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Jurassic microfacies in Western Somalia

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JURASSIC MICROFACIES IN WESTERN SOMALIA

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Abstract. The main stratigraphic features of Western Somalia Jurassic are reported. The sequence, essentially carbonate, ranges in age from the Callovian to the lowermost Cretaceous. The fairly characteristic microfacies are also including microfossils indicative of age, among the calcareous Algae and Foraminifera.

Riassunto. Vengono illustrate le caratteristiche stratigrafiche principali del Giurassico della Somalia occidentale. La serie, fondamentalmente carbonatica, si estende dal Calloviano alla base del Cretacico. Le microfacies, piuttosto caratteristiche, contengono anche microfossili indicativi, tra le Alge calcaree ed i Foraminiferi.

Introduction.

In the years 1963-65 the writer had the opportunity to study the stratigraphy of Western Somalia for «Somali Gulf Oil Company». The area is bounded as follows (text-figs. 1 and 2): by the Kenya boundary to the west, by the Ethiopian boundary to the north, by the line Ted-Oddur-Baidoa to the east, extending down to Anole to the south.

The stratigraphic work was carried out in conjunction with field work done by A. Cortesini and G. Giannini under the supervision of M. D. Beltrandi and consisted of the micropaleontological and stratigraphical study of some ten stratigraphic sections.

ACKNOWLEDGEMENTS. The writer acknowledges the cooperation of the following companies and individuals who made this study possible: Gulf Eastern Company; Mr. S. B. Frazier, former Somali Gulf Oil Company General Manager; Dr. M. D. Beltrandi, Advisor of the Gulf Eastern Company; Dr. G. Flores, Gulf Eastern Company; Prof. S. Venzo, Head of the Departments of Geology and Paleontology in Parma University; Adriana Barbieri, Laboratory Technician.

Geological setting (Figs. 1, 2).

The geology of Western Somalia is characterized by the presence of a Mesozoic basin which developed on the Precambrian basement. The basin reached its maximum extension at the end of the Jurassic,

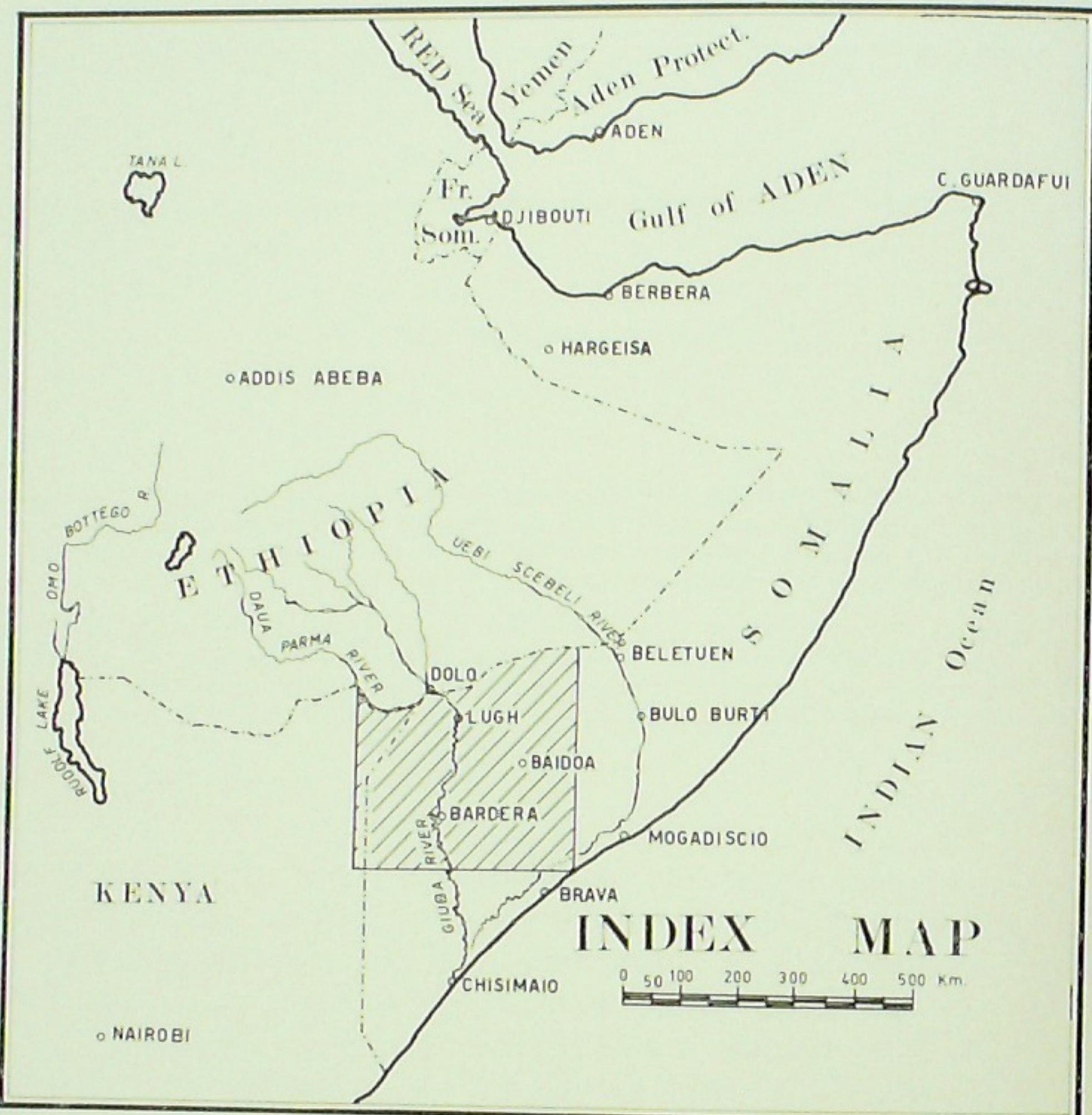


Fig. 1.

becoming afterwards a relict sea with evaporitic deposition during the Lower Cretaceous.

This basin was probably developed on the entire Arabian peninsula area and beyond.

The tectonic activity in the basin resulted mostly in normal faults.

Stratigraphy

Previous works.

Mesozoic rocks are the only present in outcrops in Western Somalia, with the exception of the coastal belt where Quaternary continental

deposits cover the prevailingly littoral Tertiary beds (with subcontinental and neritic episodes) and the pelagic Mesozoic sediments.

The earliest studies of the Mesozoic outcrop belt were the result of the geological expeditions by Stefanini and by AGIP with several geological and paleontological papers (Stefanini, 1930, 1932, 1933, 1939; Zuffardi-Comerci, 1932; Venzo, 1942, 1949; Tavani, 1948; Valduga, 1954).

The studies culminated with the issue of geological map (1957-1960). The Kenia Geological Survey issued, in these last years, a geological map of NE Kenia.

Lithostratigraphy (1) (Figs. 2, 3).

From bottom to top, and starting from the Iscia Baidoa formation which transgresses onto the Precambrian basement, the following units have been recognized:

ISCIA BAIDOA FORMATION.

Lithology: basal shale and sandstone, limestone, bioclastic limestone, recrystallized and oolitic limestone. Transgressive onto the basement.

Members: Deleb (sandstone and shale) and Uanei (shale) (these members partly from subsurface); Baidoa (limestone and bioclastic limestone); Goloda (limestone, limestone recrystallized and oolitic).

Paleontology (Pl. 57, figs. 1-5; Pl. 58, figs. 1-5): *Coprolithus (Favreina)*, *Cylindroporella*, *Clypeina*, « *Algoolites* » (2), *Nerinea*, *Itieria*, *Valvulinidae* and *Verneuilinidae*.

ANOLE FORMATION.

Lithology: marl and shale with limestone and coquina intercalations, lying conformably on the Iscia Baidoa formation.

Paleontology (Pl. 58, fig. 6; Pl. 59, fig. 1): *Ammobaculites* spp., *Lenticulina tricarinella* Reuss, *Vaginulinopsis* cf. *pasquetae* Bizon, *Epistomina* aff. *mosquensis* Uhlig, *Epistomina* aff. *parastelligera* (Hofker).

At about the boundary between this formation and the underlying formation (Iscia Baidoa) were previously found, in Anole neighbourhood,

(1) The reported lithostratigraphic units will be formally published soon.

(2) Stromatolites, Spongstromata s.l., Algal pisolithes and algal knolls of the Authors.

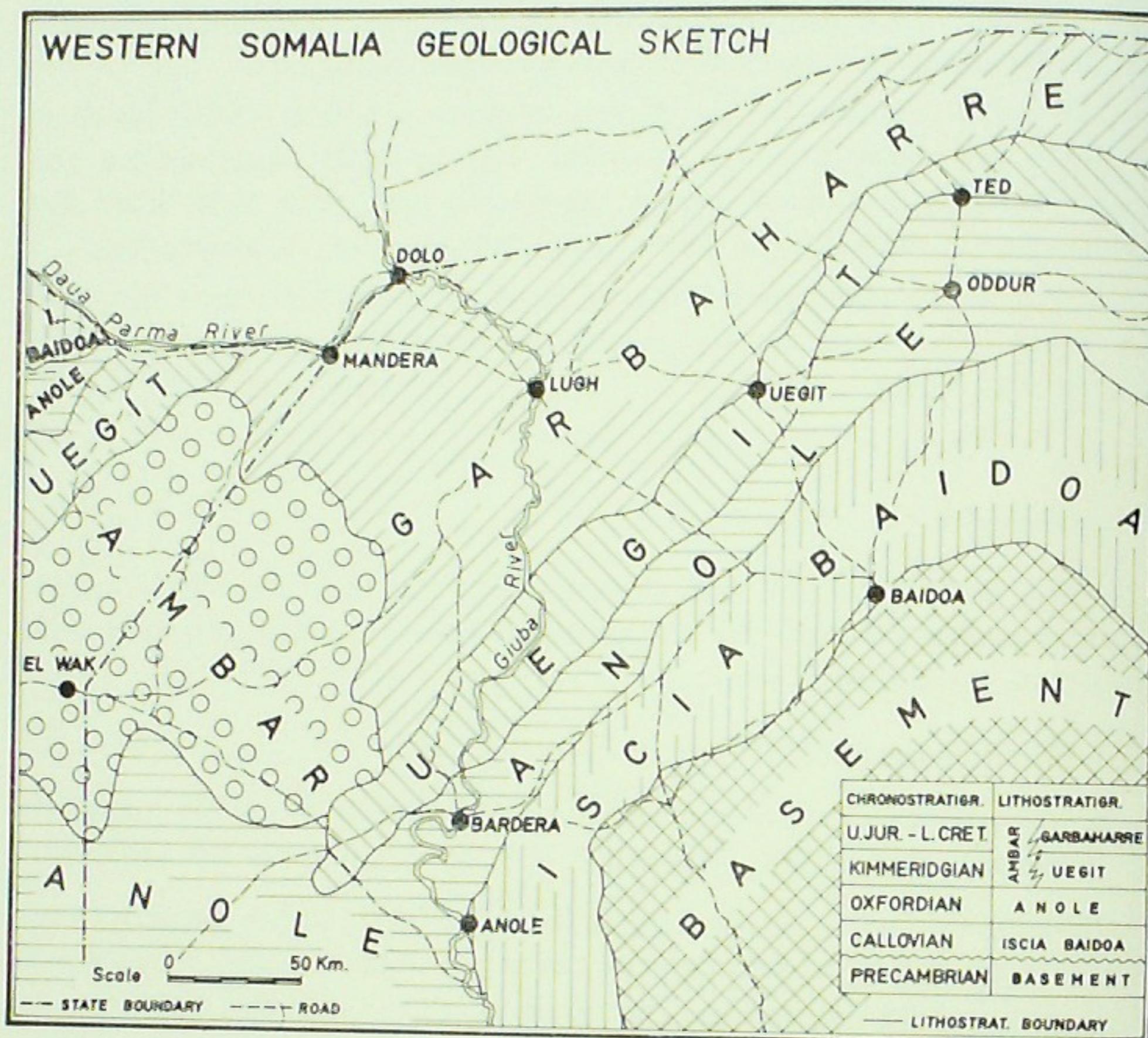


Fig. 2.

some Ammonite specimens referable to *Macrocephalites* and to *Hecticoceras*.

UEGIT FORMATION.

Lithology: limestone, oolitic and algal in places, with sandstone and shale, lying conformably on the Anole formation.

Members: Colilio (limestone, marly limestone, gray, oolitic and sandy in places); Curao (shale); Mugdile (sandstone and limestone).

Paleontology (Pl. 59, figs. 2-6; Pl. 60, figs. 1-4; Pl. 61, figs. 1-2): *Pseudocyclammina jaccardi* (Schrodt), *Pseudocyclammina* spp., «Algoolites», *Chara* sp., *Serpula* sp., turriculate Gastropods.

At the boundary with the underlying formation (Anole) were previously found, in Ted locality, some Ammonites: *Idoceras durangense*

Burckhardt (collected by S. Venzo) and *I. rufanum* (Dacqué) (s. Valduga, 1954).

GARBAHARRE FORMATION.

Lithology: sandstone with limestone and coquina, lying conformably on the Uegit formation.

Members: Busul (sandstone with limestone and coquina); Mao (not included in the Fig. 3) (sandstone, dolomite, limestone, shale, gypsum or anhydrite).

Paleontology: abundant thin shelled and inflated Ostracods.

AMBAR FORMATION.

Lithology: sandstone and siltstone. Equivalent to Uegit and Garbaharre formations.

Paleontology (Pl. 61, figs. 3-8): turriculate Gastropods, Pelecypods and Echinoderms remains.

The equivalence to Uegit and Garbaharre formations seems to be rather strongly shown in particular by some «Ambar facies» in the above mentioned units. In places even interfingering is observable.

Biostratigraphy (Fig. 3).

The sediments are almost all fossiliferous and prevailingly carbonate. Sandstones and siltstones are fairly represented in the uppermost part of the sequence.

The common microfacies are the following: intrasparite, intra-«oo» sparrudite, «oo»sparrudite, intraclast fossiliferous pelletiferous micrite, biosparite, «bioo»sparrudite, fossiliferous and pelletiferous micrite, intraclast micrite, biosparite, oosparite, micrite sandy, micrite silty-sandy, micrite silty, fossiliferous and pelletiferous intramicrite, «bioo»micrudite silty, intraclast fossiliferous micrite, siltstone, fine sandstone.

The biostratigraphy is based on several and different groups of fossils, from Worms to Gastropods, Foraminifera and Ostracods.

A tentative biozonation has been outlined as follows:

1) Ferruginous oolites zone.

No guide-fossil was observed. The traces useful in this stratigraphic breakdown are represented by ferruginous oolites. *Lenticulina* spp. and Ostracods are also occurring.

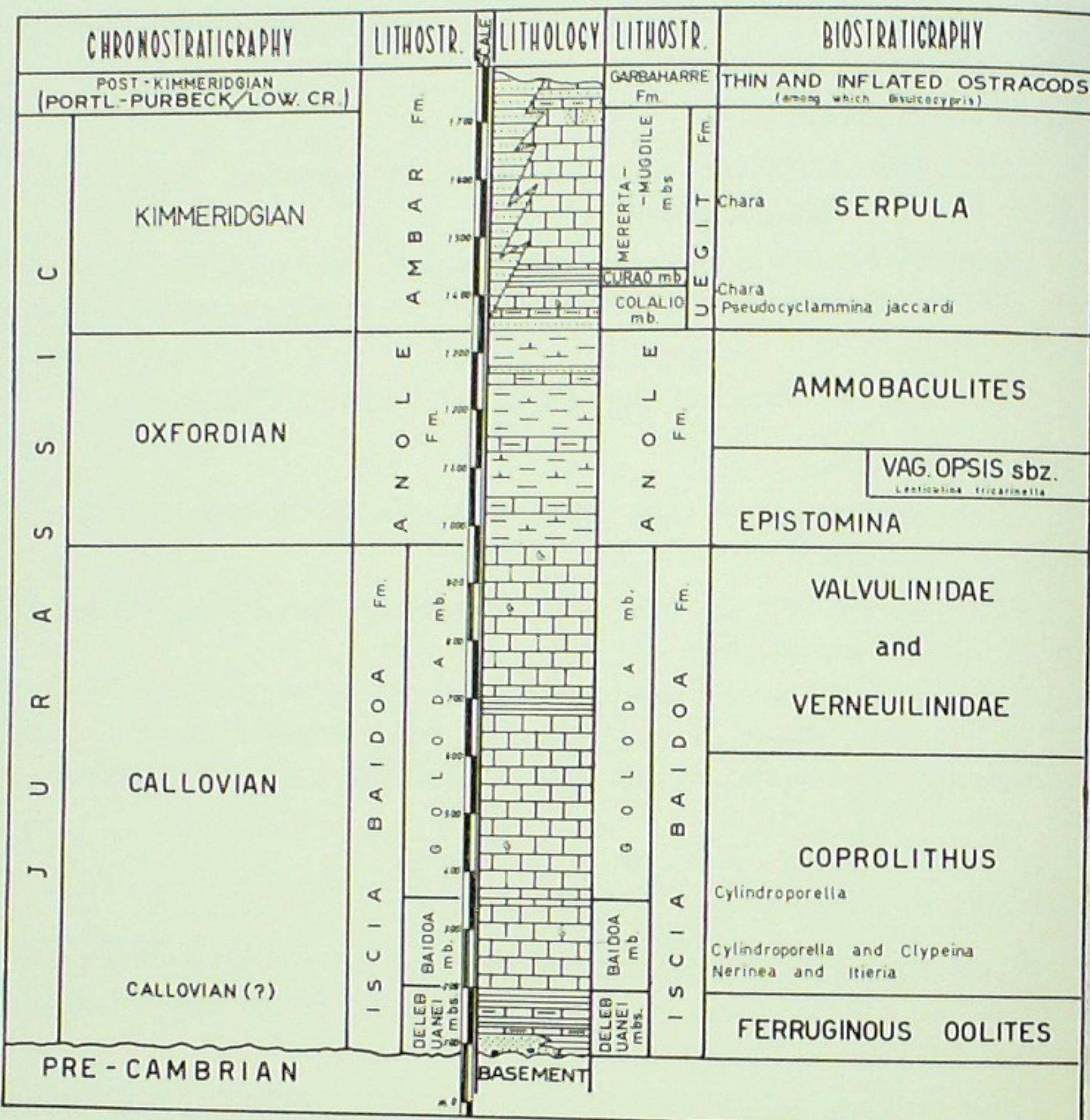


Fig. 3.

Environment: marine upper neritic to littoral with lagoonal or euxinic conditions in places.

2) *Coprolithus* zone (Pl. 57, figs. 1-5; Pl. 58, figs. 1-3).

Guide-fossil: *Coprolithus* cf. *salevensis* Paréjas. Associated fossils: *Clypeina* aff. *jurassica* Favre, *Cylindroporella* cf. *arabica* Elliott, «*Algoolites*», *Lenticulina* spp.

Environment: marine upper neritic to littoral, lagoonal in places.

3) *Valvulinidae* and *Verneuilinidae* zone (Pl. 58, fig. 4, 5).

No specific guide-fossil in this zone. It is characterized by a micro-

facies showing in abundance of *Valvulinidae* spp. and *Verneuilinidae* spp. Environment: marine upper neritic to littoral.

4) *Epistomina* zone (Pl. 58, fig. 6; Pl. 59, fig. 1).

Guide-fossils: *Epistomina* aff. *mosquensis* Uhlig, *Epistomina* aff. *parastelligera* (Hofker), *Epistomina* spp. The *Epistomina* species are probably without any stratigraphic value and they have only environmental meaning. They characterize, however, a good interval (fossiliferous micrite) in the lower part of the Anole formation. The specific determination is not easy and we are probably confronted, at least in part, with «new species» or with test modifications controlled by ecology.

Associated fossils: *Lenticulina* spp., *Spirillina* sp., «*Agathammina* ?», Ostracods (among which *Progonocythere* ?).

Environment: marine neritic, probably with anomalous salinity in places. The oligospecific *Epistomina* microfaunas could indicate a low or high salinity.

— *Vaginulinopsis* subzone.

Guide-fossil: *Vaginulinopsis* sp. The *Vaginulinopsis* subzone represents the upper part of the *Epistomina* zone.

Associated fossils: *Epistomina* spp., *Lenticulina tricarinella* Reuss, *Valvulina* sp., *Ammobaculites* spp., frequent Ostracods.

Environment: marine neritic, probably with anomalous salinity in places.

5) *Ammobaculites* zone.

Guide-fossils: *Ammobaculites* (and *Haplophragmium* ?) spp. This provisional name has been used to indicate probable new species of *Ammobaculites* (and *Haplophragmium* ?).

Associated fossils: *Nodosariacea* (*Lenticulina* spp.), Ostracods.

Environment: marine neritic.

6) *Serpula* zone (Pl. 59, figs. 2-6; Pl. 60, figs. 1-4; Pl. 61, figs. 1, 2).

Guide-fossil: very characteristic clusters, in this section, referable to Worms tube. These Worms probably belong to the genus *Serpula*. The material at our disposal does not allow a specific determination.

Associated fossils: arenaceous Foraminifera among which *Pseudocyclammina* (referable in part to *P. jaccardi* (Schrodt)), «*Algoolites*», Sponge spicules, somewhere *Epistomina*, Mollusca remains (among which *Nerinea*), Brachiopods, questionable Tintinnids, *Ellipsactinia* remains, rare Corals. *Chara* oogonia are present in well defined levels.

Environment: marine, middle neritic to littoral, lagoonal in places.

7) Thin and inflated Ostracods zone.

No well-defined fossil was selected to characterize this zone, but only a microfacies with many Ostracoda shell traces; they appear to be generally thin shelled and inflated.

Associated fossils: Foraminifera as *Ammobaculites* spp. and *Guttulina* sp., Ostracods, as *Bisulcocypris* sp., *Macrodentina* sp., in the lower part; Mollusca remains and somewhere Sponge spicules and thin shelled Pelecypods in the upper part.

Environment: marine to brackish water.

COMMENT ON CHARACTERISTIC FOSSILS.

In all the stratigraphic sections examined and that consisted of several hundreds of samples represented prevailingly by carbonate rocks with only a fair percentage of marls and claystones, the following fossils have been observed in well defined stratigraphic levels or intervals:

Coprolithus cf. *salevensis* Paréjas (Pl. 57, figs. 3, 4, 5).

Rare in the intra« o »sparrudite, « oo »sparrudite and intraclast fossiliferous micrite in the Baidoa member of the Ischia Baidoa formation.

It occurs also in NE Kenya (Didimtu stratigraphic section) in a unit equivalent to Baidoa member (Somgoc u.d.).

This form was observed in the Persian Gulf (Qatar), Upper Jurassic (Elliot, 1956), associated with *Clypeina jurassica* Favre. In southern Italy, it is associated to *Clypeina jurassica* Favre in Upper Jurassic sediments.

Cylindroporella cf. *arabica* Elliott (Pl. 58, fig. 3).

Rare in the intrasparite of the Baidoa member of the Ischia Baidoa formation.

This species was observed in the Arabia, Upper Jurassic (Elliott, 1957), associated with *C. jurassica* and *Kurnubia palastiniensis* (Henson). In Israel (Derin & Reiss, 1966) the Beersheva formation, Oxfordian (?) in age, is characterized by *Cylindroporella* sp.

Clypeina aff. *jurassica* Favre (Pl. 58, fig. 2).

Remains represented by vertical sections and probably referable to this species, are rare in the intrasparite of the Baidoa member (Ischia Baidoa formation).

This species is common in the Persian Gulf (Qatar), Upper Jurassic,

in the reefoidal and back reef facies of the Upper Jurassic of southern France, Switzerland, Italy, Greece, Algeria and in the Oxfordian-post-Oxfordian of Israel (Derin & Reiss, 1966).

Vaginulinopsis sp.

Frequent specimens are observed in the claystone and marl of the Anole formation and characterize a subzone of the *Epistomina* zone (upper part).

Almost all the specimens might be referable to *Vaginulinopsis pasquetae* Bizon occurring in the Lower Malm of NW Germany (Lutze, 1960).

Lenticulina tricarinella Reuss.

Typical specimens are present in the marl and claystone of the Anole formation (*Vaginulinopsis* subzone of *Epistomina* zone).

This species is distributed in NW Germany from Bathonian to Oxfordian (Lutze, 1960).

Epistomina aff. *mosquensis* Uhlig.

Abundant in the *Epistomina* zone (Anole formation).

This species is frequent in the Dogger and Lower Malm of Israel, in the German Jurassic and in the eastern Kenya Malm (Oxfordian).

Pseudocyclammina jaccardi (Schrodt) (Pl. 59, figs. 2, 3).

Frequent and easily recognizable in thin sections of the silty-sandy micrite of the lowermost Uegit formation (Colalio member-Serpula zone).

This species occurs in the Upper Oxfordian-Kimmeridgian of Europe (for some Authors it disappears with the Lower Kimmeridgian (1) since there is no general chronostratigraphic agreement on this stage). In the Oxfordian of Israel it is associated to *Kurnubia palastiniensis* Henson (Derin & Reiss, 1966; Maync, 1966). It seems to be occurring also in NE Kenya.

Tintinnids.

These fossils which characterize the Upper Jurassic-Lower Cretaceous pelagic sediments in the Thetys area, seem to be represented by very rare, questionable specimens in the *Serpula* zone.

(1) The Kimmeridgian of the English Authors is equivalent to Kimmeridgian + « Portlandian » + part of « Purbeckian » of the French Authors.

Ellipsactinia ?.

Very rare remains probably referable to *Ellipsactinia* occur in the lower part of the *Serpula* zone.

Bisulcocypris sp.

Among the thin shelled and inflated Ostracods (Garbaharre formation) the genus *Bisulcocypris* is present and it indicates, rather than a specific age, an brackish environment (restricted basin in humid climate?).

Idoceras durangense Burckhardt and *I. rufanum* (Dacqué).

At the boundary Anole-Uegit formations (Ted), have been previously found some Ammonite specimens referable to these species. These species are considered indicative of the Lower Kimmeridgian (« *tenuilobatus* zone »). The whole assemblage was interpreted by Valduga (1954) indicative of Upper Oxfordian-Lower Kimmeridgian.

Macrocephalites spp. and *Hecticoceras* spp.

These forms, indicative of the Upper Callovian, were found at about the boundary Iscia Baidoa-Anole formations.

Stratigraphic comparisons.

The areas with which it is possible to attempt some correlations, by means of characteristic fossils and even by facies, are the following: Arabia (Qatar), Israel, NW Germany.

The lower sequence (Iscia Baidoa formation), represented by limestone and bioclastic limestone, with *Cylindroporella*, *Clypeina*, *Coprolithus*, « Algaloolites » etc., is similar to the Upper Jurassic limestone of Arabia (Qatar).

The middle sequence (Anole formation), represented by marls with limestones intercalated, with *Vaginulinopsis* cf. *pasquetae* Bizon, *Lenticulina tricarinella* Reuss and frequent levels with *Epistomina* is rather similar to the Lower Malm of NW Germany. There are also fair affinities, as far as some peculiarities of facies (*Epistomina*) are concerned, with the Callovian-Oxfordian of Israel (Maync, 1966).

The upper sequence (Uegit formation) represented by limestone, oolitic in places, and by some sandstone, with *Serpula*, « Algaloolites », *Pseudocyclammina jaccardi* (Schrodt), is rather similar to the Beersheva and Halutsa formations (Oxfordian) of Israel.

Peculiarities of facies (*Serpula*), are observable in the Middle and Upper Malm of NW Germany. Microfacies with « Algaloolites » and *Serpula* are occurring in the Karkar Formation (Upper and Middle ? Jurassic) of NE Afghanistan.

Good correlations are possible with NE Kenya.

Conclusions.

The age of the sediments of West Somalia on the basis of characteristic fossils may be outlined as follows from bottom to top:

- Precambrian: basement;
- Callovian: Iscia Baidoa formation (the basal members, Deleb and Uanei transgressive on the basement, are not chronostratigraphically definable);
- Oxfordian: Anole formation;
- Kimmeridgian: Uegit formation;
- Post Kimmeridgian (Upper Jurassic-Lower Cretaceous): Garbaharre formation;
- As far as the Ambar formation is concerned, no characteristic fossils were observed. The age may be determined on the basis of the equivalence to Uegit and Garbaharre formations.

The Jurassic sequence of West Somalia, transgressive on the Precambrian basement, represents a complete sedimentary cycle, which in outcrop ranges from the Callovian (or older ?) (Iscia Baidoa) to the Lower Cretaceous evaporites (N-NE of the map, Fig. 2).

It is possible that in the subsurface are present sediments older than Callovian which are not cropping out, because are less developed.

The sedimentary environment is confined always to the littoral, to the lagoonal and to the neritic. Real reefs have not been observed.

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PLATE 57

Fig. 1 - Ischia Baidoa formation - Baidoa member.
Intrasparite with Gastropods (young specimen of *Itieria* ?). Callovian.

Fig. 2 - Ischia Baidoa formation - Baidoa member.
Intrasparite with *Nerinea* remains. Callovian.

Fig. 3 - Ischia Baidoa formation - Baidoa member.
Intra α oo α sparrudite with *Coprolithus* cf. *salevensis* Paréjas and with «Algaloolites». Callovian.

Fig. 4 - Ischia Baidoa formation - Baidoa member.
Intraclast fossiliferous and pelletiferous micrite with *Coprolithus* cf. *salevensis* Paréjas and with Mollusca remains. Callovian.

Fig. 5 - Ischia Baidoa formation - Baidoa member.
Intraclast fossiliferous and pelletiferous micrite with *Coprolithus* cf. *salevensis* Paréjas and with Mollusca remains. Callovian.

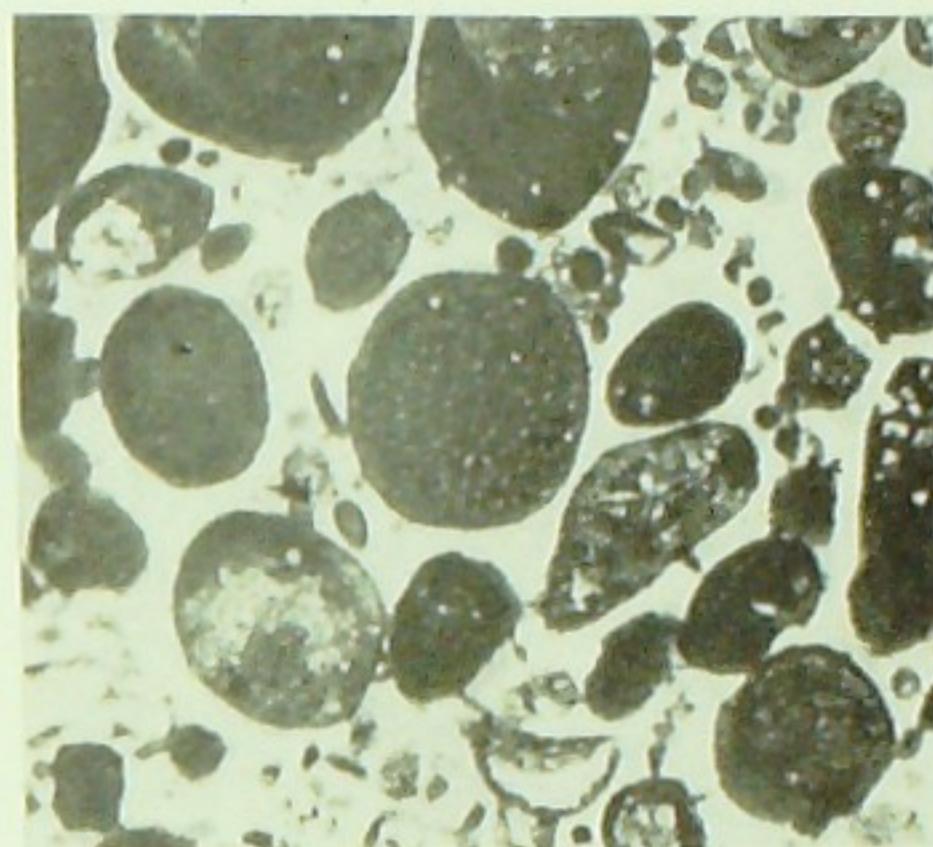
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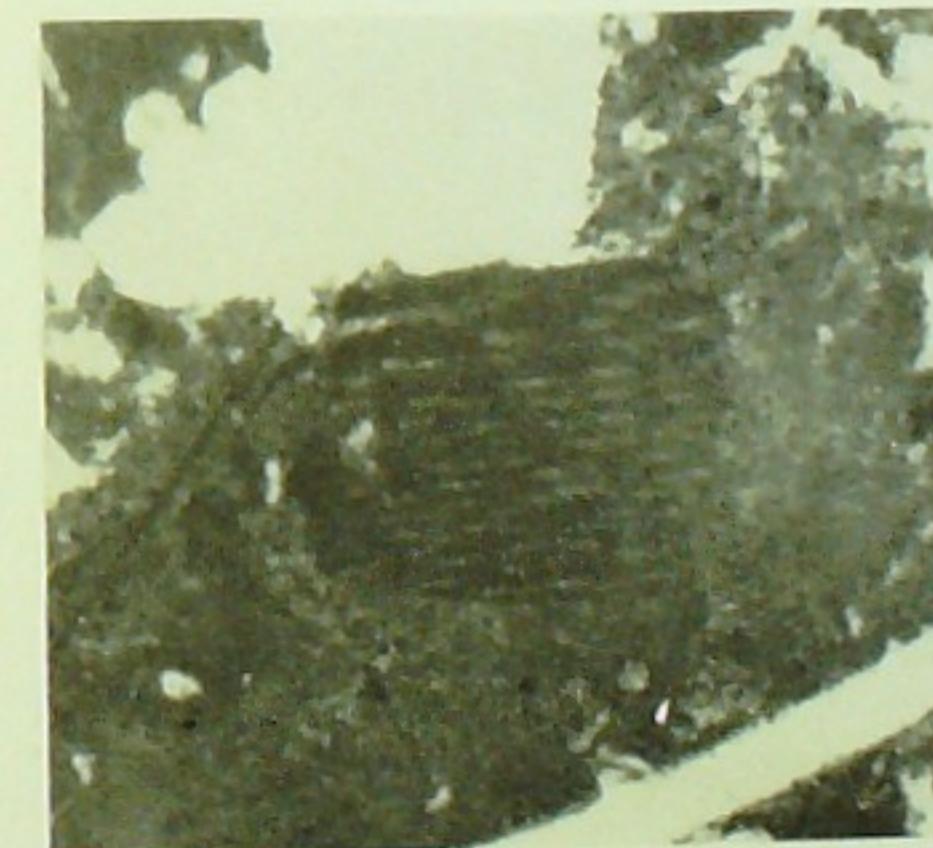
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PLATE 58

Fig. 1 - Ischia Baidoa formation - Baidoa member.
« Bioo »sparudite with « Algoolites ». Callovian.

Fig. 2 - Ischia Baidoa formation - Baidoa member.
Intrasparite with *Clypeina* aff. *jurassica* Favre and Mollusca remains. Callovian.

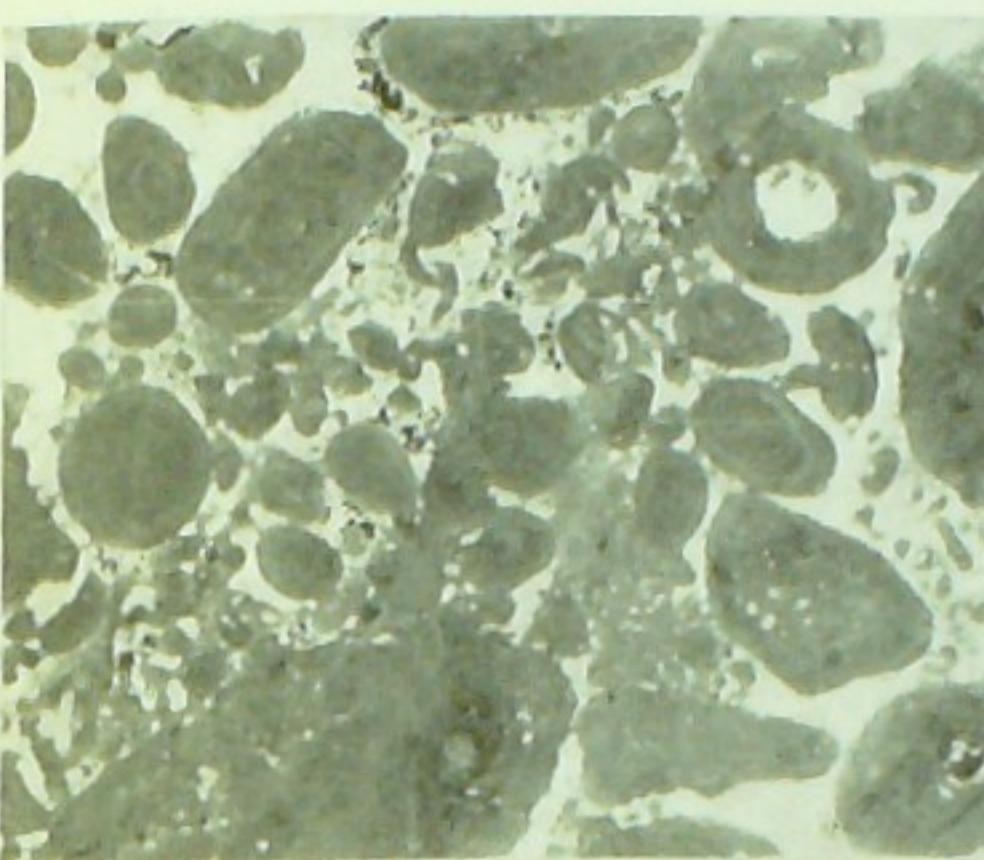
Fig. 3 - Ischia Baidoa formation - Baidoa member.
Intrasparite with *Cylindroporella* cf. *arabica* Elliott and Mollusca remains. Callovian.

Fig. 4 - Ischia Baidoa formation - Goloda member.
Biosparite with *Valvulinidae* and *Verneuilinidae*. Callovian.

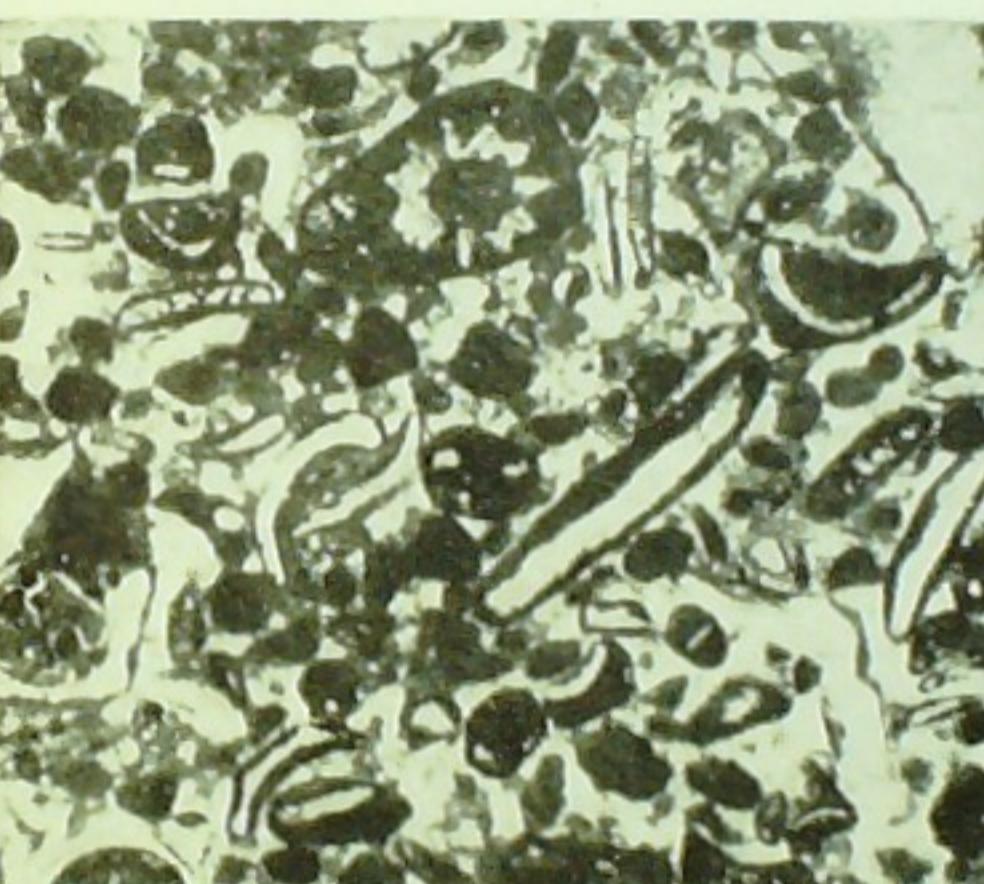
Fig. 5 - Ischia Baidoa formation - Goloda member.
Biosparite with *Valvulinidae* and *Verneuilinidae*. Callovian.

Fig. 6 - Anole formation.
Micrite with Mollusca remains and *Epistomina*. Oxfordian.

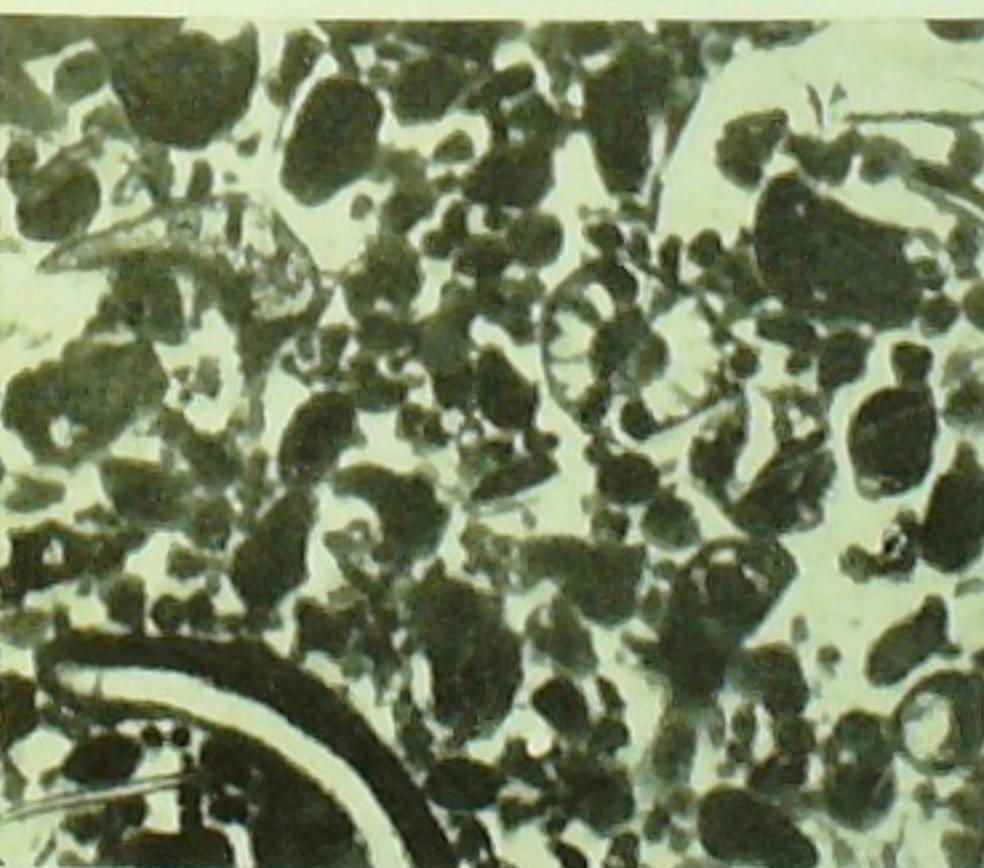
All $\times 24$.



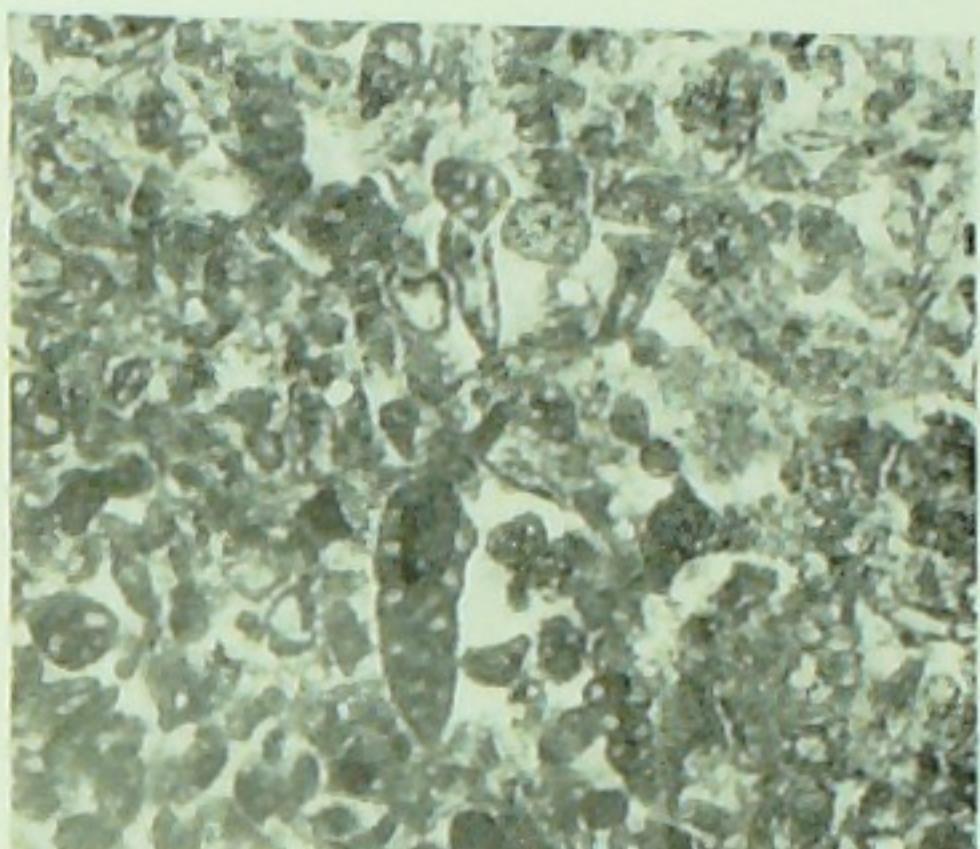
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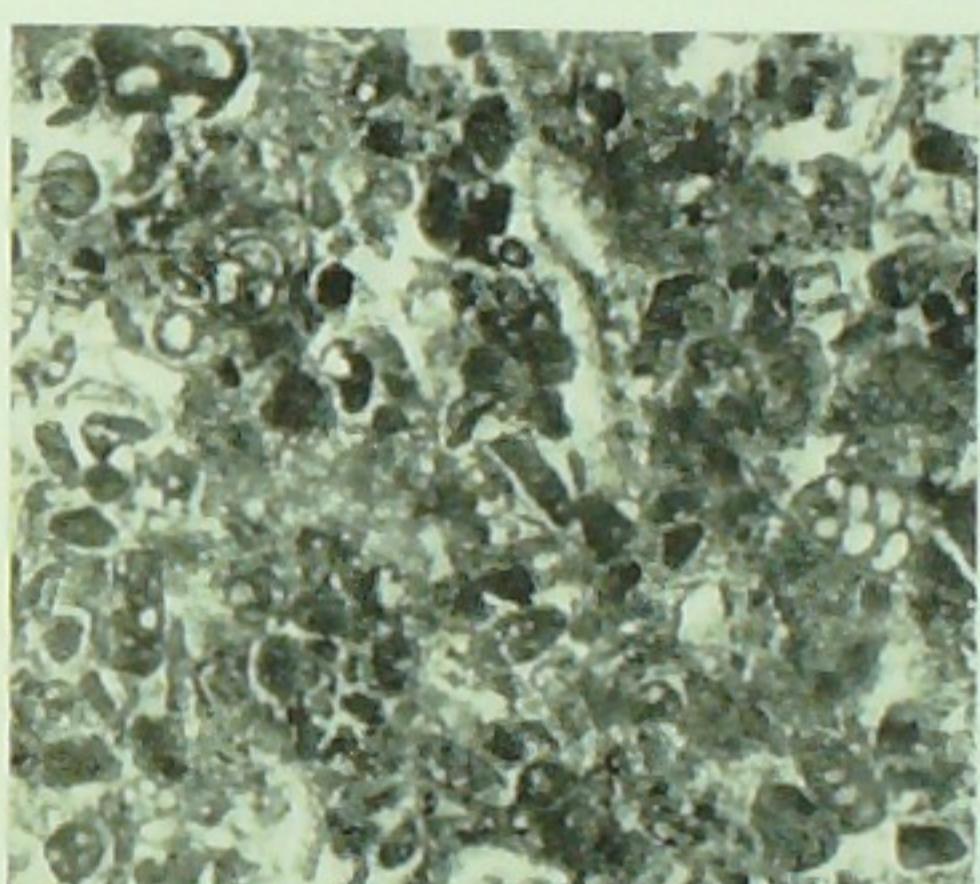
2



3



4



5



6

PLATE 59

Fig. 1 - Anole formation.

Fossiliferous and pelletiferous micrite. Oxfordian; $\times 24$.

Fig. 2 - Uegit formation - Colalio member.

Micrite silty-sandy with *Pseudocyclammina jaccardi* (Schrodt). Kimmeridgian; $\times 24$.

Fig. 3 - Uegit formation - Colalio member.

Micrite silty-sandy with *Pseudocyclammina jaccardi* (Schrodt). Kimmeridgian; $\times 24$.

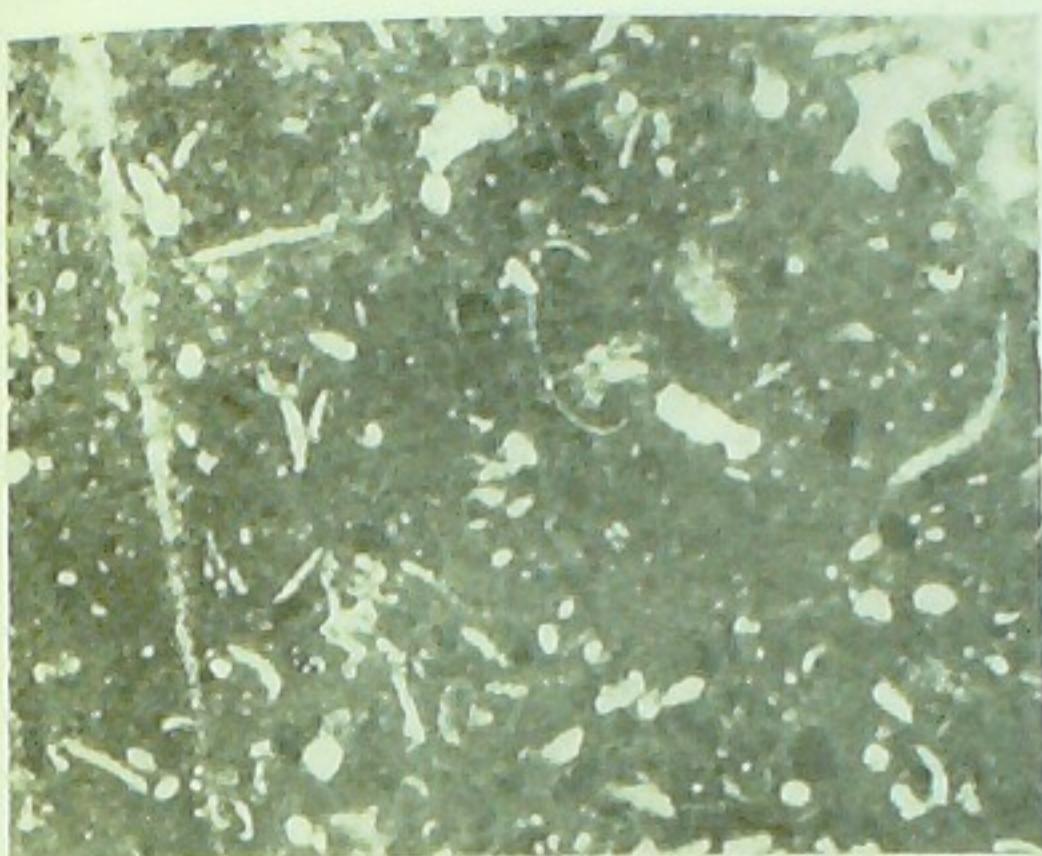
Fig. 4 - Uegit formation - Colalio member.

Fossiliferous and pelletiferous intramicrite with *Nerinea* remains. Kimmeridgian; $\times 30$.

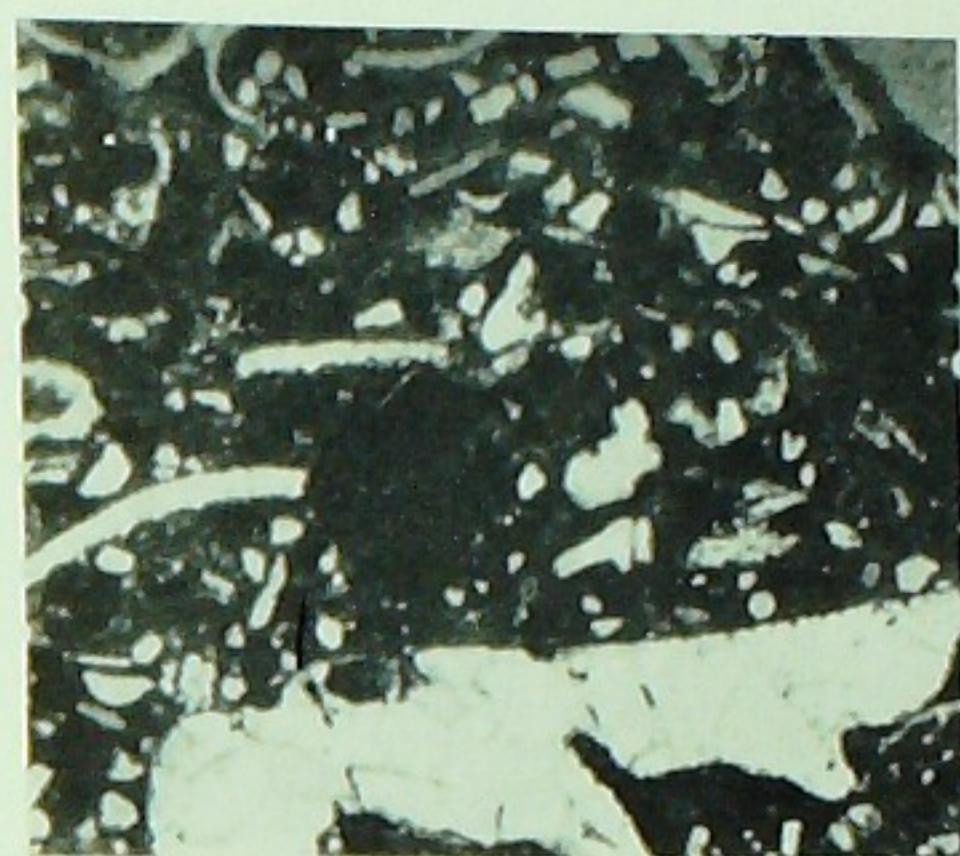
Fig. 5 - Uegit formation - Colalio member.

Intraclast micrite with *Serpula*. Kimmeridgian; $\times 30$.

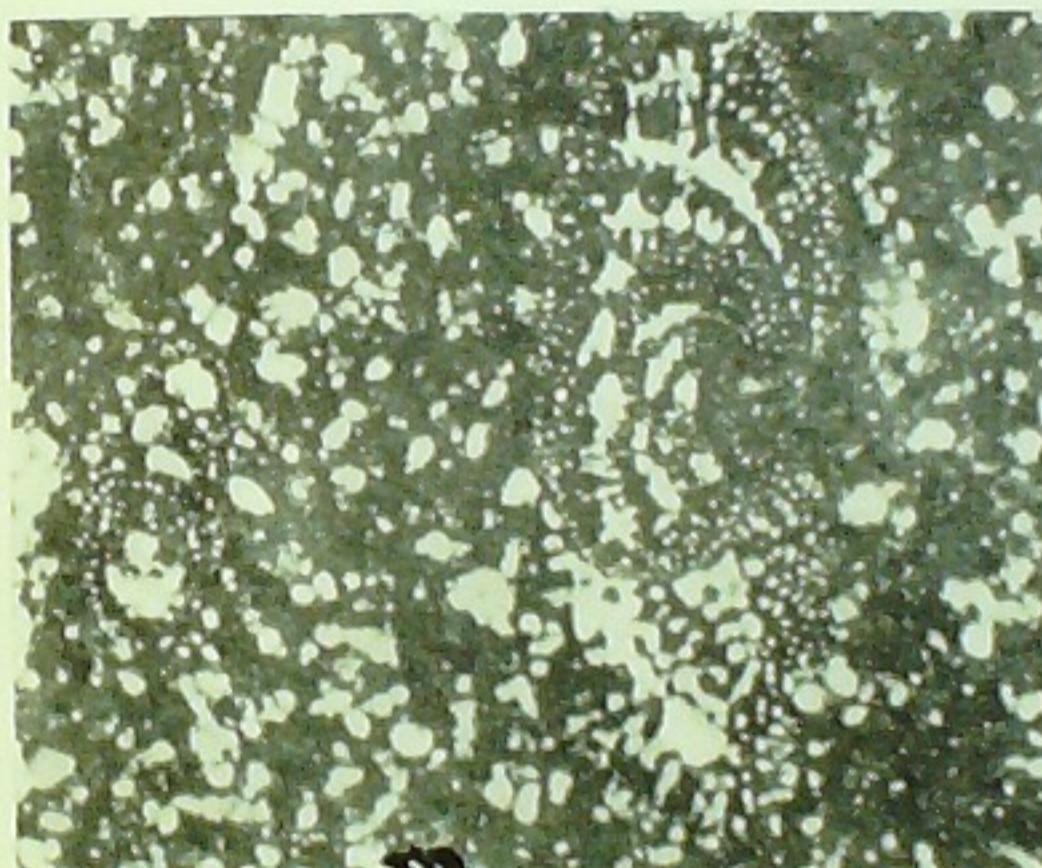
Fig. 6 - Uegit formation - Colalio member.

Oosparite. Kimmeridgian; $\times 30$.

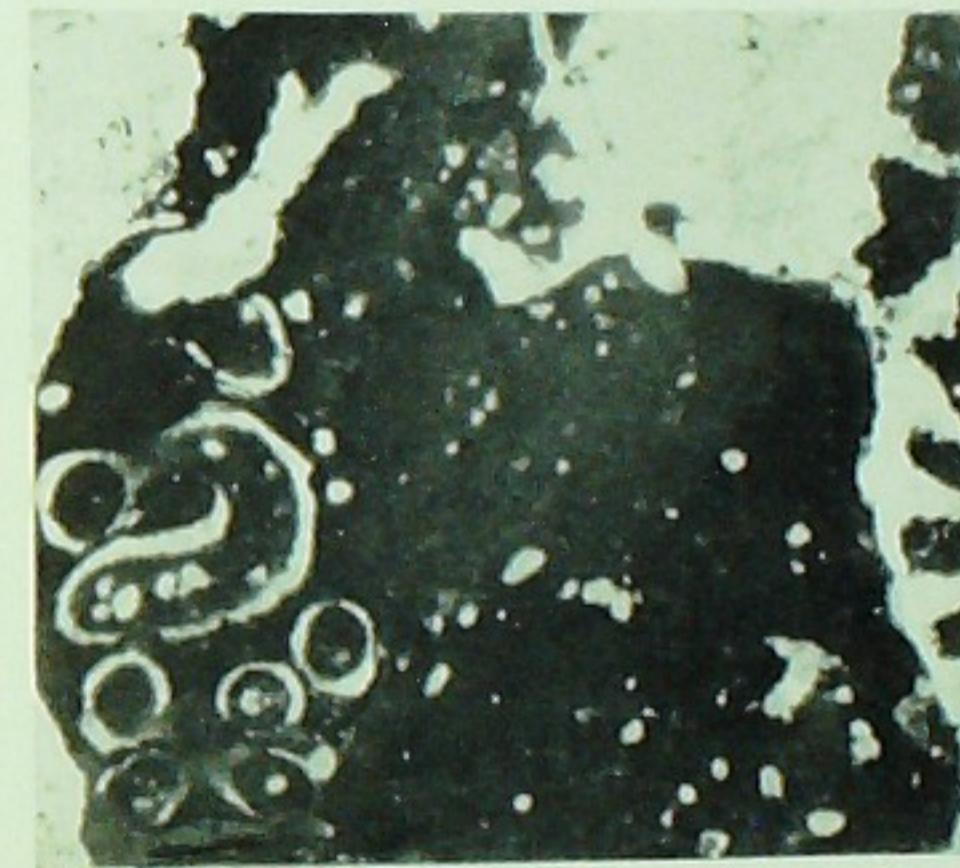
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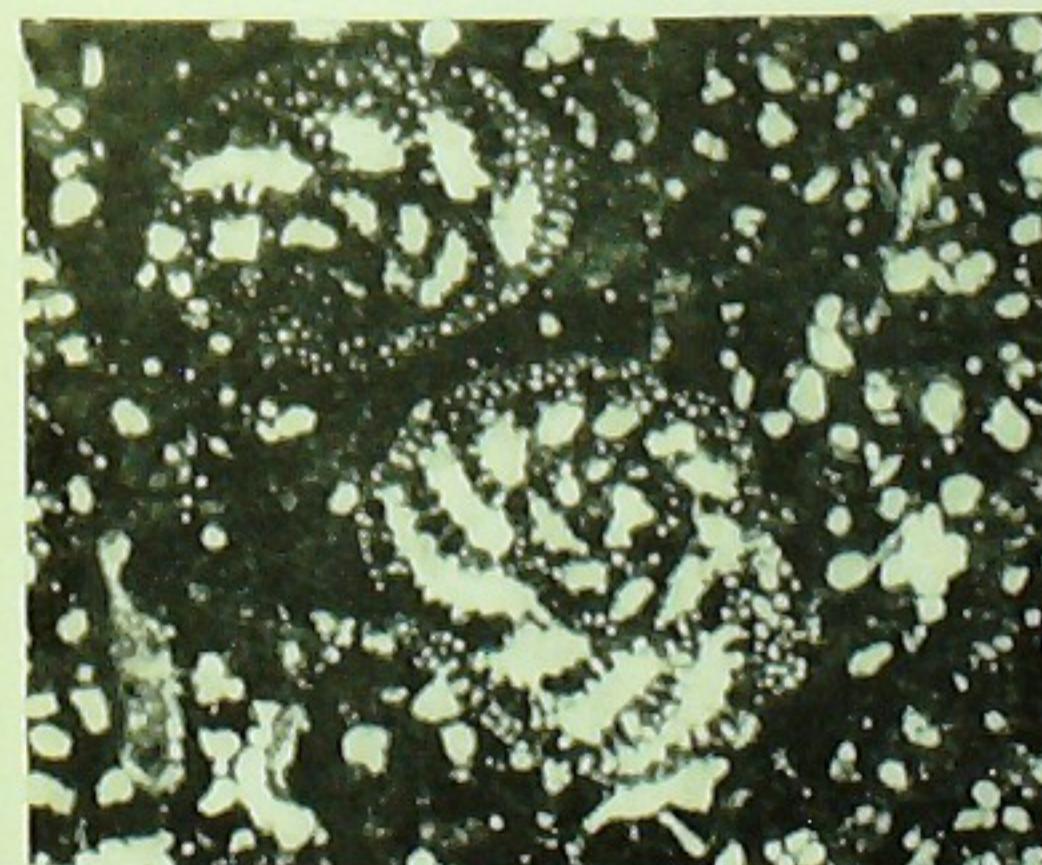
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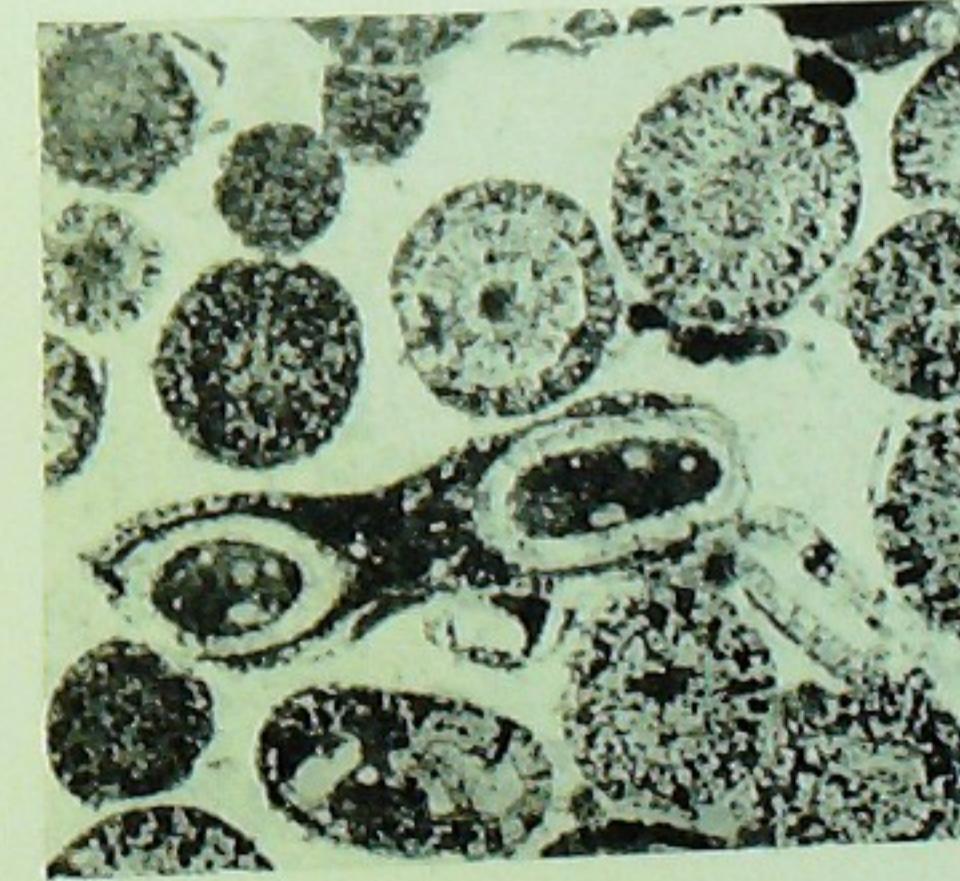
2



5



3



6

PLATE 60

Fig. 1 - Uegit formation - Colalio member.

« Bio »micrudite silty with « Algaloolites ». Kimmeridgian; $\times 30$.

Fig. 2 - Uegit formation - Colalio member.

Micrite with *Serpula*. Kimmeridgian; $\times 24$.

Fig. 3 - Uegit formation - Colalio member.

Micrite silty with turriculate Gastropods. Kimmeridgian; $\times 30$.

Fig. 4 - Uegit formation - Colalio member.

« Bio »micrudite silty with « Algaloolites ». Kimmeridgian; $\times 30$.



1



3



2



4

PLATE 61

- Fig. 1 - Uegit formation - Mugdile member.
Intraclast fossiliferous micrite with turriculate Gastropods. Kimmeridgian; $\times 30$.
- Fig. 2 - Uegit formation - Mugdile member.
Fine sandstone. Kimmeridgian; $\times 30$.
- Fig. 3 - Ambar formation.
Intraclast fossiliferous micrite with Mollusca remains and turriculate Gastropods. Kimmeridgian-post Kimmeridgian; $\times 24$.
- Fig. 4 - Ambar formation.
Fine sandstone with turriculate Gastropods and Echinoderms remains. Kimmeridgian-post Kimmeridgian; $\times 24$.
- Fig. 5 - Ambar formation.
Micrite sandy with *Nerinea*. Kimmeridgian-post Kimmeridgian; $\times 24$.
- Fig. 6 - Ambar formation.
Intramicrudite with *Epistomina*, Echinoderms and large Pelecypods remains. Kimmeridgian-post Kimmeridgian; $\times 24$.
- Fig. 7 - Ambar formation.
Fine sandstone with small turriculate Gastropods. Kimmeridgian-post Kimmeridgian; $\times 24$.
- Fig. 8 - Ambar formation.
Siltstone with turriculate Gastropods and Pelecypods remains. Kimmeridgian-post Kimmeridgian; $\times 24$.

