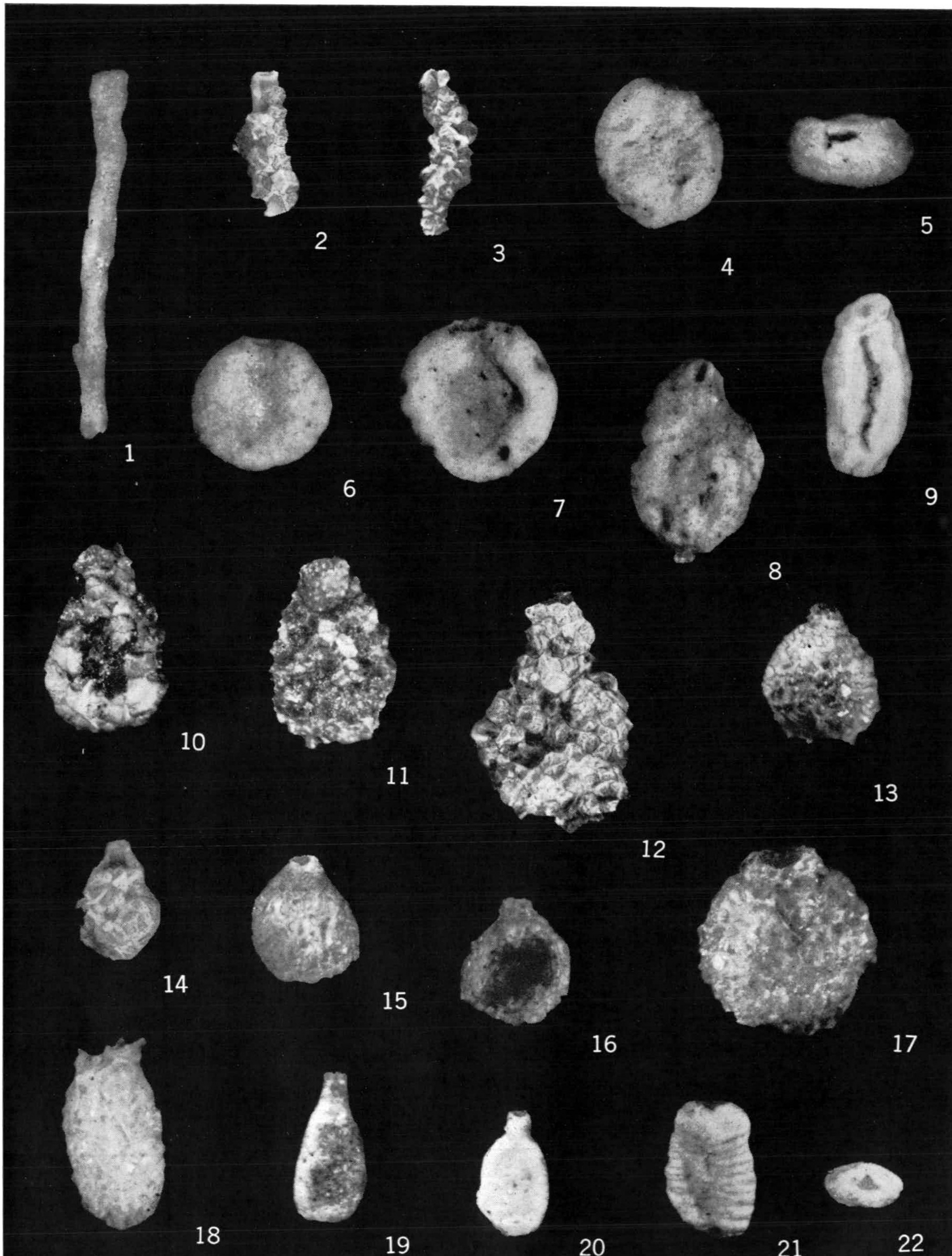

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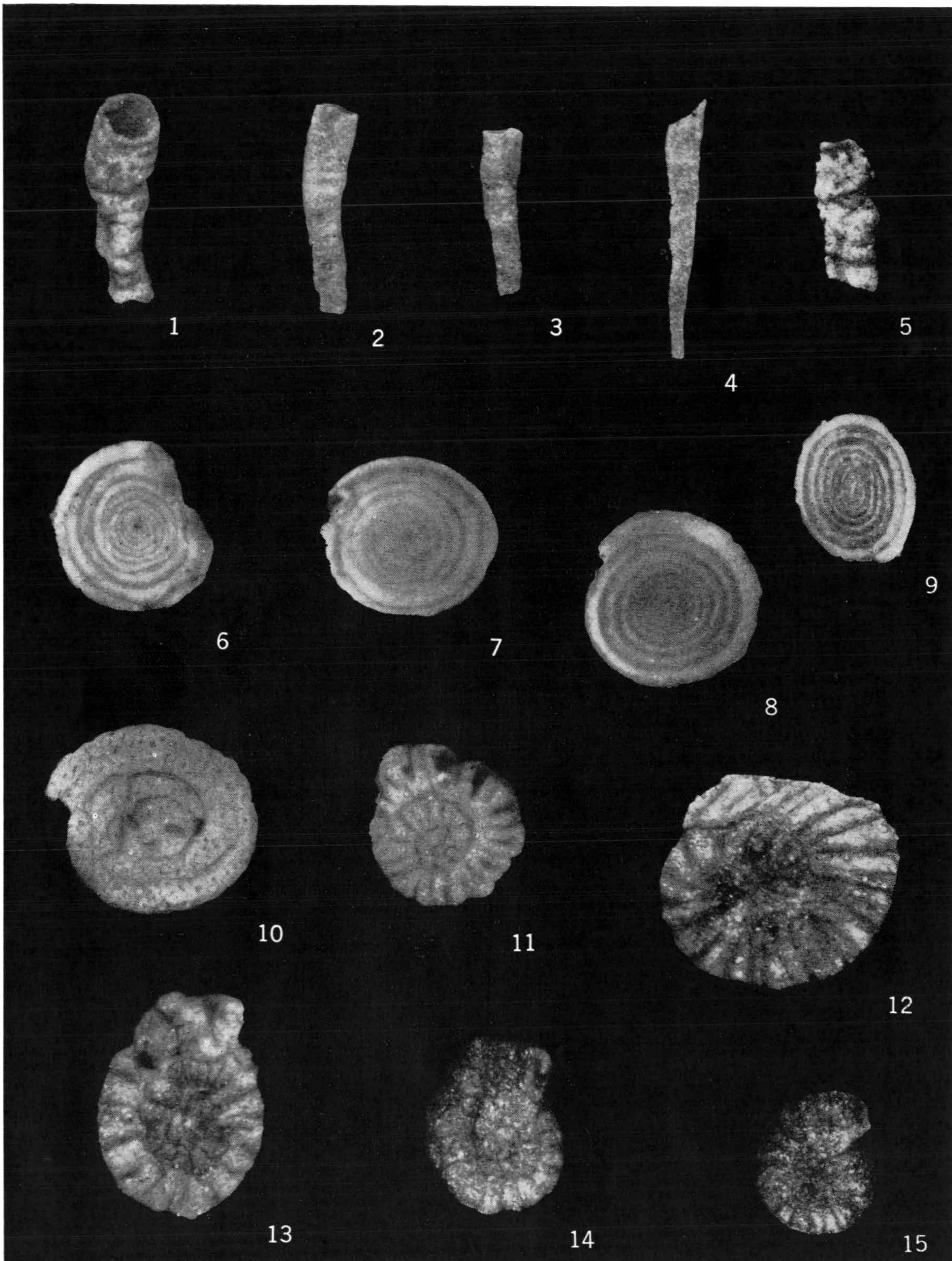

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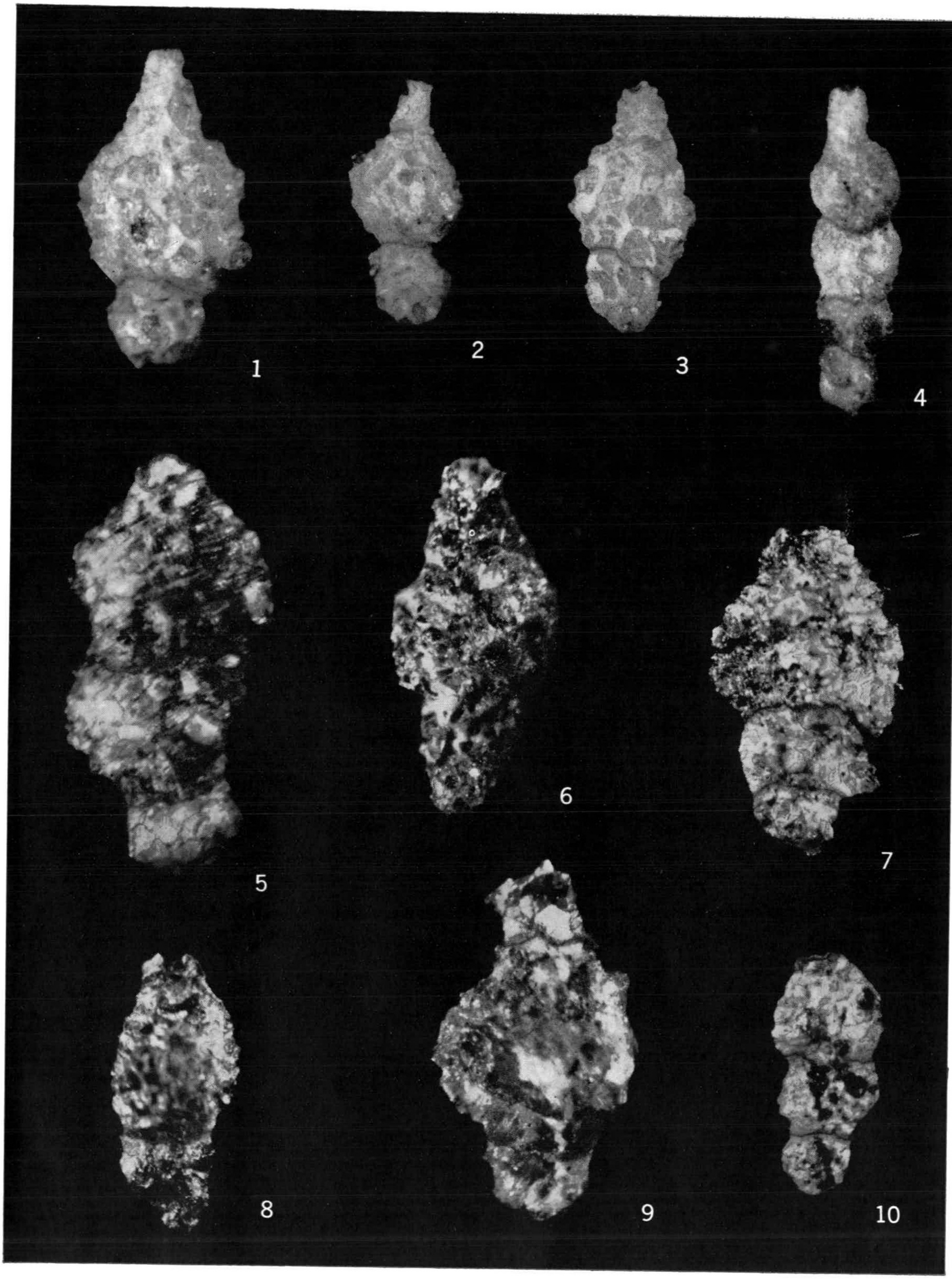

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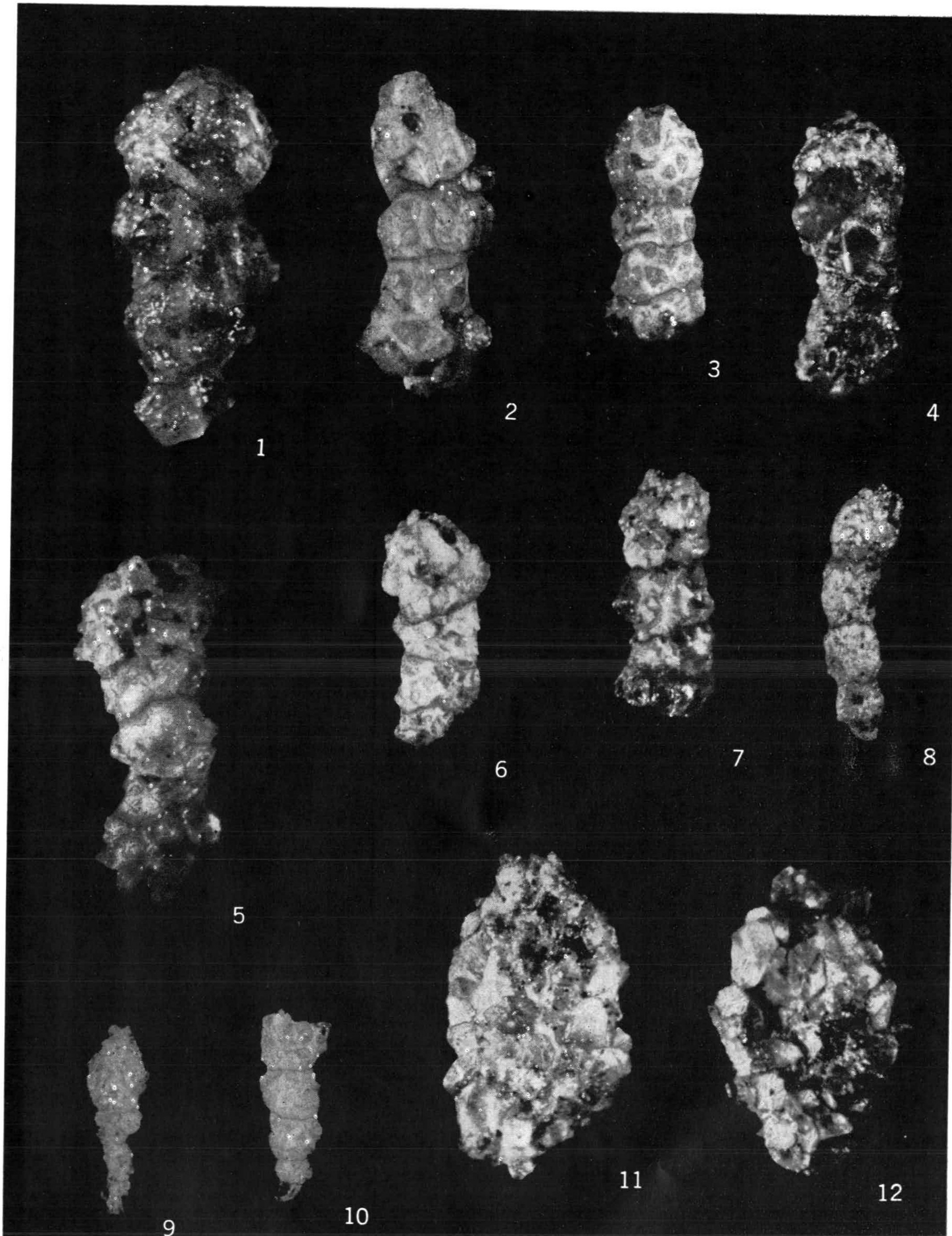

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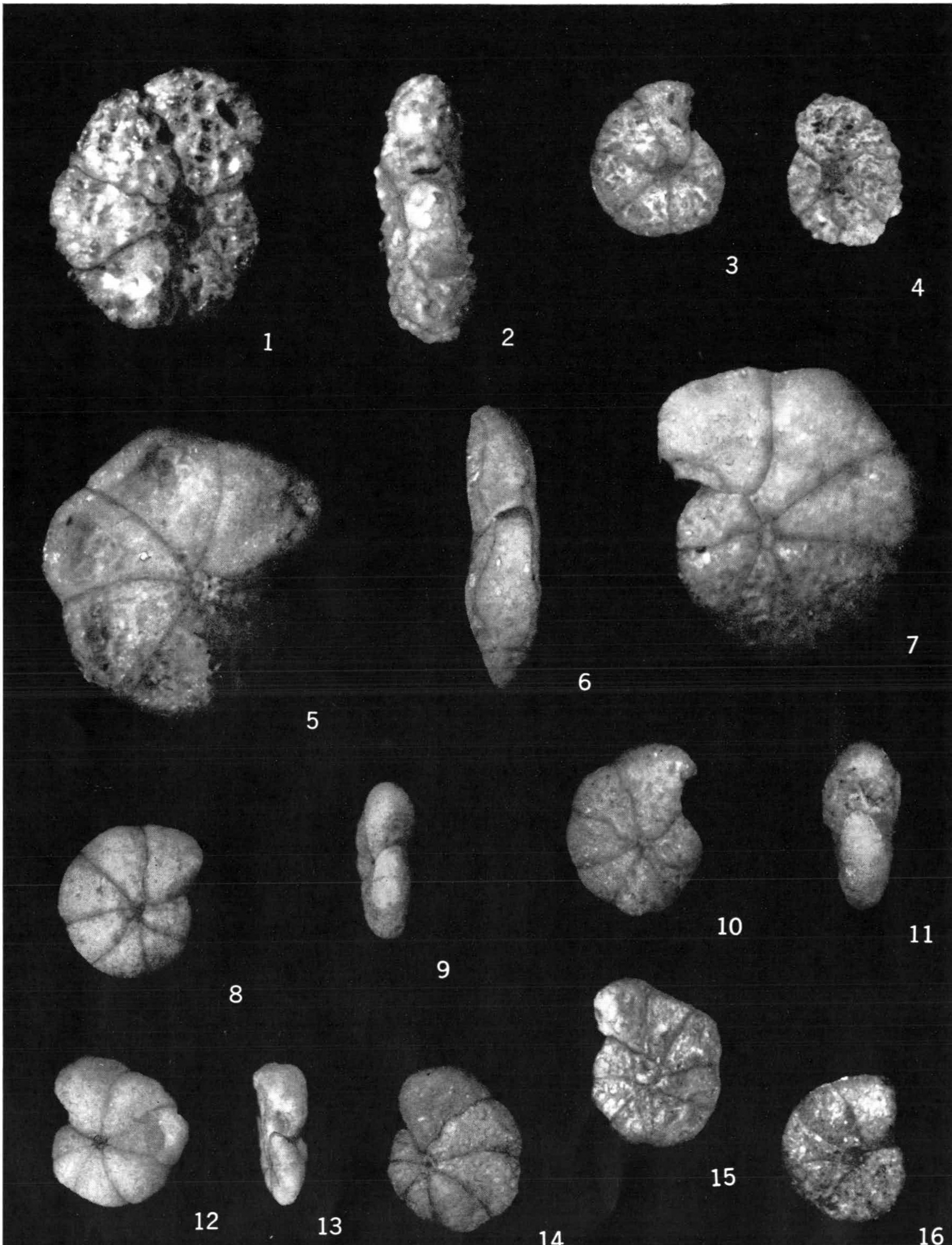

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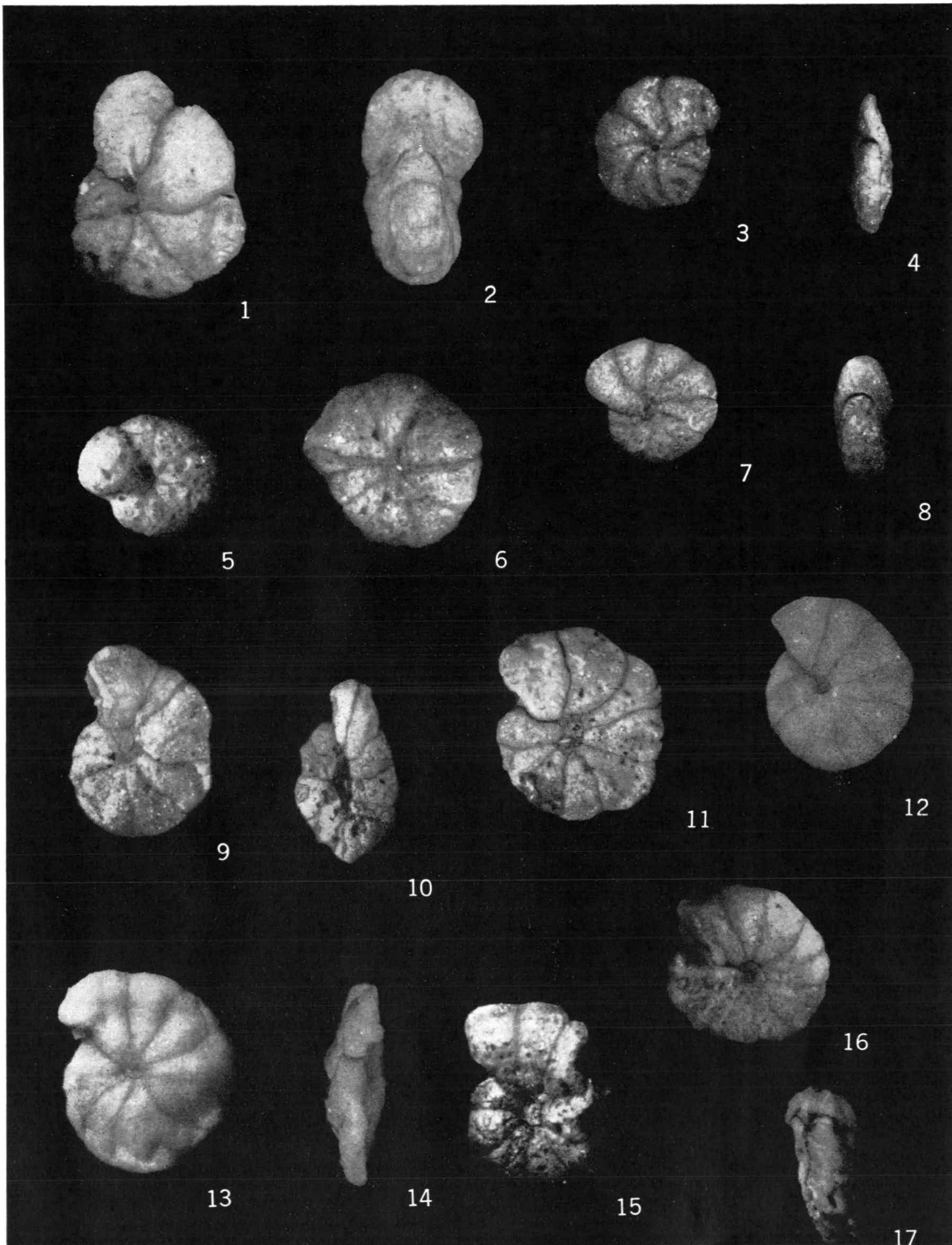

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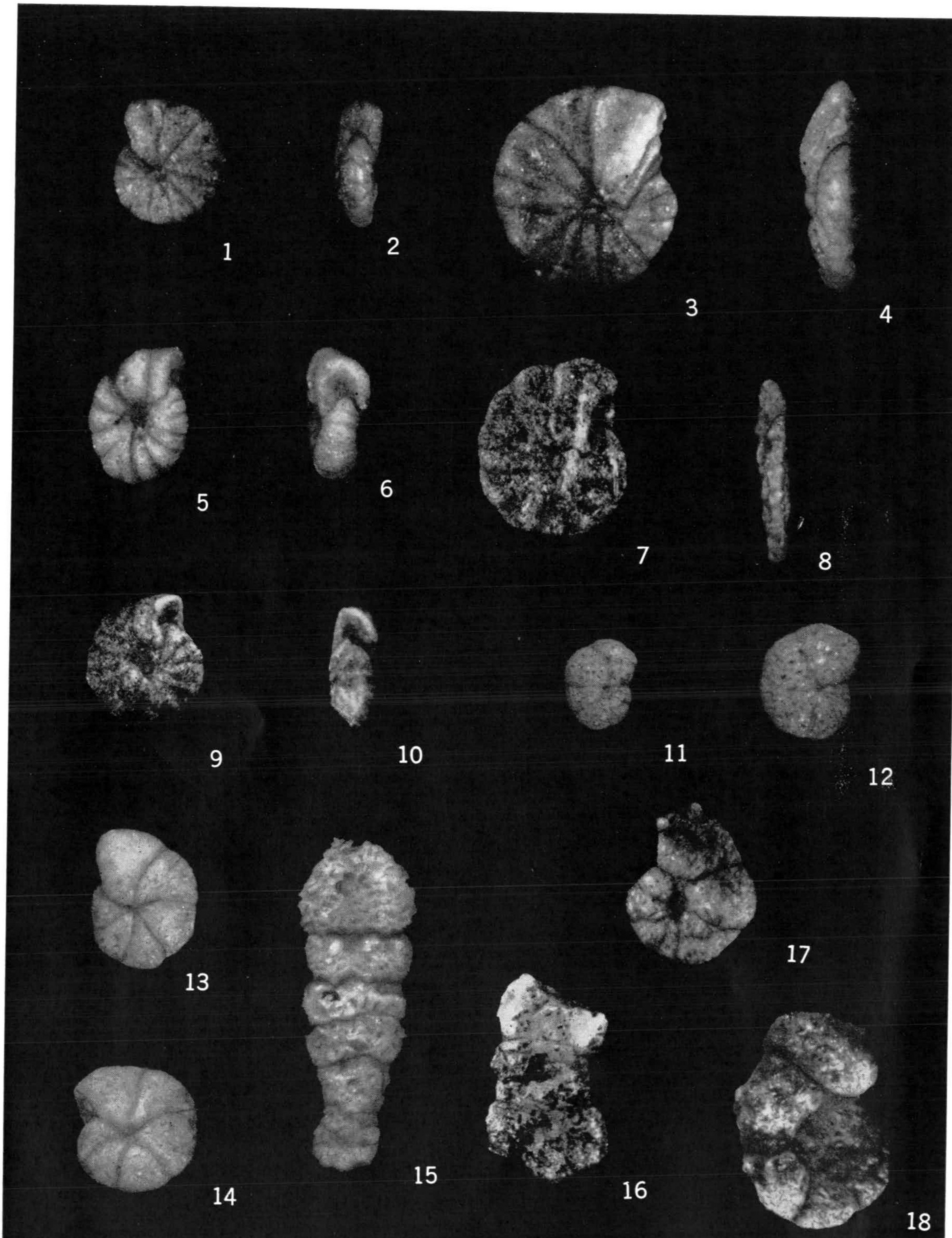

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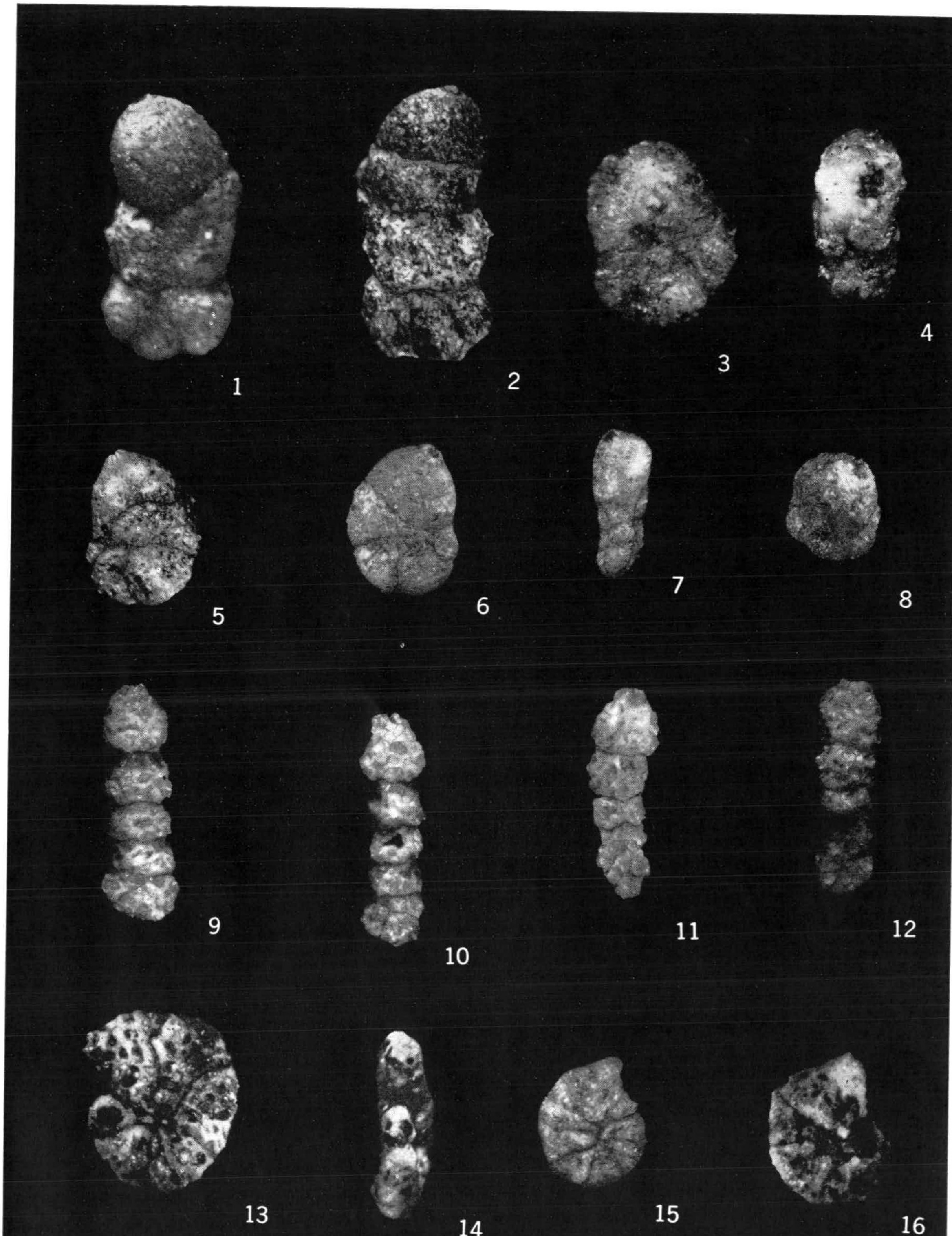

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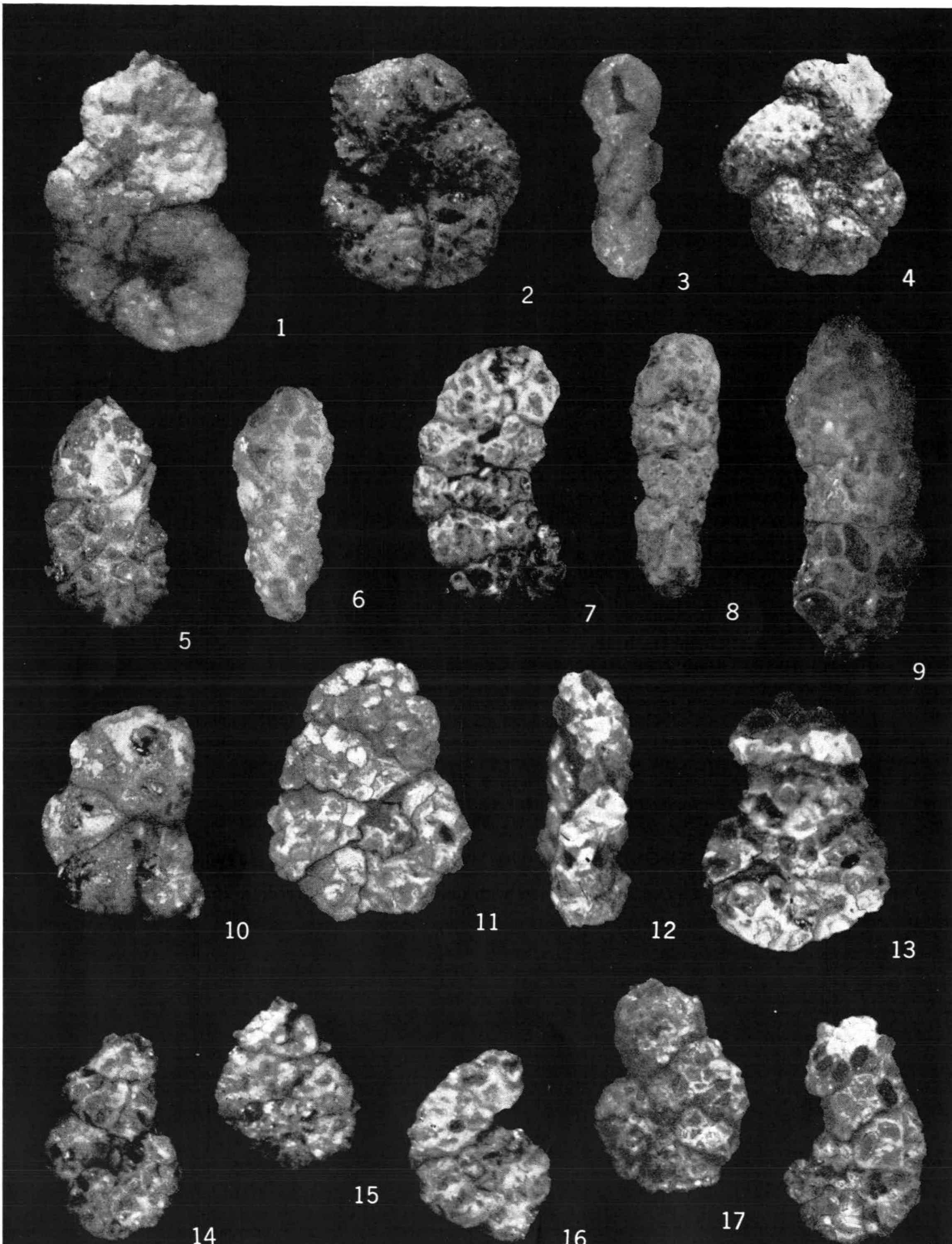

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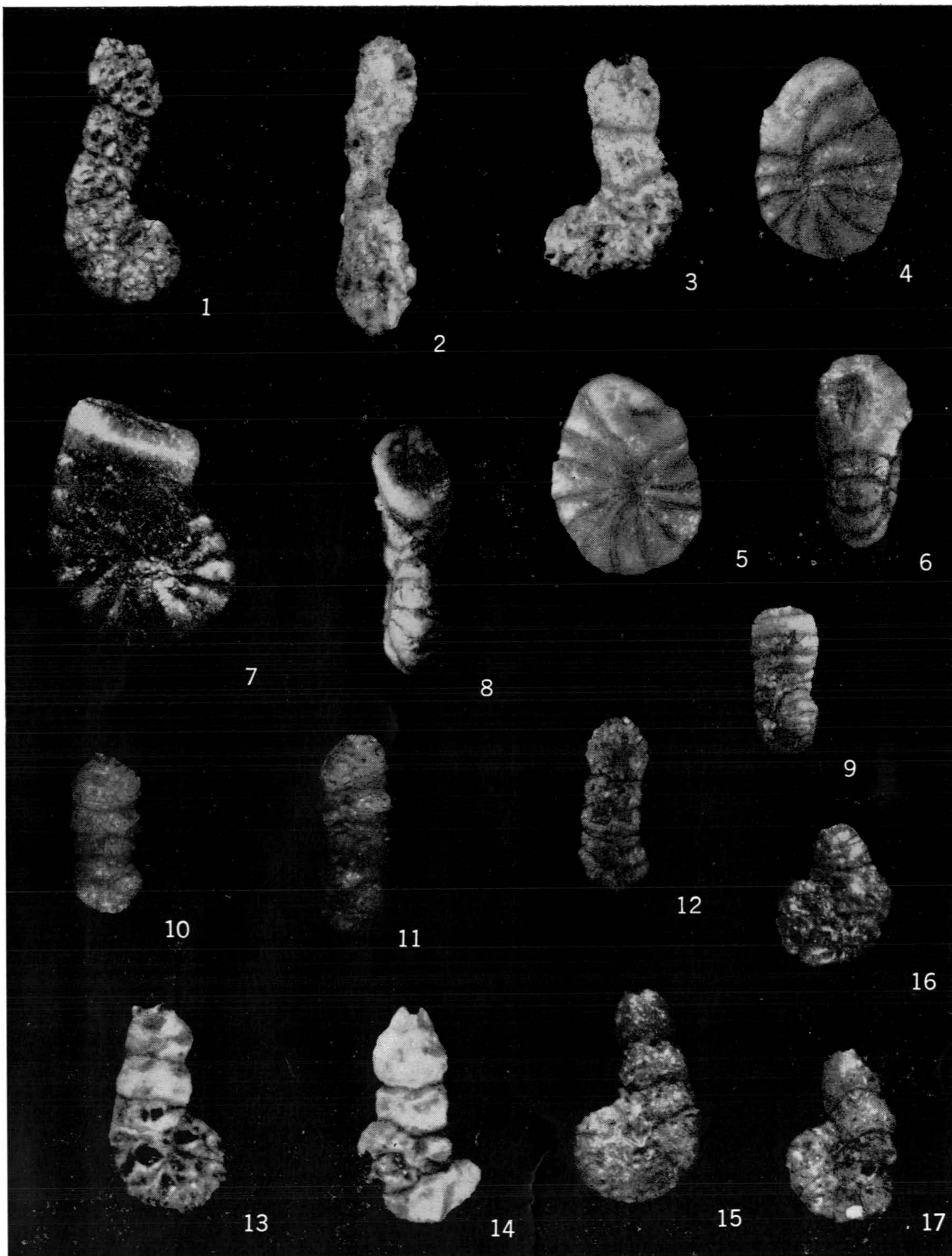

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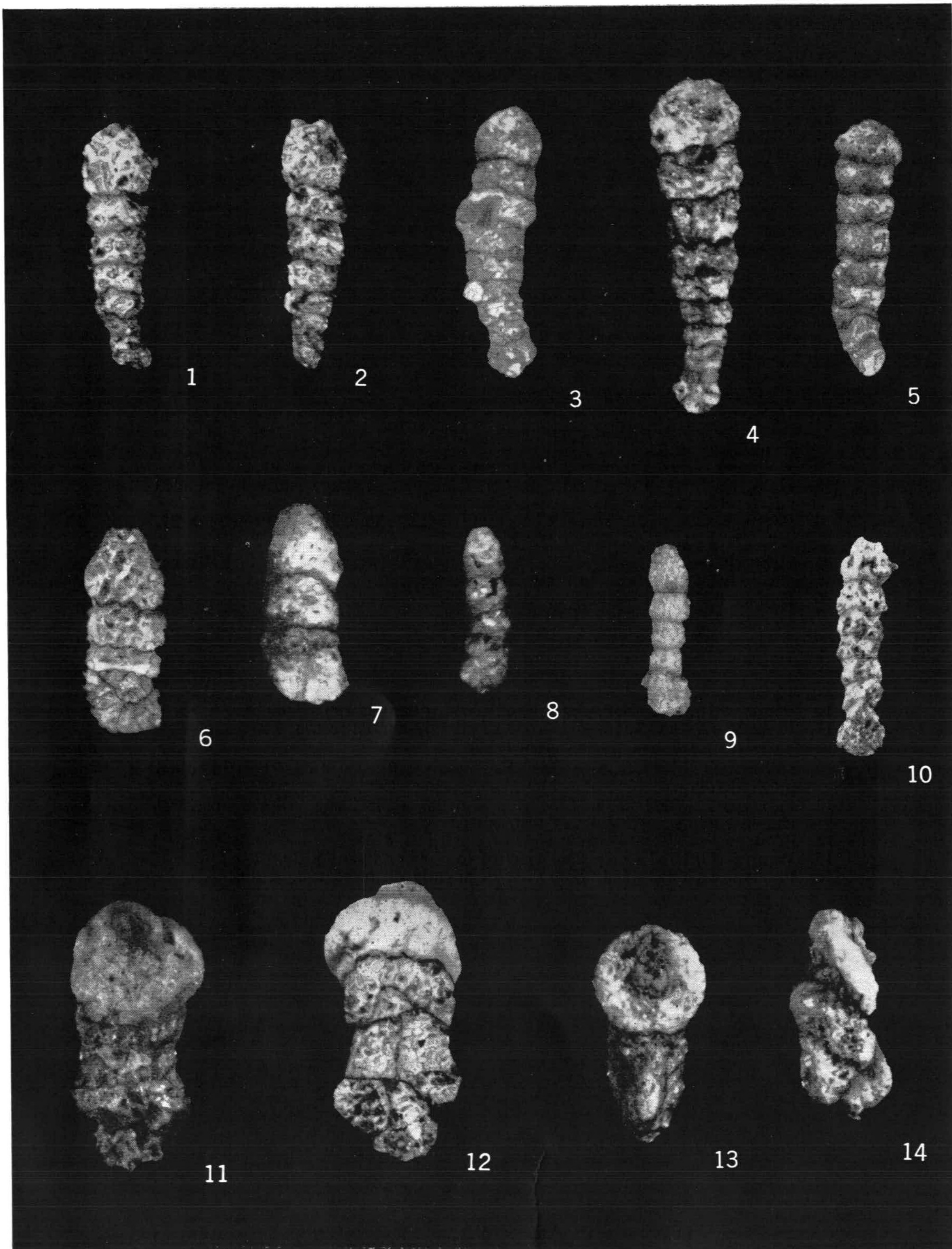

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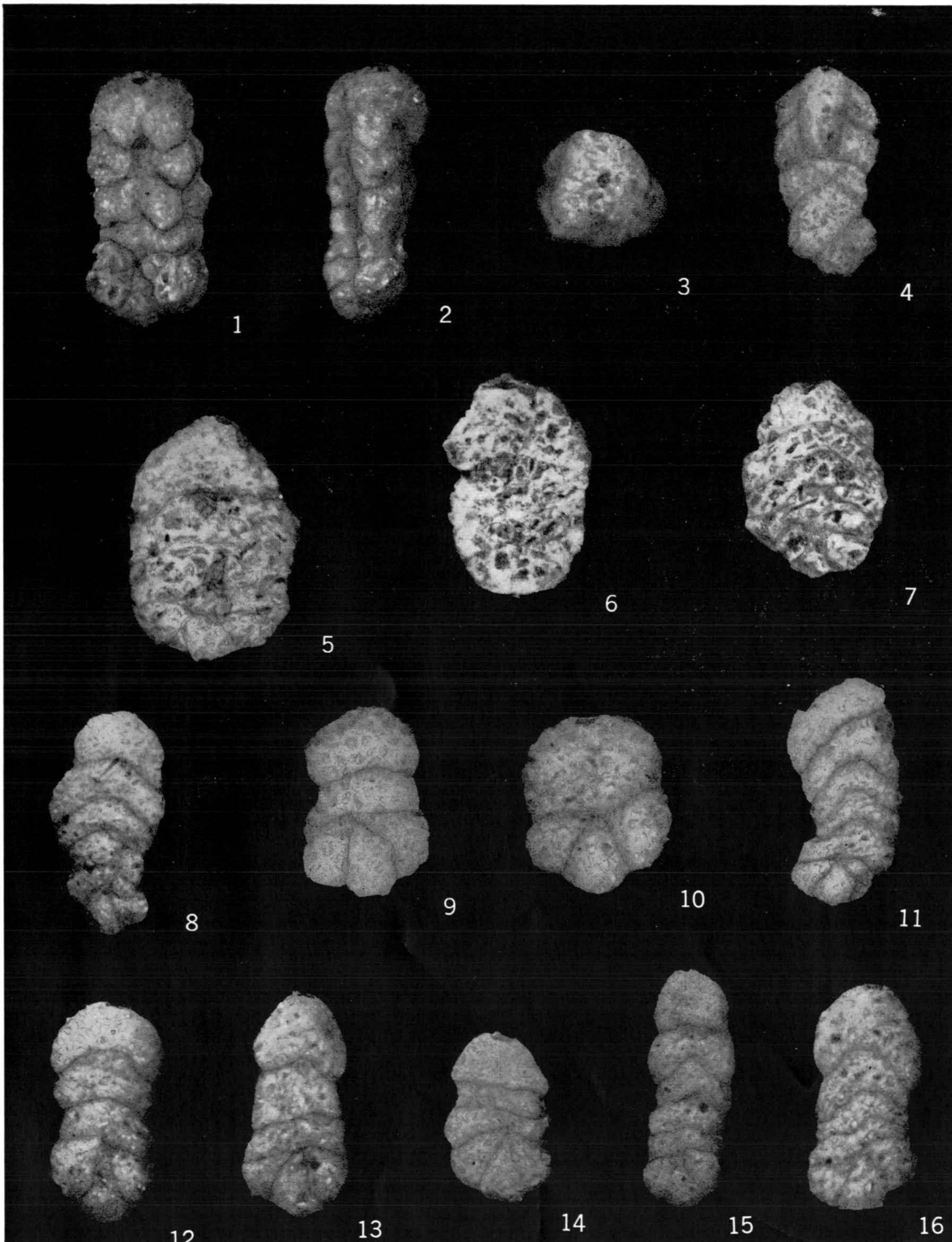

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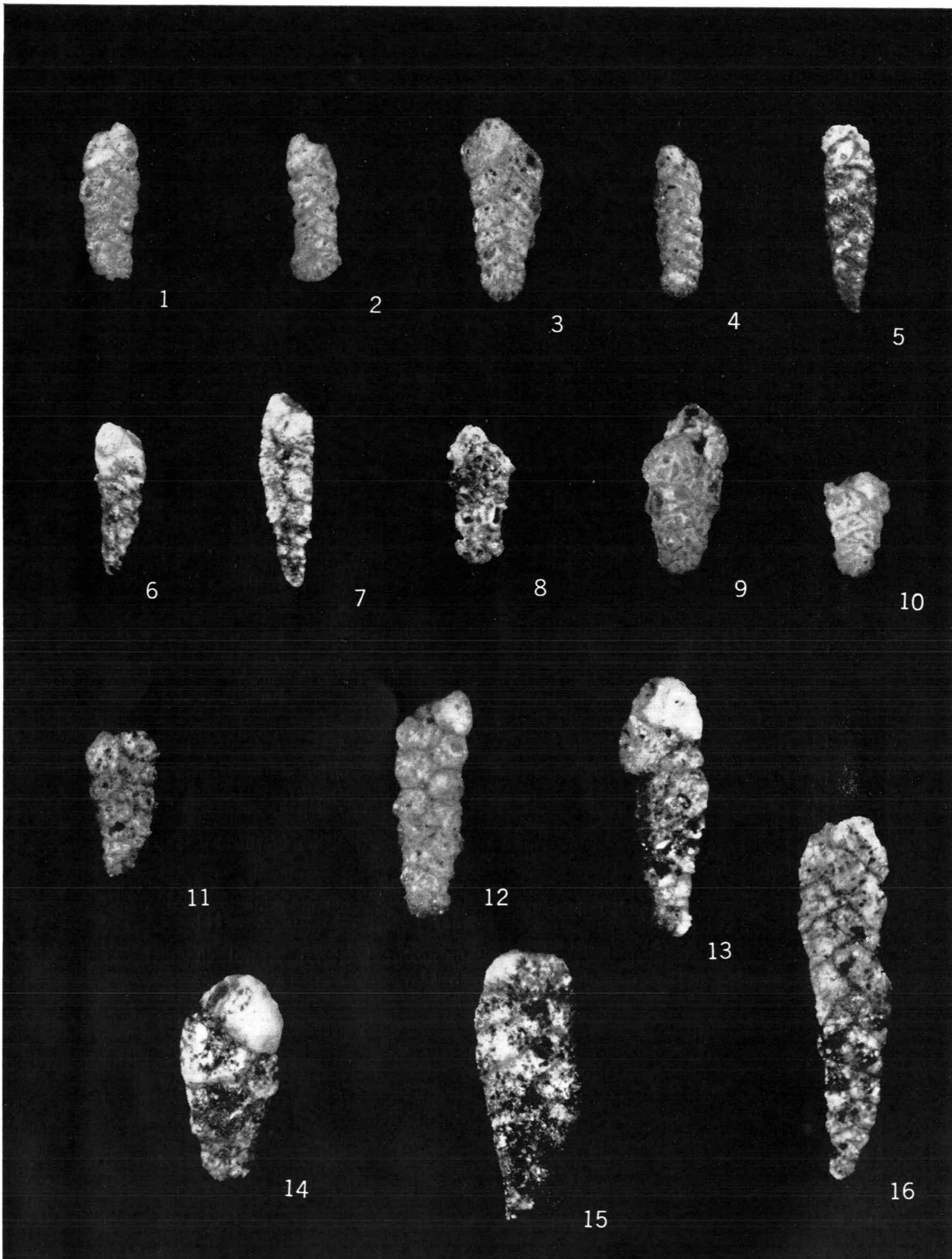

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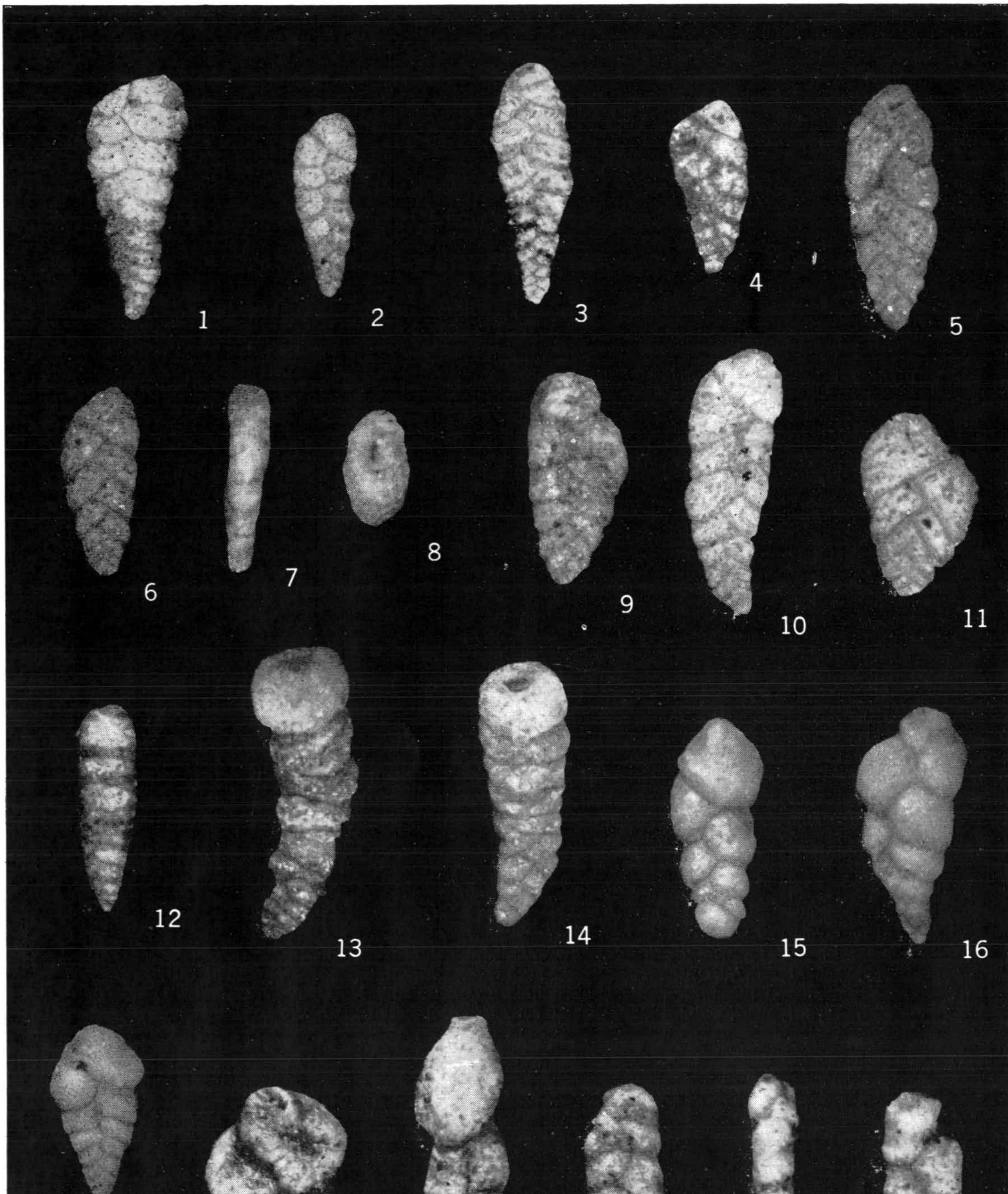

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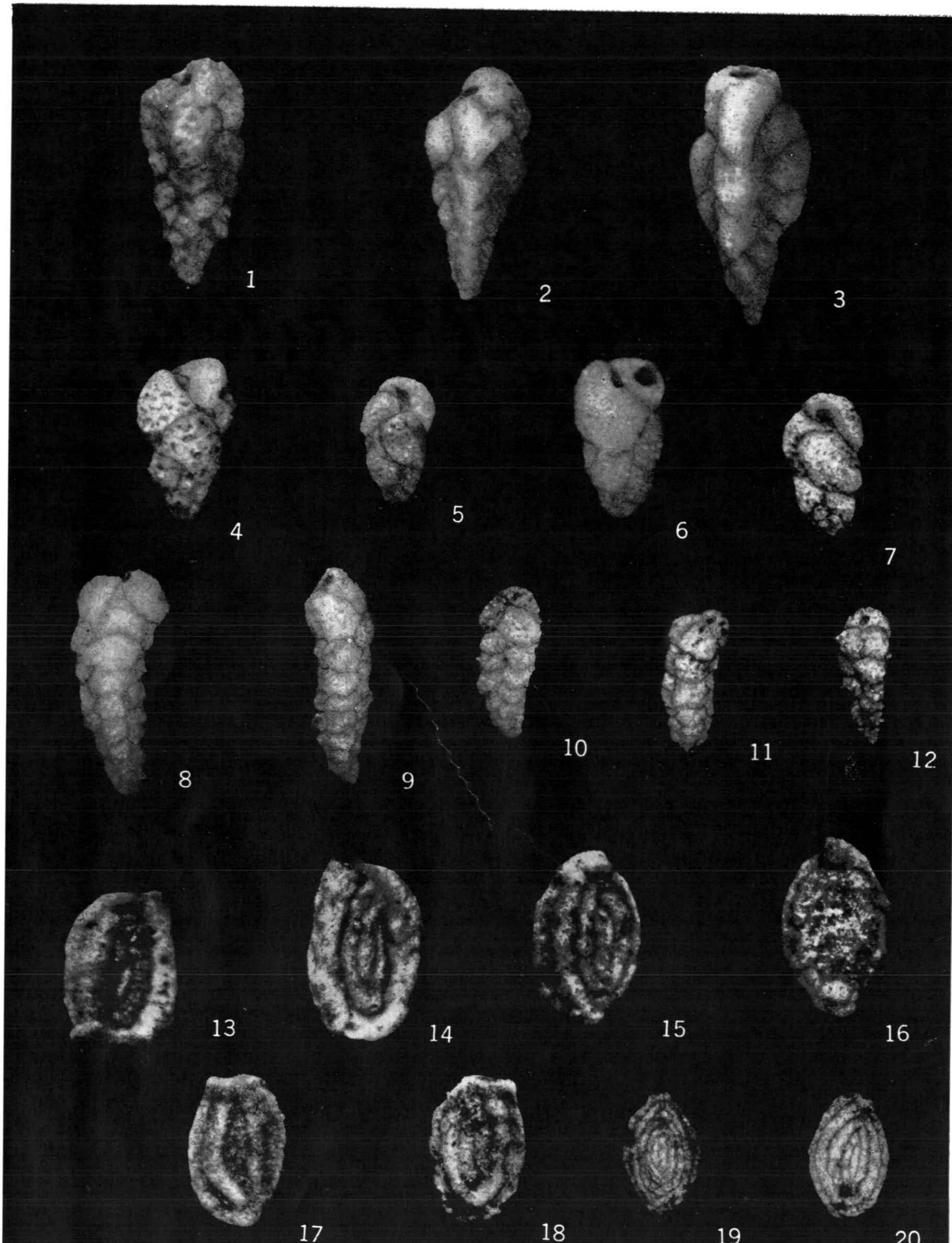

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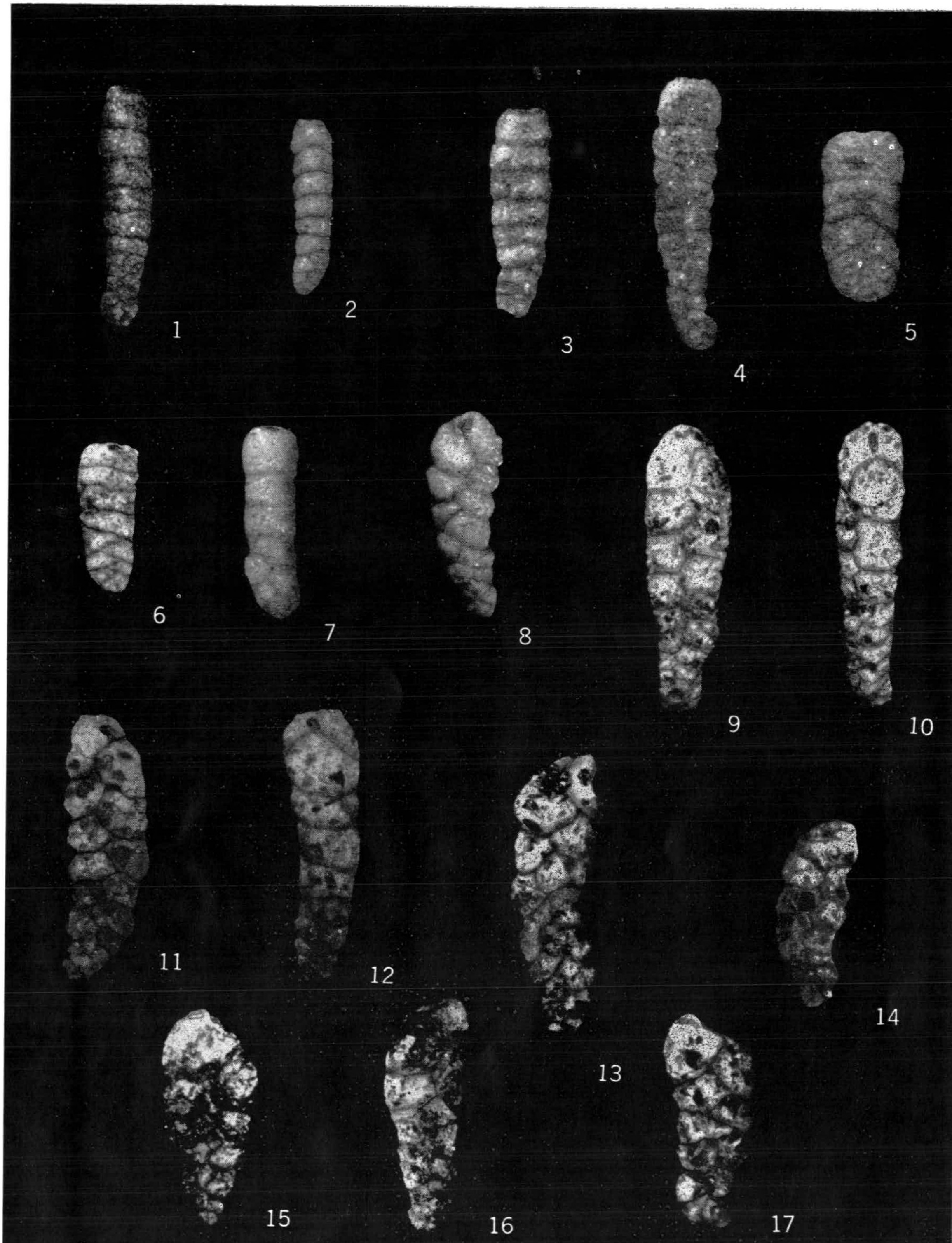

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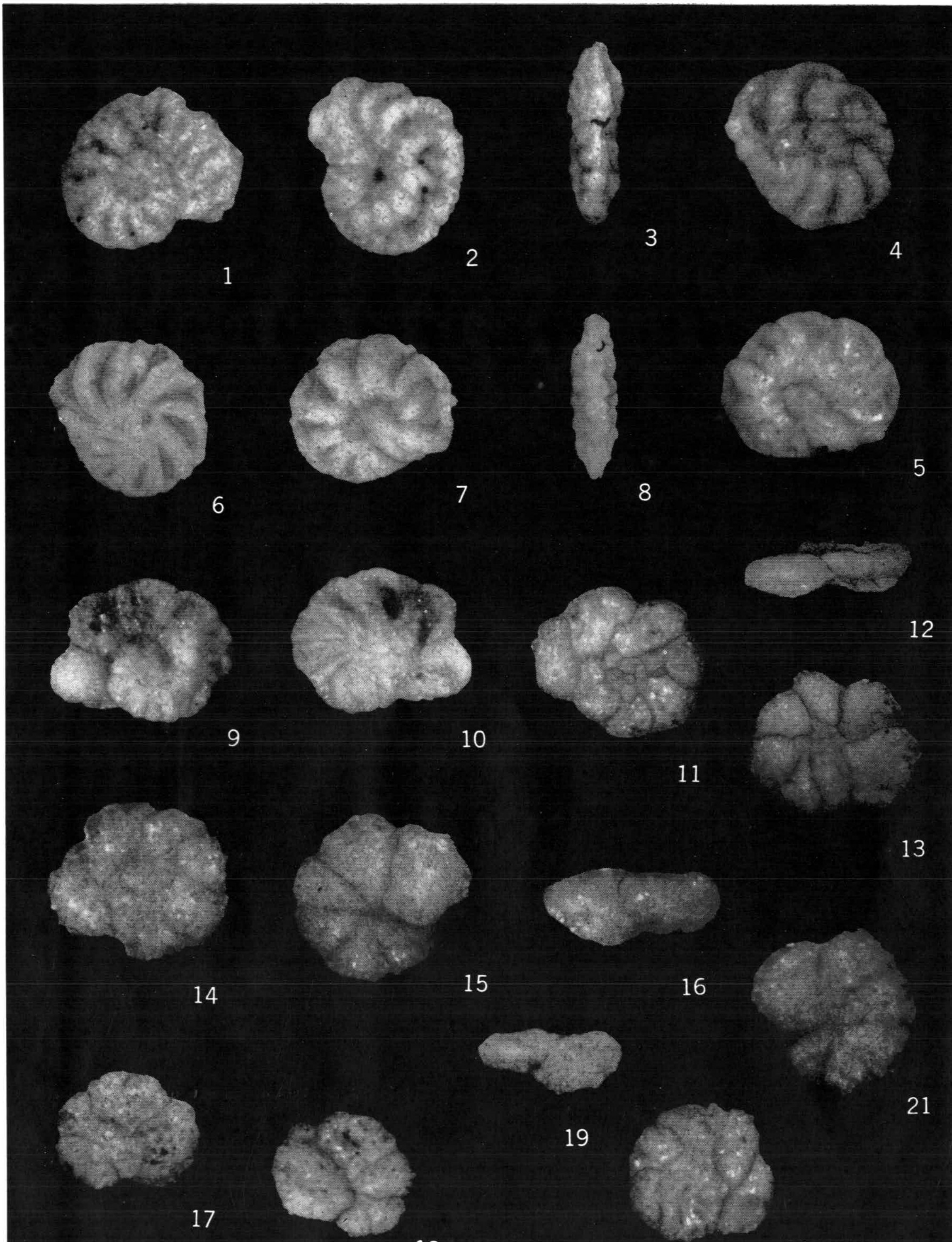

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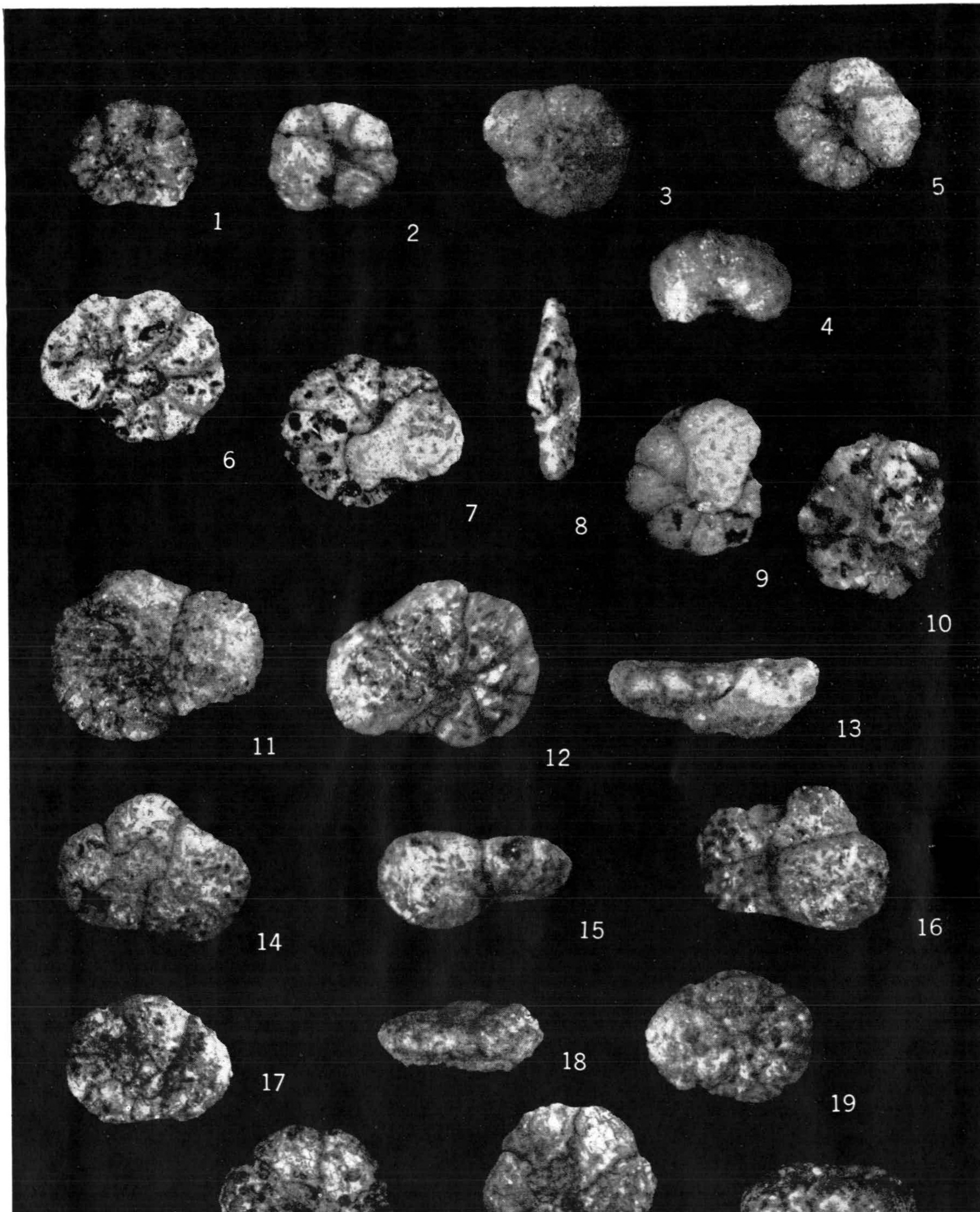

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