ZONAL STRATIGRAPHY AND FORAMINIFERA OF THE TETHYAN JURASSIC (Eastern Mediterranean)

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Preface

There are still gaps in our knowledge of Jurassic stratigraphy, mainly due to difficulties in gaining access to geological exposures, or because of a lack of fossils suitable for correlation. However, the eastern Mediterranean region, where Syria is located, cannot be classed as an inaccessible region. Neither can the lack of knowledge of the Jurassic stratigraphy be attributed to a paucity of palaeontological data: the Jurassic of Syria yields very abundant and diverse fossil assemblages. Therefore we decided that the area warranted a thorough and timely study. This book is based on the monographic study of the Jurassic micropalaeontology and stratigraphy of Syria, carried out within the framework of the International Agreement on the earth sciences between the former Academy of Sciences of the USSR (now the Russian Academy of Sciences) and the General Establishment of Geology and Mineral Resources of Syria. The collaboration took place over the period 1986 to 1990, and K. I. Kuznetsova (Geological Institute, Russian Academy of Sciences, Moscow) and A. A. Grigelis (Lithuanian Geological Institute, Vilnius, Lithuania) participated in the study. The Syrian geologists, E. Jarmakani and J. Adjamian, and the micropalaeontologist, L. Hallaq, participated in all the fieldwork. The protocol of the agreement stipulated that all the most important and interesting results should be integrated and published.

Five field expeditions were organized; the material collected allowed detailed study and bed-by-bed descriptions to be made of the key Jurassic sections. A total of around 50 sections of marine Jurassic rocks were recorded, in the Anti-Lebanon, Coastal Mountains, the Kurd-Dag and the Palmyrides. More than 1300 rock samples, mainly containing foraminifera and ostracods, were collected from the 94 exposures described.

Following the fieldwork, the next phase involved study of the foraminiferal assemblages, their composition, structure and distribution. The work focused mainly on monographic study and description of foraminiferal and ostracod species, including not only the common, well-known species, but also those recorded for the first time.

The data obtained made it possible to resolve the main stratigraphic problem, i.e. the palaeontological zonation of the Jurassic, using foraminifera. The stratigraphic distribution of species (in biozones) and their geographical ranges can provide a basis for the palaeobiogeographical study of the Syrian Jurassic foraminifera, in a regional context, i.e. within the Mesozoic Tethyan basin. This suggests that the Jurassic foraminiferal assemblages are endemic and thus of

palaeobiogeographical importance. As a result, a new palaeobiochore — a separate Arabian subprovince of the Tethys — which was formed in the eastern Mediterranean during the Jurassic, has been recognized.

Chapter 7 describes 136 species of foraminifera, eight of them new species. We gratefully acknowledge the help of the following colleagues: E. A. Tobolina and M. R. Dobrova (Micropalaeontological Laboratory, Geological Institute, Russian Academy of Sciences) who identified the foraminifera and the ostracods, respectively, and I. L. Zenyakina, who took the photomicrographs.

All the specimens described have been placed in the Geological Institute of the Russian Academy of Sciences in Moscow.

The macrofauna was also examined and data on this is available from the same source. E. Prozorovskaya and S. Lobacheva (VSEGEI) and T. N. Smirnova (Moscow State University), identified the brachiopods. L. F. Romanov (Geological Institute, Moldova) identified the lamellibranchs.

Now that we have completed our study, we are well aware that there is a wealth of palaeontological material which has not been used fully. There are still some unsolved problems and there are still some details which have not been worked out. Many unusual and interesting geological finds still await discovery in Syria, a land that was once a centre of the appearance of many faunas and the motherland of ancient civilizations and religions. However, if this work to some degree fills the gap in our geological knowledge about this wonderful area, we would consider our task to have been fulfilled.

CHAPTER 1
THE JURASSIC OF SYRIA: THE HISTORY OF EXPLORATION

1.1 GENERAL OUTLINE

The history of geological research in Syria can be divided into three phases, differing in duration and significance. The earliest reviews of Syrian geology date back to the second half of the nineteenth century and the early part of this century. They were written by the geologists Blankenhorn (1890), Fraas (1877, 1878) and Žummoffen (1899, 1926). More specialized research into the geology of Syria and Lebanon was published in the review by R. Žummoffen (1926), which summarized the results of more than 30 years of study.

Geological research continued throughout the 1920s: the French geologists: L. Dubertret, H. Vautrin, E. David, A. Keller, R. Wetzel and M. Morton contributed greatly to the field with their published papers, monographs and geological maps. It was at this time that modern ideas on the geology and the stratigraphy of the Mesozoic and the Cainozoic of Syria were first put forward.

The second phase involved research work organized by the Ministry of Geology of the former USSR, which comprised geological surveys at scales of 1:1,000,000, 1:500,000, and 1:200,000 over the period 1958 to 1961. As a result, a geological map for the entire country at the above scales, and large-scale maps (1:50,000) for the Anti-Lebanon, Kurd-Dag and Bassit Massif (Ponikarov *et al.*, 1967, 1969), were compiled. Explanatory notes to the geological maps contained a description of standard geological sections, stratigraphic data, information about the tectonic structure of Syria, the mineral resources and a history of the geological evolution of the country.

The latest phase spans the period from the 1960s to the present day. The geological surveys were carried out mainly by Syrian geologists from the General Establishment of Geology and Mineral Resources and the Geological Department of Damascus University. In the early 1970s, based on previous data, a large-scale (1:50,000) geological survey of the entire country was initiated. However, some projects preceded the compilation of the geological maps. This phase has been marked by Soviet–Syrian geological research under the auspices of the Agreement of Joint Studies in the field of earth sciences, signed by the Academy of Sciences of the former USSR and the General Establishment of Geology and Mineral Resources of Syria. The protocol of this agreement anticipated the tectonic map and research into the stratigraphy and mineral resources of the area.

1.2 EXPLORATION OF THE JURASSIC OF SYRIA

The Jurassic sediments are exposed in the main mountainous areas of Syria, namely the Anti-Lebanon, Coastal Mountains, Kurd-Dag and the Palmyrides.

The first investigations of the Jurassic of the Anti-Lebanon began at the close of the last century (Fraas, 1877; Noetling, 1886–1887; Diener, 1886–1887; Žummoffen, 1926). Bathonian and Upper Jurassic rocks were recorded in the Hermon Mountains (Jebel Sheikh). A geological map, (1:1,000,000), of this region was compiled by Dubertret (1940, 1941–1945, 1963). In his opinion, volcanic activity in the Anti-Lebanon area occurred during the late Jurassic and the early Cretaceous. Vautrin (1934a, b) studied the Jurassic of the Hermon Mountains, and, based on the contained ammonites and gastropods, identified the Lias and Dogger in this region. Renouard (1951) correlated these rocks with those occurring in the Anti-Lebanon.

The Lower, Middle and Upper Jurassic of the Coastal Mountains are of paramount interest for oil exploration. Dubertret (1936) noted that Jurassic strata are very common in this region and identified fossils from limestones of the Slenfeh section. In the 1960s, the Jurassic of the Coastal Mountains was explored in more detail when a team of geologists, led by V. P. Ponikarov, subdivided the sediments into Middle and Upper Jurassic and recorded the Oxfordian and Kimmeridgian from sections near the town of Misyaf (Ponikarov *et al.*, 1967, 1969).

In 1976, the Syrian geologist, Mouty, was the first to thoroughly examine microfossils from the Jurassic sediments of the Coastal Mountains. From 1974 to 1976 he explored the Mashta al-Helou, Slenfeh, Bab Janneh, the eastern Maareen and Kharaib Salem sections, and identified the Lower, Middle and Upper Jurassic, subdividing them into the following four zones according to the contained foraminifera:

a: *Haurania amijideserta* Henson Zone

b: *Pfenderina salernitana* Sartoni and Crescenti Zone

c: *Kurnubia palastiniensis* Henson Zone

d: *Pseudocyclammina jaccardi* Schrödt Zone

Mouty assigned the first two zones to the Middle Jurassic and Zones c and d to the Upper Jurassic. Of particular interest was the presence of the Lower Jurassic foraminifera: *Lituosepta recoarensis* Cati and *Orbitopsella* sp. in the section between Kharaib Salem and Maareen.

The position of the base of the Jurassic, drawn tentatively between completely unfossiliferous dolomites assigned to the Triassic, and those tentatively placed in the Lias, remains uncertain.

A geological survey by V. P. Ponikarov *et al.* at a scale of 1:50,000 the Coastal Mountains was continued in the 1970s by Syrian geologists (Adjamian *et al.*, 1983). This allowed subdivision of the deposits into Middle and Upper Jurassic and recognition of the stages using macrofossils and foraminifera.

Dubertret, who studied the Jebel Akra limestone section, in the NW Coastal Mountains, from 1936 to 1955, reported the presence of younger Jurassic deposits, which could be assigned to the Portlandian (Tithonian).

In the Kurd-Dag, the sediments are middle Jurassic in age only. Bathonian strata are the most common, but the Callovian was recorded in some places. The sequence is fairly thin and in most sections it is truncated by Lower Cretaceous sediments. In this part of Syria, the Jurassic is composed of diverse limestones and dolomites.

The lithology and structure of the Jurassic of the Palmyrides remain poorly known and are the subject of debate. On the 1:2,000,000 geological map, (Dubertret, 1942), the strata, previously determined as Albian, were assigned to the Jurassic. The original date was changed on the basis of the stratigraphic position of the strata, i.e. underlying the Aptian "basement sandstone". In the Palmyrides, the Jurassic forms the cores of anticlines such as Jebel Mazar, Jebel Hayan, Jebel Abtar and Jebel Satteh. Mouty (1976) reported Middle Jurassic (Bathonian) deposits yielding foraminifera, from the Jebel As-Satteh section. The V. P. Ponikarov's team of geologists noted the presence of Upper Jurassic sediments in the Jebel As-Satteh section of Upper Jurassic deposits, earlier determined as Oxfordian from their contained lamellibranchs.

Thus, the Jurassic of Syria has been studied in detail from outcrops in the Anti-Lebanon, the Coastal Mountains, the Kurd-Dag and the Palmyrides. In other areas of Syria, it is overlain by younger deposits and is only exposed by drilling: on the Haleb Plateau, in the Mesopotamian Depression and on the Rutba Uplift. On the Rutba Uplift, Jurassic sediments were penetrated by a hydrogeological well just below Palaeogene rocks. The Callovian–Oxfordian age of the former, assigned by K. I. Kuznetsova, was from the rich foraminiferal assemblage (Krasheninnikov, 1965). To the north-east and south-west of the River Euphrates (Mesopotamian Depression), rocks assigned to the Jurassic, were encountered by drilling in the Al-Sweida, Al-Dubaiat and Al-Buab oilfields. They comprise unfossiliferous carbonate rocks and, by correlation with similar deposits in Iraq, are early Jurassic in age (they are known as the Sargelu Formation). On the Haleb Plateau, Jurassic deposits were drilled by the Syrian Oil Company. Some of these rocks contain foraminifera suggesting a middle Jurassic age (Bajocian, Bathonian). In lithology, these are mainly carbonate rocks which may be correlated with the Mulussa Formation (late Triassic to Jurassic in age).

CHAPTER 2
DESCRIPTION OF THE JURASSIC SECTIONS

In terms of its geological structure, Syria is located within the Arabian Platform, bordered to the north by the Alpine orageni belt. To the north-west, a transition zone separates these major structural features. The Levant rift system (Al Ghab rift zone) extends along the Mediterranean coast of Syria.

Jurassic rocks crop out in the Anti-Lebanon, the Coastal Mountains, the Kurd-Dag and the Palmyrides (Fig. 2.1). The structure, lithology and fossil composition of the Jurassic rocks differ between these regions. In all, 50 sections were investigated and described, in some cases on the basis of several closely spaced exposures. These exposures totalled 94 in number (Fig. 2.2).

In the Anti-Lebanon, seven of the most representative sections were studied, ranging in age from Lias to Tithonian inclusive. Descriptions of five of the sections, located at Arneh, Hadar, Rowda, Wadi al Karn and Sad al Karn, are given below.

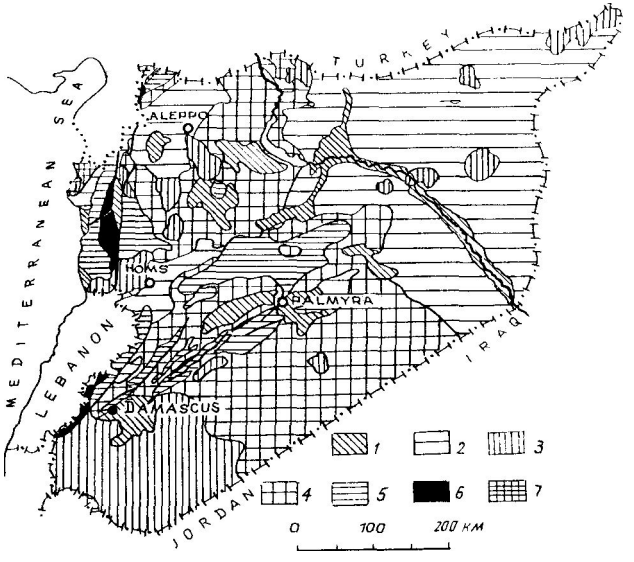

FIGURE 2.1 Sketch geological map of Syria, 1:5,000,000.
1 Quaternary deposits; 2 Neogene deposits; 3 Cainozoic volcanics; 4 Palaeogene deposits; 5 Cretaceous deposits; 6 Jurassic deposits; 7 ophiolitic rocks.

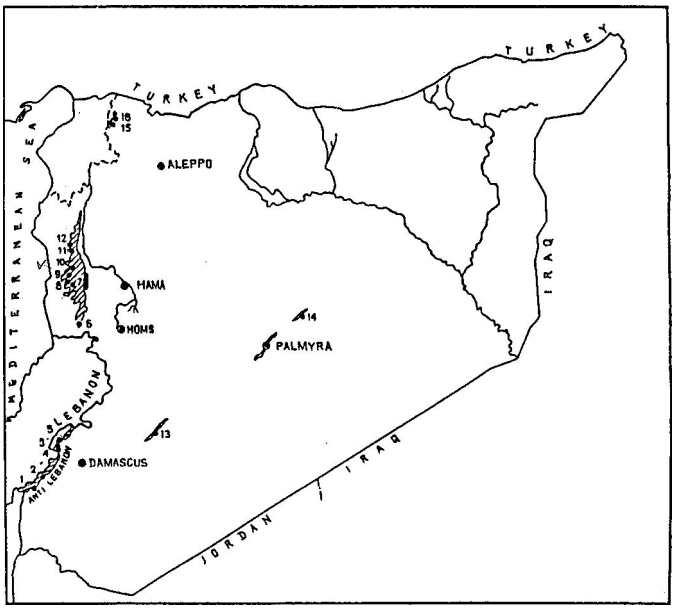

FIGURE 2.2 Locality map showing the Jurassic sections studied. Anti-Lebanon: 1 Hadar, 2 Arneh, 3 Wadi al Karn, 4 Sad al Karn, 5 Rowda; Coastal Mountains: 6 Nicola Quarry, 7 Qadmous, 8 Wadi Jahannam, 9 Jdaida, 10 the eastern Maareen, 11 Bab Janneh, 12 Shuekha; Palmyrides: 13 Al-Zbeidi, 14 As-Satteh; Kurd-Dag: 15 Rajo, 16 Smalek.

In the Coastal Mountains, where Jurassic rocks are well exposed, 18 sections were explored; the seven most representative are described below. The oldest Liassic rocks were reported from a section near Jdaida village. The Bajocian rocks are mainly dolomitized, unfossiliferous and recognized only tentatively. The Bathonian, Callovian and Oxfordian sediments are more common and richly fossiliferous (Bab Janneh, the eastern Maareen, Bchili, Qadmous, Wadi Jahannam and Shuekha sections). The Kimmeridgian rocks have been strongly eroded over most of the area and are known only from a section at Nicola Quarry. The youngest Jurassic deposits (Tithonian) not hitherto recorded from the Coastal Mountains, were reported from the Qadmous section; they contain abundant foraminifera.

In the Kurd-Dag (north-western Syria), the Jurassic is represented mainly by the Bajocian and Bathonian; thin Callovian outcrops yielding scarce foraminifera and corals occur near Smalek village, at the top of Jurassic succession.

In the Palmyrides, the Jurassic was explored in seven sections, in which fossiliferous Bathonian and Oxfordian deposits were recognized. The Al-Zbeidi and the As-Satteh sections are described below.

FIGURE 2.3 Anti-Lebanon, Syria. View of Jebel Sheikh near Arneh village (photo by K. Kuznetsova).

2.1 THE ANTI-LEBANON

2.1.1 Arneh

2.1.1.1 Exposure 92

The following rocks are exposed on the southern hillside (south anticlinal limb), 1.5 km west of Arneh village (Fig. 2.3):

(a) The Lower Jurassic J_1

Bed 1 Medium-bedded, dense black limestone grading up section into: black, thin-bedded limestone interbedded with dense, finely laminated shale. A layer of medium-bedded, yellow limestone, with limonite (3 m thick) occurs 12 m from the base of the bed. This is overlain by hard black limestone which is very thin bedded and is intercalated with finely laminated marl. The upper part is a layer of crushed argillaceous greyish green limestone with lenses and impersistent bands of greyish green lumpy clay, yielding the ostracods: *Limnocythere alata* Dobrova, *L. lobata* Dobrova, *L. improcera* Dobrova, *L. cribellata* Dobrova, *Procytheridea magnicoutensis* Apostolescu, *P. sermoisensis* Apostolescu, *P. vermiculata* Apostolescu, *Progonocythere stilla* Sylvester-Bradley, *Aphelocythere* Triebel and Klinger.

25 m

Bed 2 Black, dense, massive limestone (this forms a cliff in the topography).

4 m

Bed 3 Black, dense limestone, rich in detritus.

40 m

Higher up, the section is not exposed, covered by soil and grass and hidden by debris.

30–35 m

Bed 4 Lumpy, greenish grey clay with obscure bedding, rarely interbedded with limestone and dolomite. Bands of buff-brown and yellowish grey clay, interbedded with yellow flaggy limestone and dolomite, appear in the upper part of the section.

55 m

(b) Middle Jurassic (J_2)

The Bajocian

Bed 5 Grey, massive, saccharoidal dolomite (forms a cliff in the topography).

55–60 m

Bed 6 Black, dense limestone, rich in detritus, containing bands and streaks of calcite along the joints, interbedded with dark-grey dolomite and brecciated rock.

10 m

Bed 7 Spilite.

30 m

Bed 8 Yellowish green, poorly consolidated, lumpy clay, with impersistent layers of dense, grey limestone (0.1–0.3 m).

13 m

Bed 9 Dense, grey limestone, locally dolomitic medium-bedded (0.3–0.5 m). In the upper part of the bed grading into cryptocrystalline, dark-grey limestone, locally along the strike replaced by argillaceous, nodular medium-bedded limestone, interbedded with grey and greenish grey, dense, friable clay. There is a distinct erosion surface 12 m from

the bed base, and 4 m higher up, at the top of the limestone band, there is another erosion surface with evidence of an erosional unconformity (Figs. 2.4 and 2.5).

50 m

2.1.2 Arneh

2.1.2.1 Exposures 71, 77 and 78

Some 2.5 km west of Arneh village, Aalenian and Bajocian rocks are exposed in the floor of a small ravine (Fig. 2.6).

Bed 1 Spilite.

5 m

Bed 2 Breccia/conglomerate: coarse-clastic and tuff conglomerate.

3 m

Bed 3 Spilite.

5 m

Bed 4 Obscurely bedded, locally massive, grey and yellowish grey dolomite, dense and locally saccharoidal in texture.

4 m

Bed 5 Dolomitized, grey and yellowish grey clay, intercalated with dolomitized limestone and dolomite. Clay 0.8–1.6 m thick, limestone and dolomite 0.5–2 m thick.

30 m

Bed 6 Coarse to medium-grained, breccia/conglomerate and tuff conglomerate.

12 m

No exposure for a distance of 100 m.

Further along the road, 500 m south-west of Arneh village, the following beds are exposed:

Bed 7 Alternation of dark-grey, dense, cryptocrystalline, locally recrystallized limestone, with calcite streaks.

10 m

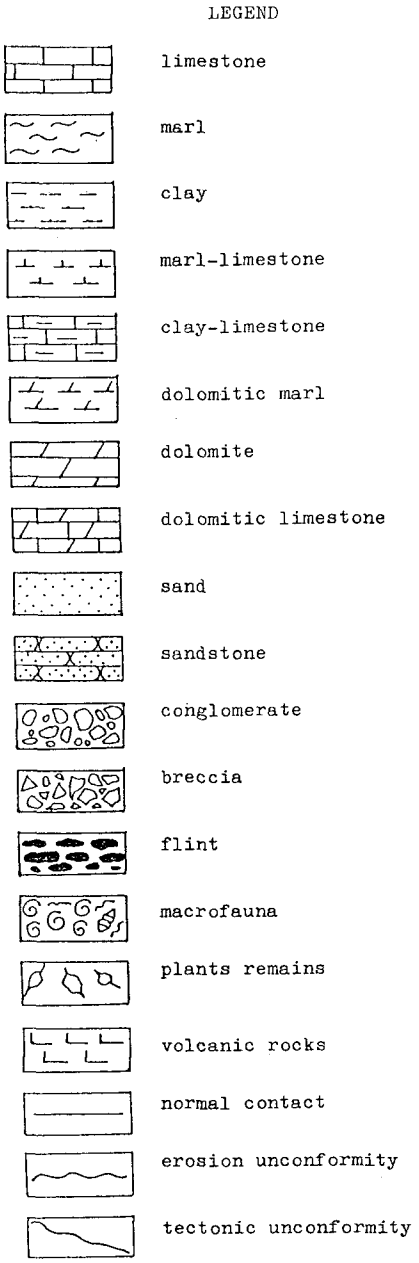

FIGURE 2.4 Key to lithological sections.

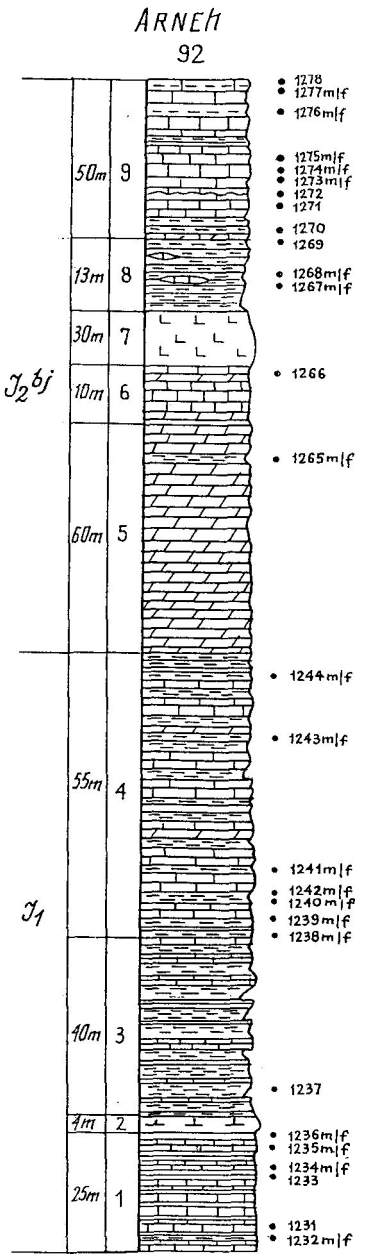

FIGURE 2.5 Anti-Lebanon. Section at Arneh village (exposure 92).

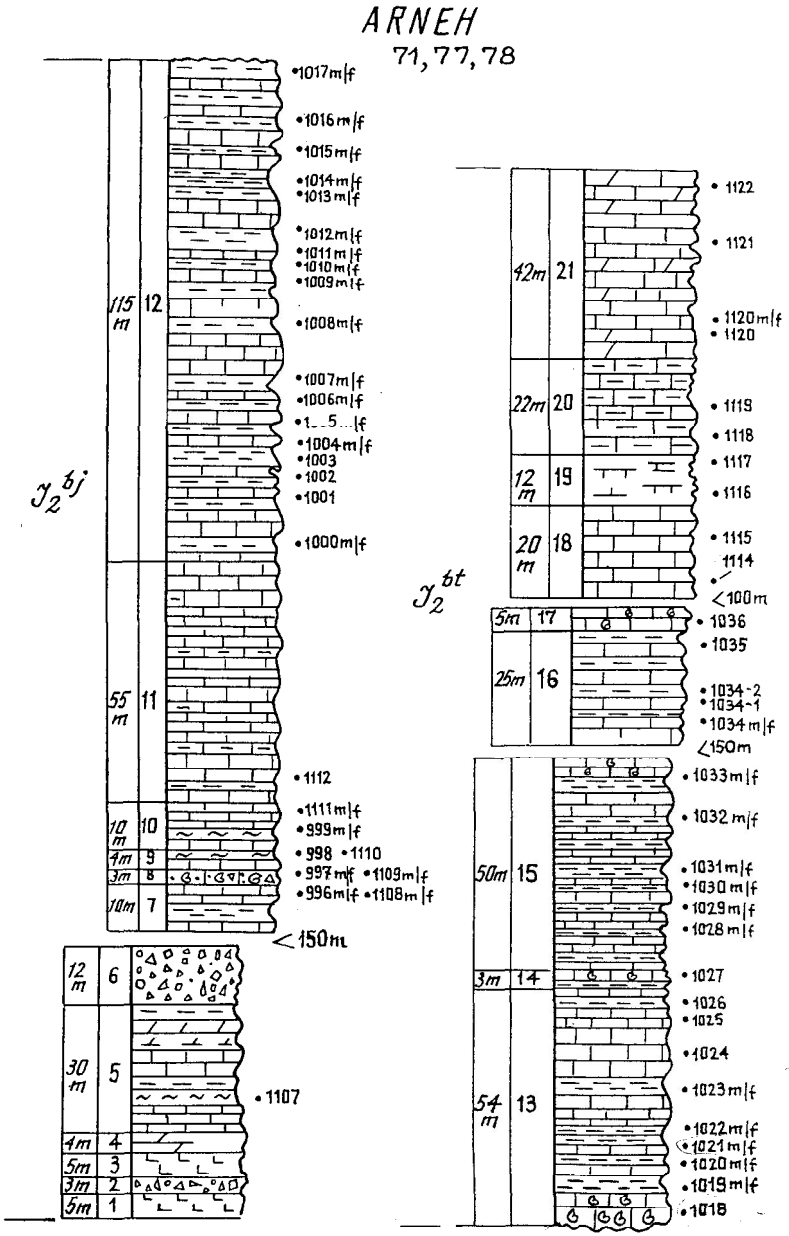

FIGURE 2.6 Anti-Lebanon. Section at Arneh village (exposures 71, 77, 78).

Bed 8 Pale-grey, bioclastic, poorly consolidated limestone.

3 m

Bed 9 Dark-grey and black limestone intercalated with marl.

4 m

No exposure for 10 m.

Bed 10 Dolomitized, yellowish grey, dense, oolitic and bioclastic limestone with distinst marl bands (up to 0.3 m thick)

10 m

Bed 11 Bioclastic, oolitic and pseudo-oolitic limestone, locally recrystallized.

55 m

Bed 12 Dense, grey, bioclastic, oolitic, pseudo-oolitic and cryptocrystalline limestone, intercalated with greenish grey, calcareous, friable clay (0.5–1 m thick). The clay contains abundant foraminifera: *Timidonella sarda* Bouss. *et al.*, *Lamarckella media* Kapt., *Praelamarckina humilis* Kapt., *Epistomina coronata* Terq., *Lenticulina polymorpha* (Terq.), *Lenticulina varians* (Born.), *L. protracta* (Born.) *L. veta* Hoffm., *Citharina inconstans* (Terq.), *C. elegantica* Sossip. et Boh., *Verneuilinoides mauretii* (Terq.), *Ammobaculites agglutinans* Orb. and *Bulbobaculites* sp.

115 m

The Bathonian

Distinct erosion surface.

Bed 13 Oolitic–bioclastic, ochreous, rusty-yellow limestone, crowded with detritus, numerous fragments and intact shells of lamellibranchs, gastropods and rare corals. The limestone contains numerous bands of calcareous greenish grey, fragmentary clay (0.5–1 m) yielding the following foraminiferal assemblage: *Ammobaculites suprajurassicus* (Schwag.), *Reophax difflugiformis* (Brady), *R. horridus* (Schwag.), *Riyadhella hemeri* Redm., *Ophthalmidium* sp., and the ostracods *Procytheridea crassa* Peterson, *Fastigatocythere bakeri* (Basha) and *Kirtonella sulcata* Malz.

54 m

Bed 14 Oolitic–bioclastic, thick-bedded, yellowish grey limestone, crowded with fragments and intact shells of lamellibranchs, brachiopods and corals.

3 m

Bed 15 Argillaceous limestone, showing conchoidal fracture, intercalated with calcareous, fragmentary, pale-grey and yellowish grey clay. The clay contains the foraminifera: *Reophax horridus* (Schwag.), *Recurvoides bartouxi* Said and Barak., *Bulbobaculites* sp., *Lenticulina polymorpha* (Terq.), *Lenticulina centralis* (Terq.), *Astacolus filosus* (Terq.), *Eoguttulina triloba* (Terq.), *Quinqueloculina occulta* Anton., *Lamarckella antiqua* Kapt. and *Globuligerina bathoniana* (Pazdro).

50 m

No exposure for 150 m.

Bed 16 Pseudo-oolitic, medium-bedded (0.8–1 m), pinkish grey limestone, crammed full of lamellibranch and brachiopod shell fragments, interbedded with calcareous, pale-grey, fragmentary clay (0.6–0.8 m). The clay contains a foraminiferal assemblage similar in composition to that of Bed 15, but foraminifera are less abundant.

25 m

Bed 17 Cryptocrystalline, dark-grey, medium-bedded limestone (0.5–0.8 m thick) show karstic weathering, with small lamellibranch fragments.

Apparent thickness 5 m

No exposure for about 100 m.

Bed 18 Yellowish grey, argillaceous, thick-bedded (0.8–1.5 m) limestone, locally grading into cryptocrystalline, dark-grey limestone, containing the foraminifera: *Ammodiscoides magharaensis* Said et Barakat, *Reophax difflugiformis* (Brady), *R. metensis* Franke and *Nautiloculina circularis* Said et Barakat.

20 m

Bed 19 Cliff composed of massive, light-grey limestone, rich in clay material in the lower part, brecciated, forming small fragments when weathered.

12 m

Bed 20 Pale-grey argillaceous, medium-bedded (0.3–0.6 m) limestone, containing the foraminifera: *Nautiloculina circularis* Said et Barakat, *Redmondoides lugeoni* (Septfontaine), *Verneulinoides minuta* Said et Barakat and *Lenticulina* sp.

22 m

Bed 21 Grey, medium-bedded (0.6–0.8 m) limestone, locally grading into oolitic and pseudo-oolitic rock, partly dolomitized, with some

persistent bands of dolomitized limestone (up to 0.7 m thick) up section grading into cryptocrystalline dark-grey, cavernous limestone showing karstic weathering. The rocks yielded foraminifera similar in composition to those found in Bed 20.

42 m

2.1.3 Hadar

2.1.3.1 Exposures 41 and 53

The following rocks are exposed on the valley side 5 km north of Hadar village (Fig. 2.7):

The Callovian

Bed 1 Cryptocrystalline, pale-grey, dense limestone with the scarce foraminifera: *Planularia* sp., *Lenticulina* sp. and *Epistomina* sp. (Fig. 2.8)

Apparent thickness 2 m

Bed 2 Marl, and calcareous, friable, yellowish brown clay, intercalated with dense, grey dolomitized limestone and bioclastic limestone (the limestone bands are up to 1.5 m thick)

3.5 m

The Oxfordian

Bed 3 Thin-bedded, finely laminated, grey clay, with scarce *Gryphaea* shells and the foraminifera *Reophax horridus* (Schwag.), *Haplophragmoides rotundatus* Barn., *Lenticulina russiensis* (Mjatl.), *L. tympana* Grig., *Astacolus vacillantes* Esp. et Sig., *Epistomina nemunensis* Grig., *E. stelligeraeformis* Mjatl., *Spirillina kuebleri* Mjatl. and *Turrispirillina* sp.

30 m

Bed 4 Pale grey clay, low in carbonate, interbedded with grey argillaceous limestone (bands 0.6–0.8 m thick), with abundant fragments of large *Gryphaea* shells, casts and unidentifiable fragments of ammonites and belemnites. The foraminifera are similar in composition to those of Bed 3, but complemented by *Epistomina volgensis* Mjatl., *Lenticulina quenstedti* (Gümb.), *Planularia tricarinella* (Reuss), *P. deeckei* (Wish.) and *Saracenaria* sp.

12 m

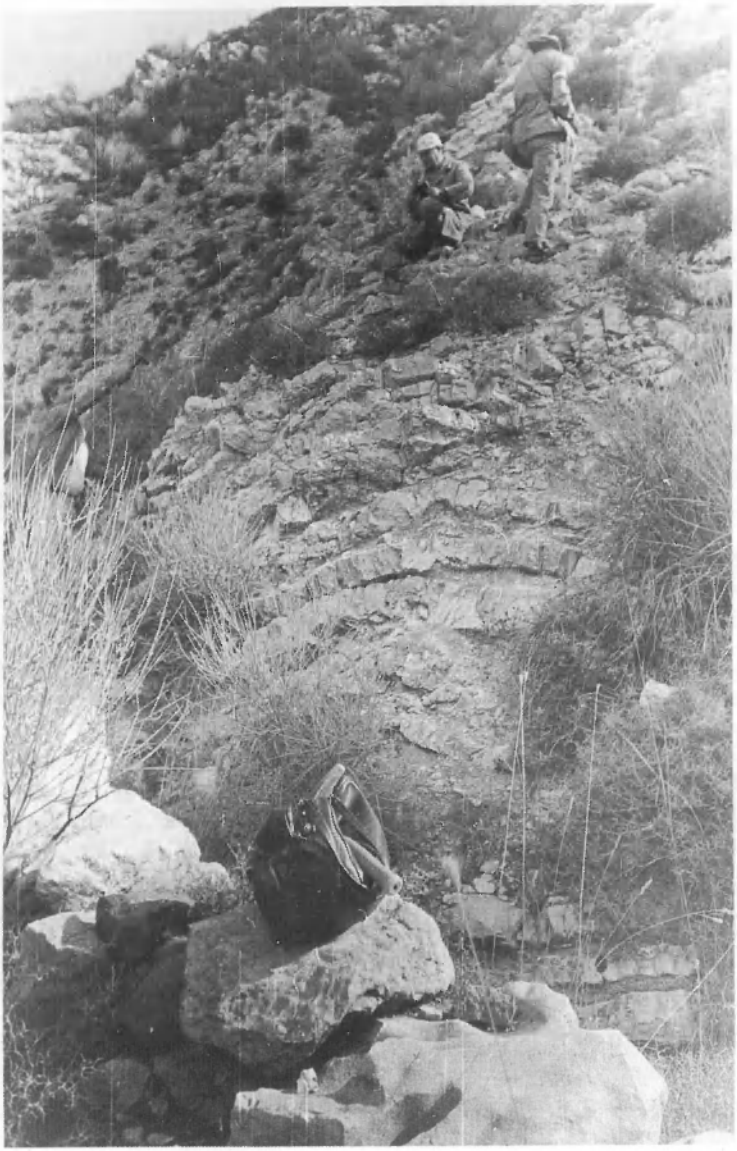

FIGURE 2.7 Anti-Lebanon. Section at Hadar village. Oxfordian reef (photo by A. Grigelis).

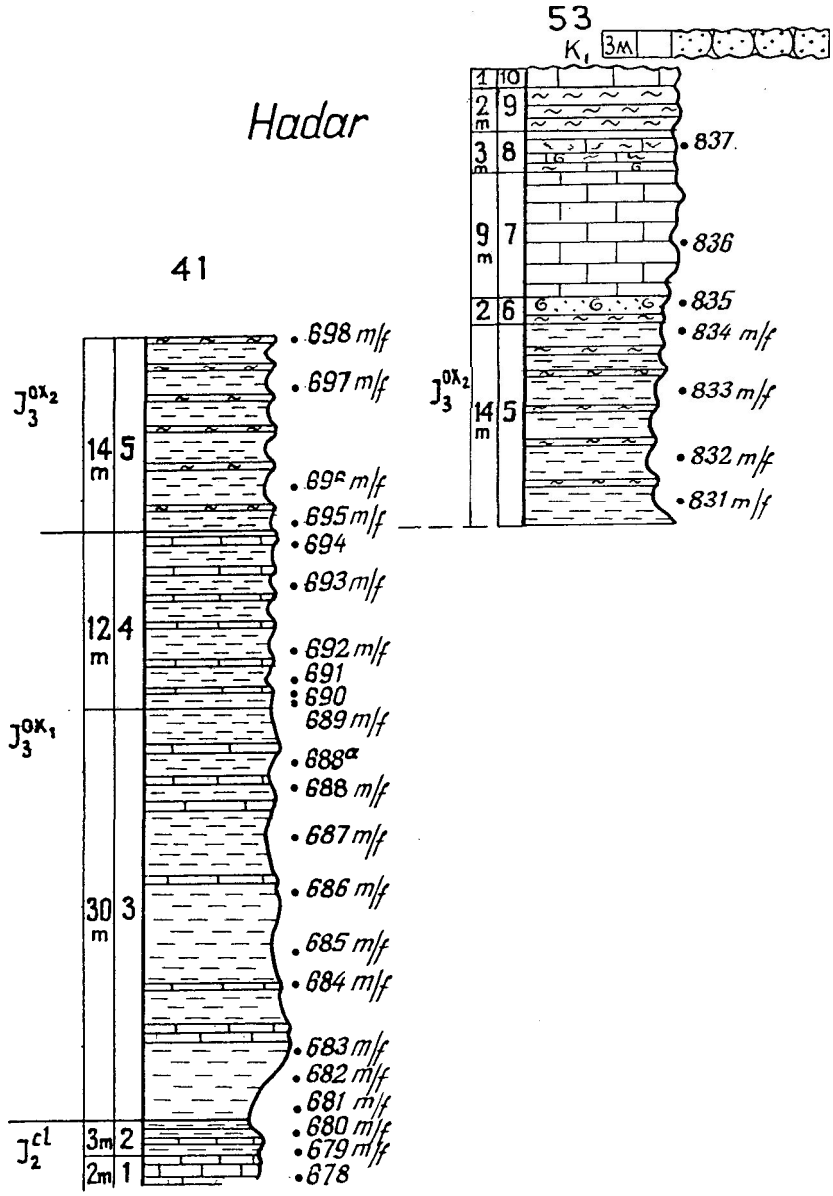

FIGURE 2.8 Anti-Lebanon. Section at Hadar village (exposures 41 and 53).

Bed 5 Calcareous, brown, fragmentary clay, intercalated with argillaceous limestone (0.3–0.5 m thick), yielding the foraminifera *Redmondoides rotundatus* (Redm.) and *Ammobaculites* sp.

14 m

Bed 6 Bioclastic yellowish grey limestone, locally sandy with algae and corals *Aggomorphastrae barabei* All., and the foraminifera: *Reophax* sp., *Haplophragmium* sp. and *Lenticulina* sp.

2 m

Bed 7 Cavernous, dense, grey coral limestone, with patches and dark nodules, impregnated with iron hydroxide.

9 m

Bed 8 Grey, algal limestone crowded with lithothamnia, oncolites and shelly detritus. Up the bed, the lithothamnia disappear, and the limestone becomes dense, cryptocrystalline and yellowish grey, with occasional burrows and lamellibranch casts.

2.5–3 m

No exposure for about 50 m
Along the transitional boundary, 200 m north-westward:

The Oxfordian

Bed 9 Clayey pale-grey marl, containing the foraminifera: *Lenticulina hebetata* (Schwag.), *Astacolus folium* (Wish.), *Citharina* sp., *Epistomina uhligi* Mjatl., *Conorboides* sp. and *Spirillina kuebleri* Mjatl.

2 m

Bed 10 Cryptocrystalline creamy grey, dense limestone with rare foraminifera, similar in found composition to those of Bed 9

Apparent thickness of 1 m

No exposure for about 50 m
The Lower Cretaceous overlies this unit with a marked disconformity.

(a) The Lower Cretaceous

Greenish grey clay intercalated with dense, cryptocrystalline, grey limestone, along a sharp erosion boundary, overlain by coarse-grained buff–brown sandstone, locally showing well-defined cross-bedding (this is known as the basement sandstone).

Apparent thickness of 3 m

2.1.4 Wadi al Karn

2.1.4.1 Exposure 5

Along the Damascus–Beirut Highway, 46 km from Damascus, the following rocks are exposed in the core of an anticline (Fig. 2.9):

The Callovian

Bed 1 Cryptocrystalline, thick-bedded, pale-grey, dense limestone, with rare veinlets of calcite. Up section, there appear bands of argillaceous, yellowish grey, jointed limestone, up to 0.8–1.2 m thick, and seams of dense, yellowish grey marl (0.03–0.05 m thick). The limestone is locally brecciated and displays fault planes. Scarce *Gryphaea* and fragments and casts of lamellibranchs were recorded. The clay and marl contain the foraminifera: *Rhabdammina indivisa* Brady, *Lituotuba nodus* Kosyr., *Ammobaculites suprajurassicus* (Schwag.), *A. fontinensis* (Terq.), *Labyrinthina recoarensis* (Cati), *Verneuilina polonica* Cushm. et Glaz., *Nautiloculina oolithica* Mohler, *Palaeogaudryina magharaensis* Said et Bar. and *Globuligerina calloviensis* K. Kuzn.

Apparent thickness 200 m

The lower Oxfordian

Bed 2 Cryptocrystalline, dense, grey limestone grading upward into bioclastic and oolitic limestone.

30 m

Bed 3 Bioclastic, pinkish grey limestone, with many lamellibranch and brachiopod shell fragments and crinoid columnals. In places, the organic remains form banks. The limestone yields the foraminifera: *Reophax sterkii* Haeus., *Haplophragmoides* sp., *Haplophragmium* cf. *lutzei* (Hanzl.), *Alveosepta jaccardi* (Schrödt), *Marssonella jurassica* Mitjan., *Quinqueloculina* sp., *Lenticulina* sp., *Planularia* sp. and *Epistomina* cf. *volgensis* Mjatl.

75 m

The upper Oxfordian

Bed 4 Greenish yellow marl, poorly consolidated and locally ochreous, intercalated with argillaceous limestone and dense greenish black

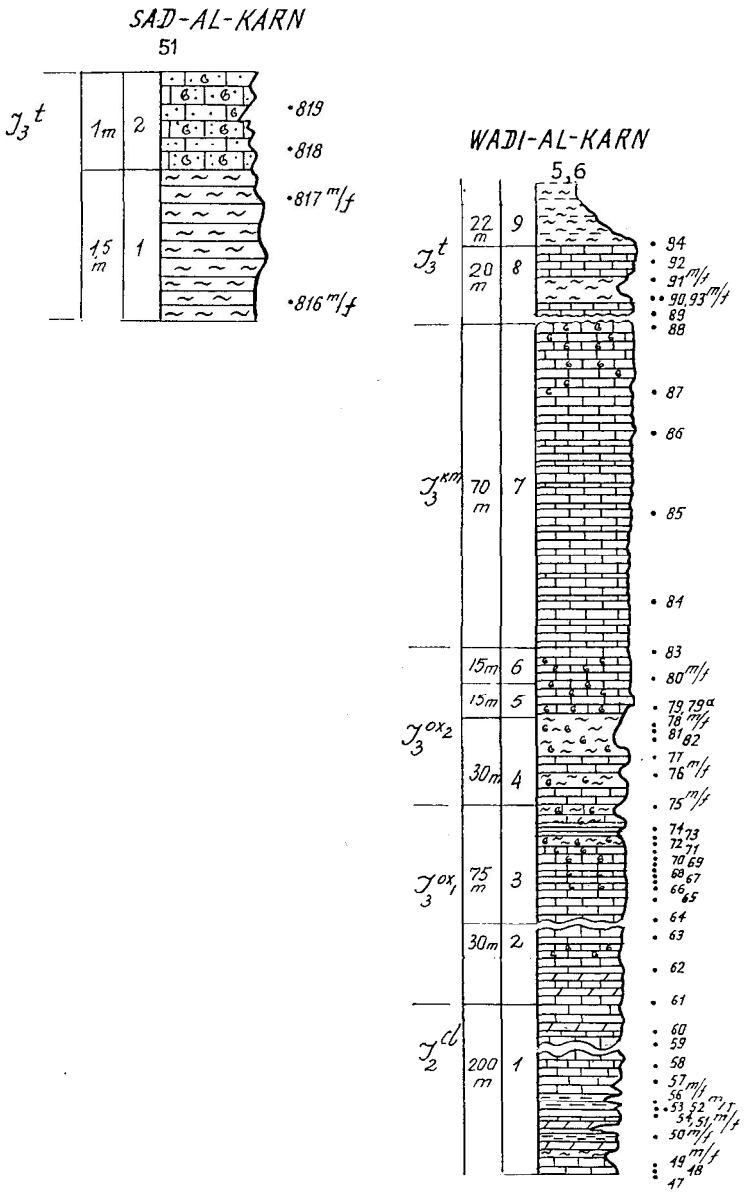

FIGURE 2.9 Anti-Lebanon. Wadi al Karn section (exposures 5 and 6) and Sad al Karn section (exposure 51).

fragmentary marl, showing distinct bedding (0.7–0.9 m thick). The rocks yield rare brachiopod and lamellibranch shells and the following foraminifera: *Reophax horridus* (Schwag.), *Haplophragmoides rotundatus* Barn., *Ammobaculites coprolithiformis* Schwag., *A. hagni* Bhalla et Abbas, *A. sequanus* Mohler, *Nautiloculina oolithica* Mohler, *Haplophragmium monstratus* (Dain), *Alveosepta jaccardi* (Schrodt), *Marssonella metaeformis* Esp, et Signal, *Verneuilinoides minuta* Said et Barak., *Palaeogaudryina varsoviensis* (Biel. et Poz.), *Spirillina kuebleri* Mjatl., *Turrispirillina amoena* Dain, *Dentalina* sp., *Lenticulina hebetata* (Schwag.), *L. nostra* Grig., *L. quenstedti* (Gümbel), *Astacolus vacillantes* Esp. et Sigal, *Planularia cordiformis* (Terq.), *Citharina sokolovi* Mjatl., *Epistomina* cf. *nemunensis* Grig. and *Paulina furssenkoi* Grig.

30 m

Bed 5 Very dense, grey marl, grading into argillaceous limestone, intercalated with poorly consolidated argillaceous marl and carbonate, laminated, greenish grey clay. Bands of dense marl (0.3–0.8 m), and loose marl and clay (1–3 m). The foraminiferal assemblage is similar in composition to that of Bed 4.

15 m

Bed 6 Very dense, cryptocrystalline, pale-grey limestone, with numerous lamellibranch, brachiopod and gastropod shell fragments, echinoid spicules and crinoid columnals. Along strike, the cryptocrystalline limestone grades into bioclastic rock, also richly fossiliferous.

15–19 m

The Kimmeridgian

Bed 7 Cryptocrystalline, massive, very dense, grey limestone, with abundant corals, gastropods and brachiopods, and bands of cryptocrystalline laminated limestone (0.8–1.2 m). The limestone forms cliffs when eroded (Fig. 2.10). The limestone contains rare, very thin impersistent seams of marl, containing the foraminifera: *Reophax hounstoutensis* Lloyd, *Haplophragmoides nonioninoides* (Reuss), *Triplasia elegans* (Mjatl.), *Torinosuella peneropliformis* (Yabe et Hanzawa), *Mesoendothyra croatica* Gusic, *Marssonella haeusleri* (Groiss) *Gaudryina vadazi* Cushm. et Glaz and *Spirillina* sp.

70 m

FIGURE 2.10 Anti-Lebanon. Wadi al Karn (exposure 7). Kimmeridgian limestones forming a cliff near the Damascus-Beirut Highway (photo by K. Kuznetsova).

The Tithonian

Along a sharp boundary with traces of erosional unconformity:

Bed 8 Dense, laminated (0.4–0.6 m), cryptocrystalline, pale-grey limestone with brachiopod fragments and the calpionellids *Crassicolaria intermedia* Durand-Delga and *Tintinnopsella carpatica* (Murg.-Fil).

20 m

Bed 9 Poorly consolidated marl, and calcareous, chalky, obscurely bedded, pale-grey and yellowish clay which is weathered white, containing the foraminifera: *Reophax folkestonensis* Chapm., *Ammobaculites aequale* (Roem.), *Recurvoides limbatus* (Chapm.), *Palaeotextularia crimica* Gorb., *Verneuilina angularis* Gorb., *Stomatostoecha compressa* Gorb., *Nautiloculina oolithica* Mohl., *Melathrokerion eospirialis* Gorb., *Pseudocyclammina lituus* (Yokoyama), *Choffatella decipiens* Schlumb., *Alveosepta powersi* (Redm.), *Anchispirocyclina lusitanica* (Egger), *Dorothia praehauteriviana* Dieni et Massari, *Belorussiella taurica* Gorb., *Gaudryina neocomiana* Chalilov and *Globospirillina neocomiana* Moullade.

Apparent thickness of 22 m

2.1.5 Sad al Karn

2.1.5.1 Exposure 51

The following rocks crop out in quarries and on terraces, 0.5 km north of the Damascus–Beirut Highway along the valley, on its right-hand slope, 0.5 km south of the lake at the top of the hill.

The Tithonian

Bed 1 Pale-grey and yellowish grey marl, weathered, almost white, with abundant fossils. Foraminifera are represented by: *Ammobaculites* sp. 1, *Alveosepta powersi* (Redm.), *A. personata* (Tobler), *Gaudryina vadazi* Cushm. et Glaz., *G.* cf. *neocomiana* Chalinov, *Dorothia* sp., *Charentia evoluta* (Gorb.), *Choffatella decipiens* Schlum., *Palaeotextularia crimica* Gorb., *Textularia* cf. *crimica* (Gorb.), *Melathrokerion eospirialis* Gorb., *Marssonella hechti* Dieni et Massari, *Haplophragmoides nonioninoides* (Reuss), *Astacolus* sp., *Ichthyolaria* sp., *Nodosaria* sp., *Anchispirocyclina lusitanica* (Egger), *Kurnubia* sp., *Eoguttulina oolithica* (Terq.), *Globulina* sp., *Guttulina* sp., *Spirillina tenuissima* Gümbel, *S. polygyrata* Gümbel and *Trochospirillina* sp.

Apparent thickness of 1.5 m

Bed 2 Along a sharp boundary: dense, cryptocrystalline, locally bioclastic, fossiliferous limestone, yielding foraminifera: *Choffatella decipiens* Schlumb., *Pseudocyclammina* sp., *Kurnubia* sp., *Melathrokerion eospirialis* Gorb, *Ammobaculites* sp. and *Anchispirocyclina lusitanica* (Egger).

1 m

2.1.6 Rowda

2.1.6.1 Exposure 30

The following rocks are exposed 1 km south-west of Rowda village, above terracettes: (Fig. 2.12)

(a) The Lower Cretaceous

Bed 1 Dense, pale-grey limestone, locally jointed, with abundant worm burrows and shell fragments. Under the microscope, the limestone is fine-grained and homogeneous, with numerous small round pores (due to leaching), with thin randomly orientated cracks, individual microstylolites and scarce fragments of echinoderms, and fine-grained authigenic quartz. The foraminifera are: *Dorothia kummi* (Zedler), *Dorothia* sp., *Textularia* sp., *Spiroplectammina obscura* Said et Barakat, *Palorbitolina lenticuaris* (Blumenbach), *Gavelinella barremiana* Bettenstaedt and *Trocholina* sp.

Apparent thicknesss 4 m

Bed 2 Bioclastic and cryptocrystalline limestone, up to 1 m thick (more commonly 50–70 cm in thickness), intercalated with pale yellow, poorly consolidated calcareous clay. Clay seams are 1.5–2.5 m thick. Locally the clay becomes darker (brown–purple) and more dense. The clay is crowded with corals, brachiopods, nerineids and oysters. The upper part of the final clay seam contains crushed, angular limestone fragments. Under the microscope, the limestone is fine- to medium-grained and bioclastic. The cement is porous, fine-grained and calcitic in composition. The detritus is rounded and sub-rounded, mainly fragments of echinoderms and bivalves. The limestone yields abundant foraminifera: *Melathrokerion spirialis* Gorb., *Ammobaculites* sp., *Dorothia kummi* (Zedler), *D. hechti* Dieni et Massari, *Torinosuella*(?) sp., *Spirillina italica* Dieni et Massari and *Palorbitolina lenticularis* Blum. The clay contains the following foraminifera: *Flabellammina alexandrae* S. Mark, *Choffatella decipiens* Schlumb., *Palorbitolina lenticularis* (Blum.) and *Hedbergella delrioensis* Carsey.

25 m

Bed 3 Dense cryptocrystalline, locally bioclastic, creamy grey limestone. Microscopically, the limestone is fine- to medium-grained and bioclastic, composed of sub-rounded, randomly orientated debris of echinoderms, bivalves (up to 10–15%) and foraminiferal remains. Matrix fine-grained, calcitic, locally siliceous. Individual joints are infilled with clear crystals of calcite, with film of iron around grains. Foraminifera are: *Spiroplectammina obscura* Said et Barakat, *Dorothia hechti* Dieni et Massari, *Dorothia praehauteriviana* Dieni et Massari, *Quinqueloculina* sp., *Sigmoilina* sp., *Spirillina italica* Dieni et Massari, *Coskinolina*(?) sp., *Torinosuella* cf. *peneropliformis* (Yabe et Hanzawa) and *Palorbitolina lenticularis* (Blumenbach).

20 m

2.1.7 Rowda

2.1.7.1 Exposure 34

The Callovian

Bed 1 Cryptocrystalline, pale-grey and saccharoidal dolomite, obscurely bedded, with joint blocks. In places, the cryptocrystalline limestone contains accumulations of small fossils and fragments. The limestone bands are about 1–2 m thick. In the upper part of the succession, the angle of dip increases to 45°. Richly fossiliferous bioclastic limestone appears here. Eastward, it varies from 2 to 30 m in thickness. Under the microscope, the limestone is cloddy and pseudo-oolitic, with basal cement. It shows thin joints, infilled with clear granular calcite, very fine-grained detritus. It contains the foraminifera: *Kurnubia palastiniensis* Henson, *Palaeopfenderina salernitana* (Sartoni et Crescenti), *Nautiloculina oolithica* Mohler, *Protopeneroplis* sp., *Pseudomarssonella* sp., *Quinqueloculina semispheroidalis* Danitch and *Q. frumenta* Azbel et Danitch.

300 m

The limestone is separated from the overlying strata by a dry valley (wadi), about 40 m wide. The opposite valley slope exposes the rocks described below.

The Oxfordian

Bed 2 This unit is an argillaceous, grey, medium-bedded limestone (up to 0.5 m thick) intercalated with clay and argillaceous, greenish grey, poorly consolidated marl. Clay (marl) layers are 0.4–0.5 m thick. Up

section, the thickness of the marly layers increases to 1 m. The clay content in the limestone decreases; the limestone becomes lighter in colour and denser. Some 8–10 m from the base of the unit, the thickness of limestone inceases to 10–12 m. Along strike, the layer is impersistent (it is lenticular). In places, the limestone is crowded with bivalves, corals and brachiopods; the surface is coated with fossil algae (Fig. 2.11). The clay contains a rich foraminiferal assemblage: *Reophax sterkii* Haeusler, *Pseudocyclammina* sp., *Alveosepta jaccardi* (Schrödt), *Ammobaculites ex gr. coprolithiformis* (Schwag.), *A. hagni* Bhalla et Abbas, *A. sequanus* Mohler, *Haplophragmium subaequale* (Mjatl.), *H. aequale* (Roem.), *H. lutzei* Hanzl., *Pseudobolivina aegyptiaca* (Said et Bar.), *Palaeogaudryina varsoviensis* (Biel. et Poz.), *Marssonella dumortieri* (Schwag.), *Kurnubia palastiniensis* Henson, *Nautiloculina oolithica* Mohler, *Quinqueloculina jurassica* Biel. et Styk, *Lenticulina hebetata* (Schwag.), *L. russiensis* (Mjatl.), *L. attenuata* (Kübl. et Zwingli), *L. audax* Loeb, et Tappan, *Astacolus vacillantes* Esp. et Sigal, *A. limataeformis* (Mitjan.), *Planularia tricarinella* (Reuss), *P. flexuosa* (Brückm.), *Marginulinopsis suprajurassicus* (Schwag.), *Citharina sokolovae* Mjatl., *C. macilenta* (Terq.), *C. flabelloides* (Terq.), *C. entypomatus* Loeb. et Tappan, *C.* aff. *lepida* (Schwag.), *C. implicata* (Schwag.), *Trocholina* sp., *Paalzowella feifeli feifeli* (Paalz.), *Ceratocancris* sp., *Ceratolamarckina*(?) sp. and *Epistomina praereticulata* Mjatl.

60 m

Bed 3 Up section, Bed 2 grades into a unit of dense, cryptocrystalline, locally slightly argillaceous limestone with fine detritus, ostracod valves, and the foraminifera: *Mesoendothyra croatica* Gusic, *Quinqueloculina tersa* Danitch, *Marssonella* sp., *Protopeneroplis striata* Weynschenk and *Astacolus* sp.

25 m

Bed 4 Dolomitized, dense limestone and dolomite.

100 m

A part of the outcrop is obscured in the valley and covered by soil and grass.

Bed 5 Very dense, cryptocrystalline, pale grey and creamy grey limestone, with sharp fracture, intercalated with dolomitized limestone or secondarily dolomitized limestone, replacing it along the strike (Fig. 2.12).

Apparent thickness >20 m

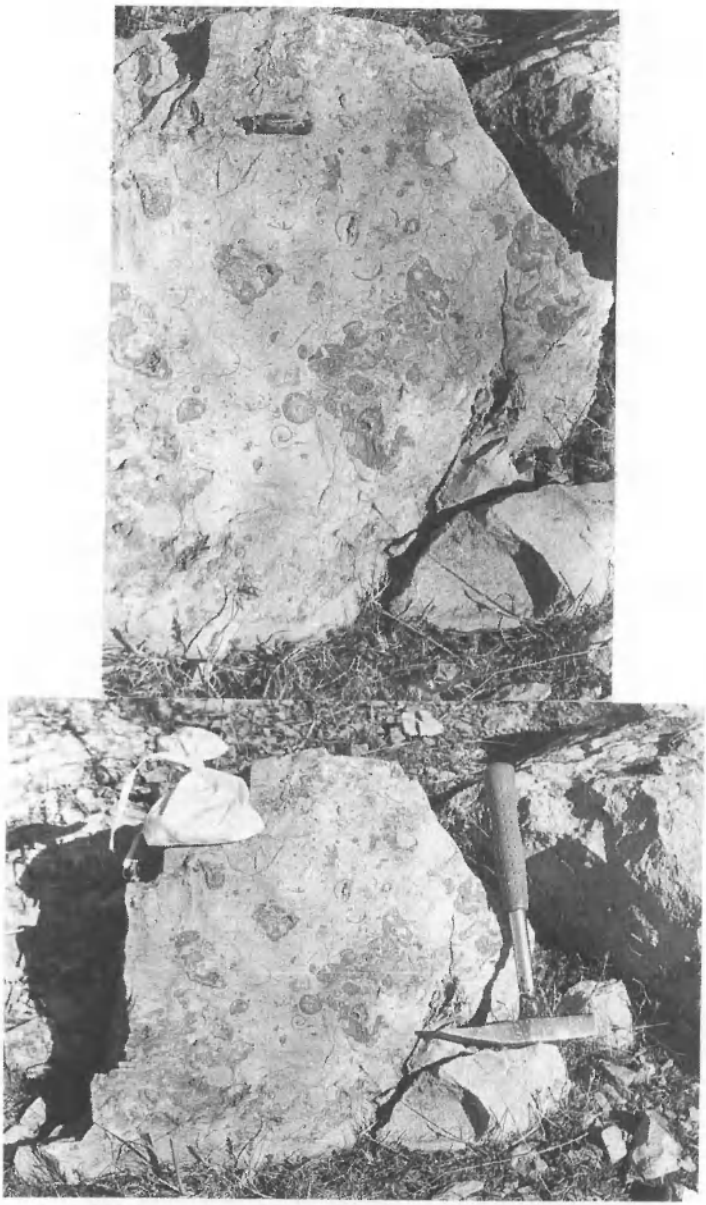

FIGURE 2.11 Anti-Lebanon. Section at Rowda village (exposure 34). Fossils and casts on the surface of Bed 2. Oxfordian (photo by A. Grigelis).

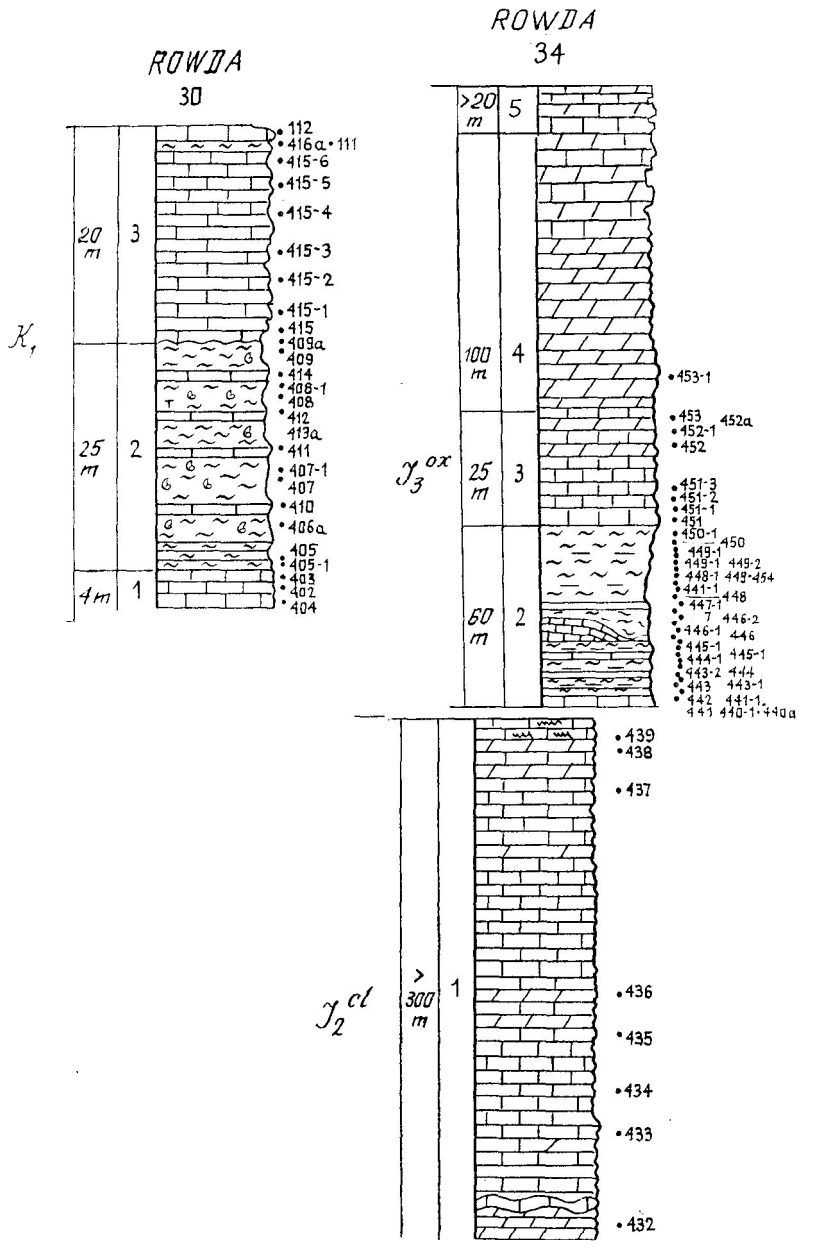

FIGURE 2.12 Anti-Lebanon. Section at Rowda village (exposures 30 and 34).

2.2 THE COASTAL MOUNTAINS

2.2.1 Jdaida

2.2.1.1 Exposure 40

The following rocks are exposed on the outskirts of Jdaida village along the road.

The Bajocian

Bed 1 Dense, cryptocrystalline and fine-grained, sub-argillaceous limestone, with up to 5% clay, locally dolomitized, pale-grey with a tinge of yellowish cream colour, with rare fragments of bivalve and ostracod shells and the tests of the foraminiferid *Lenticulina* cf. *polymorpha* (Terq.) (Fig. 2.13).

Apparent thickness 1 m

Bed 2 Yellowish grey, bedded, dense dolomite.

12 m

Bed 3 Yellow, "plastic" clay, with inclusions of denser lime nodules and lenses.

1.3 m

Bed 4 Yellowish grey, poorly bedded dolomite, grading into a massive variety up section.

80–85 m

The Bathonian

Bed 5 Cryptorcrystalline creamy-grey limestone with traces of secondary dolomitization, locally biogenic, algal, with tiny dolomite crystals making up 3% of the rock. Scarce foraminifera are represented by: *Pseudomarssonella*(?) sp. and *Globuligerina*(?) sp.

8 m

Bed 6 Yellowish grey, dense, bedded dolomite, grading into a massive variety along strike.

14 m

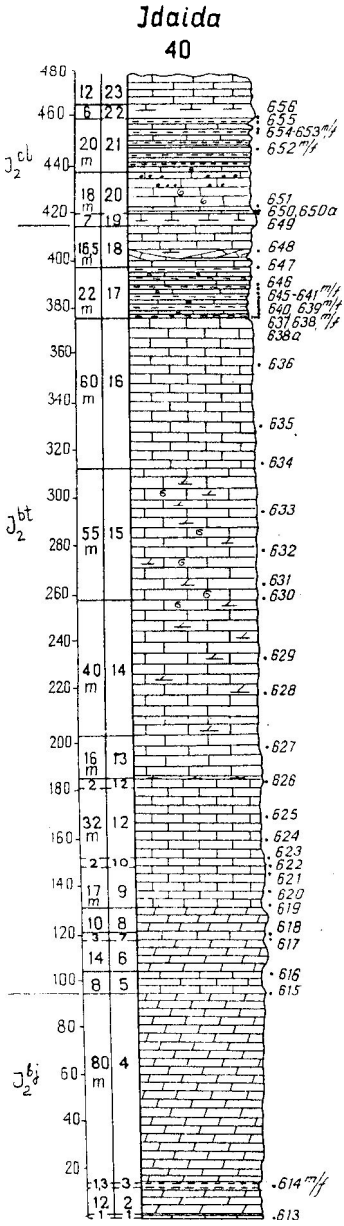

FIGURE 2.13 Coastal Mountains. Section at Jdaida (exposure 40).

Bed 7 Dense, cryptocrystalline, well-bedded limestone (0.4–0.8 m), creamy grey, jointed, with the joints infilled with clear granular calcite. Locally, the limestone is fine grained and coprolitic, with occasional large dolomite crystals, set in a porous cement. This bed contains scarce ostracod valves and the foraminifera *Pseudobolivina* sp. and *Riyadhella* sp.

3 m

Bed 8 Laminated and massive dolomite, locally grading into dolomitized limestone.

10 m

Bed 9 Cryptocrystalline, cream-coloured limestone, containing small fossils; the upper part is crowded with fauna. The erosion surface is at the top of the bed. Under the microscope patches and clots of algae are revealed, stylotites, thin cracks, infilled with clear granular recrystallized calcite and iron hydroxide. There are corals, ostracod valve fragments, and the foraminifera *Pseudomarssonella* sp. and *Redmondoides* sp.

17 m

Bed 10 Dense, lumpy, pale-grey limestone with a jointed uneven surface at the top.

2 m

Bed 11 Dense, creamy-grey, cryptocrystalline, lumpy, coprolitic limestone, with fine detritus, locally cream-coloured with small cracks, infilled with fine-grained recrystallized calcite in a filmy (pellicular) envelope on the surface of the grain. Abundant ostracod shell fragments and foraminifera *Pseudobolivina* sp. and *Mesoendothyra*(?) sp.

32 m

Bed 12 Grey-yellow, dense, massive dolomite.

2 m

Bed 13 Creamy grey, dense, cryptocrystalline limestone, with small joints infilled with finely crystalline calcite. There are abundant ostracod valves, rare coprolites and foraminifera *Redmondoides medius* (Redm.) and *Redmondoides* sp.

16 m

Bed 14 Pale-grey, jointed cryptocrystalline limestone in the lower part, up section, it is bioclastic, and contains dolomite bands up to 2 m thick. It

yields numerous shell fragments, algae, corals, rare ostracod valves and the foraminifera *Protopeneroplis* cf. *striata* Weynschenk, *Redmondoides* cf. *inflatus* (Redm.), *R. rotundatus* (Redm.), *Pseudobolivina* sp. and *Mesoendothyra*(?) sp.

40 m

Bed 15 Dense, porous, grey, laminated limestone (0.2–0.8 m thick), with ostracod valve fragments and the foraminifera *Riyadhella* sp., *Epistomina*(?) sp. and *Protopeneroplis*(?) sp.

55 m

Bed 16 Jointed thinly- and unevenly bedded, dense, cryptocrystalline limestone with fine detritus of bivalves and gastropods, and the foraminifera *Meyendorffina bathonica* Aurouze et Bizon, *Pseudocyclammina* sp. and *Mesoendothyra croatica* Gusic.

60 m

Bed 17 A unit of clay, intercalated with limestone, is exposed above the road, in the terracettes. The clay is yellow and hard, intercalated with a dense, cryptocrystalline, very pale-grey limestone, containing many bivalve fragments and casts, rare corals, with bands of dense argillaceous limestone, and with thick (0.4–0.6 m thick) bands of pure cryptocrystalline limestone with siliceous concretions at the base. The limestone contains: *Palaeopfenderina salernitana* (Sartoni et Crescenti), *Satorina apuliensis* Fourcade et Chorowitz, *Meyendorffina bathonica* Aurouze et Bizon, *Riyadhella* sp., *Redmondoides inflatus* (Redm.) and *Timidonella sarda* Bassoullet *et al.* The clay yields the foraminifera *Meyendorffina bathonica* Aurouze et Bizon, *Redmondoides reflexus* (Redm.) and *Redmondoides* sp. and ostracods.

22 m

Bed 18 Dense, cryptocrystalline, thinly and unevenly bedded, jointed limestone, intercalated with argillaceous, very well-jointed limestone. This unit weathers to form gentle slopes. In places, the argillaceous limestone contains scattered dolomite crystals, calcite grains, fine detritus, and abundant foraminifera: *Satorina apuliensis* Fourcade et Chorowitz, *Palaeopfenderina salernitana* (Sartoni et Crescenti), *Timidonella* sp., *Redmondoides rotundatus* (Redm.), *R. primitivus* (Redm.), *Nautiloculina oolithica* Mohler and *Kurnubia bramkampi* Redm.

16.5 m

The Callovian

Bed 19 Very dense, cryptocrystalline limestone, which forms as a cliff in topography. Microscopy revealed numerous patches and masses of algae, thin joints, infilled with fine-grained calcite, fine detritus, ostracod shells and the foraminifera *Riyadhella* sp. and *Sigmoilina paraminima* N. Ivan. et Danitch.

7 m

The following rocks overlie Bed 19. The boundary is transitional.

Bed 20 Dense, cryptocrystalline, laminated limestone, very light in colour, with rare siliceous concretions, fossils, worm burrows, fine detritus, and the foraminifera *Trocholina* sp., *Kurnubia* sp., *Globuligerina calloviensis* K. Kuzn., *Palaeopfenderina* cf. *gracilis* (Redm.) and *Labyrinthina*(?) sp.

18 m

Bed 21 Yellow, plastic clay, weathered grey, intercalated with dense, cryptocrystalline, pale-grey limestone. Some 8 m above the base of the bed, the clay disappears and the limestone becomes bioclastic and cavernous, with numerous bivalve, brachiopod and coral fragments.

20 m

Bed 22 Cryptocrystalline, pale-grey, very dense limestone, thickly bedded (up to 2 m), with sharp cutting edges. This unit forms a cliff in the topography. Microscopy revealed fine detritus and the foraminifera *Palaeopfenderina salernitana* (Sartoni et Crescenti), *Satorina* sp., *Kurnubia variabilis* Redm., *Praekurnubia crusei* Redm., *Redmondoides* sp. and *Nautiloculina oolithica* Mohler.

6 m

Bed 23 Locally cryptocrystalline limestone, dolomitized and weathered yellow, showing karstic weathering with sharp forms of surface weathering, containing fine detritus, corals and abundant foraminifera: *Palaeopfenderina salernitana* (Sartoni et Crescenti), *Satorina* sp., *Kurnubia variabilis* Redm., *Praekurnubia crusei* Redm., *Redmondoides* cf. *plicatus* (Redm.), *R. rotundatus* (Redm.) and *Nautiloculina oolithica* Mohler.

10–12 m

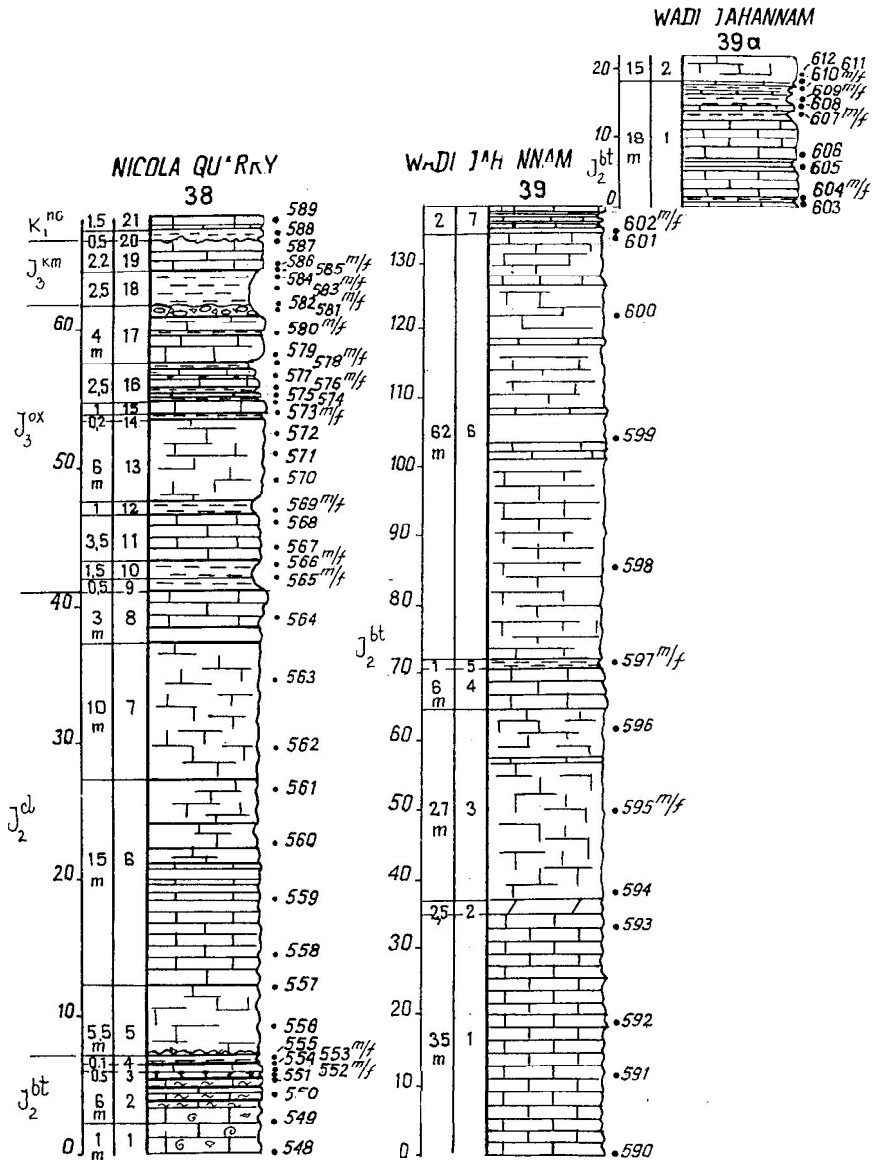

FIGURE 2.14 Coastal Mountains. Section along Wadi Jahannam (exposures 39 and 39a). Section at Nicola Quarry (exposure 38).

2.2.2 Wadi Jahannam

2.2.2.1 Exposure 39

The following rocks are exposed on either side of the valley and in the dry river-bed, 7 km north-west of the town of Qadmous (Fig. 2.14).

The Bathonian

Bed 1 Cryptocrystalline, medium-bedded, very pale-grey limestone, with many fossils and shell fragments, brachiopods, fine detritus, rare ostracod valves, and the foraminifera *Redmondoides medium* (Redm.), *R. inflatus* (Redm.), *R. rotundatus* (Redm.), *Riyadhella regularis* Redm., *Textularia jurassica* Gümb., *Nautiloculina* sp. and *Sigmoilina amphoroidale* Danitch.

35 m

Bed 2 Yellow-grey, saccharoidal, dense limestone, very dark grey on weathered surfaces. This unit forms well-defined cliffs in the topography.

2–2.5 m

Bed 3 Cryptocrystalline, creamy-grey limestone with numerous burrows on the surface, very thickly bedded (1.5–2 m thick), with clay partings (0.2 m thick). The foraminifera are: *Reophax metensis* Franke, *Redmondoides rotundatus* (Redm.), *Riyadhella reflexus* (Redm.), *R. regularis* Redm., *Palaeopfenderina trochoidea* Smout et Sugden, *Nautiloculina oolithica* Mohler, *Meyendorffina bathonica* Aurouze et Bizon and *Globulina oolithica* (Terq.).

27 m

Bed 4 Argillaceous, grey, jointed limestone, with brachiopod, bivalve and ostracod shell fragments.

6 m

Bed 5 Yellow-brown marl and clay, and argillaceous pale-grey limestone, yielding foraminifera similar in composition to those of Bed 3.

1 m

Bed 6 Cryptocrystalline, creamy-grey, locally biocalstic limestone, containing remains of brachiopods, bivalves and corals, thickly bedded

(1–2 m), with large siliceous concretions up section. Under the microscope, the limestone is well jointed, with the fine joints infilled with fine-grained calcite, with abundant fine detritus and the foraminifera *Palaeopfenderina trochoidea* (Smout et Sugden), *Meyendorffina bathonica* Aurouze et Bizon, *Nautiloculina oolithica* Mohler, *Kilianina* sp. and *Praekurnubia crusei* Redm.

62 m

Bed 7 Yellow-green clay, intercalated with argillaceous, jointed, thinly bedded limestone.

Apparent thickness 2–2.5 m

2.2.3 Wadi Jahannam

2.2.3.1 Exposure 39a

The following rocks are exposed in the valley floor, 0.7 km from Exposure 39 and farther along the road, 7 km north-west of Qadmous.

The Bathonian

Bed 1 The strata are intercalated dense, cryptocrystalline, creamy-grey limestone and clay with argillaceous well-jointed limestone. The limestone is obscurely and unevenly bedded, with thin partings of finely laminated green clay, varying from 0.1 to 0.3 m in thickness. The units of jointed limestone may be as thick as 0.7 m. The clay contains the foraminifera *Kilianina* sp., *Satorina apuliensis* Fourcade et Chorowitz, *Praekurnubia crusei* Redm., *Kurnubia bramkampi* Redm., *K. variabilis* Redm., *Palaeopfenderina gracilis* (Redm.), *Palaeogaudryina textularioides* (Reuss), *Valvulina* sp., *Globulina paalzovi* Mjatl., *Redmondoides plicatus* (Redm.), *R. inflatus* (Redm.) and *Riyadhella regularis* Redm.

18 m

Bed 2 Dense, cryptocrystalline, cream-coloured, massive, obscurely bedded limestone, which forms a cliff in the topography. It contains fine detritus, corals, rare ostracod valves, and the foraminifera *Kurnubia palastiniensis* Henson, *Nautiloculina oolithica* Mohler, *Timidonolla sarda* Bassoullet *et al.* and *Pseudomarssonella* sp.

Apparent thickness 15 m

2.2.4 Shuekha

2.2.4.1 Exposure 59

The following rocks are exposed below the asphalt road, 5 km south of Bab Janneh and 1 km south of Shuekha village (Fig. 2.15).

The Bathonian

Bed 1 Cryptocrystalline, dense, cream-coloured limestone, thickly and unevenly bedded (1–2 m thick), with unusual table-like weathering forms and rare and uneven accumulations of fine detritus (Fig. 2.16.)

Apparent thickness >50 m

Bed 2 Yellow, poorly consolidated clay, intercalated with pale-grey biogenic, jointed limestone, with rounded joint sets. The limestone shows many burrows, gastropods, oysters and corals. The middle part is hidden by terracettes.

10 m

Bed 3 Cryptocrystalline, cream-coloured, jointed medium- to thickly bedded limestone with mushroom-like jointing (0.4–0.8 m thick). The upper 4 m contains bioclastic limestone, including bands of argillaceous nodular limestone (0.2–0.4 m), weathered along the conchoidal fracture. Foraminifera are represented by *Protopeneroplis striata* Weynshenk, *Nautiloculina oolithica* Mohler, *Palaeopfenderina salernitana* (Sart. et Cresc.), *Praekurnubia crusei* Redm., *Kurnubia variabilis* Redm., *K. bramkampi* Redm., *Palaeotextularia* sp., *Redmondoides rotundatus* (Redm.), *R. primitivus* (Redm.) and *R. inflatus* (Redm.).

8 m

Bed 4 Creamy-grey, biogenic limestone, locally grading into the massive cryptocrystalline variety. Foraminiferal assemblage similar to that of Bed 3.

8 m

Bed 5 Pale-grey to white cryptocrystalline limestone crowded with small fragments of fossils, burrows. Well-jointed, with calcite along the joints, locally grading into biogenic limestone with large compound corals. The following foraminifera were recorded: *Labyrinthina* sp., *Everticyclammina* sp., *Ammobaculites* sp., *Redmondoides reflexus* (Redm.), *R. medius* (Redm.), *R. lugeoni* (Septfontaine),

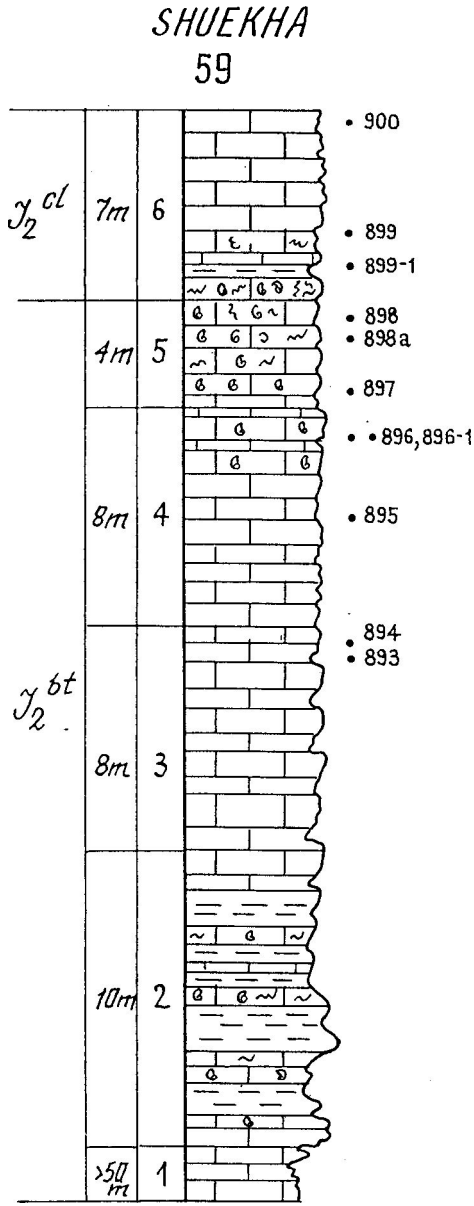

FIGURE 2.15 Coastal Mountains. Section at Shueka village (exposure 38).

FIGURE 2.16 Coastal Mountains. Section at Kharaib Salem village (exposure 15). Bathonian limestones showing unusual table-like weathering forms (photo by K. Kuznetsova).

Riyadhella arabica Redm., *Palaeopfenderina salernitana* (Sart. et Cresc.), *Kurnubia* cf. *variabilis* Redm., *Protopeneroplis striata* Weynchenk, *Paracoskinolina*(?) sp., *Marginulinopsis stilla* (Terq.), *Dentalina sinemuriensis* Terq., *Nautiloculina oolithica* Mohler, *Ichthyolaria* sp. and *Quinqueloculina compressa* Terq.

4 m

Bed 6 Cryptocrystalline, creamy-grey limestone, with numerous burrows and shell fragments at the bed base. Higher up, along a distinct but not sharp boundary, the limestone becomes cryptocrystalline and the amount of shelly detritus decreases; above this the limestone shows karstic weathering and is very cavernous. An unusual erosion surface is exposed on a terracette near the road. The limestone yields a rich foraminiferal assemblage: *Haplophragmium bartouxi* Said et Barakat, *Spiroplectammina biformis* (Park et Jones), *Psedocyclammina* sp., *Quinqueloculina compressa* Terq. et Berth., *Nautiloculina oolithica* Mohler, *Protopeneroplis striata* Weynchenk, *Kilianina*(?) sp., *Lenticulina* sp. and *Redmondoides lugeoni* (Septfontaine).

7 m

2.2.5 Bab Janneh

2.2.5.1 Exposure 76

The following rocks are exposed in the floor of the deep wadi, 1.5 km south-west of Bab Janneh village (Fig. 2.17).

The lower Bathonian

Bed 1 Dense, cryptocrystalline, creamy-grey, medium-bedded limestone (0.6–1 m), with trace fossils and isolated accumulations of small lamellibranch shells on bedding planes.

Apparent thickness of 30 m

Bed 2 Cryptocrystalline, massive limestone, which forms a cliff in the topography. Along strike, the massive limestone becomes rich in clay material and grades into thickly bedded limestone (1–1.5 m), forming mushroom-like jointing when weathered. There is an erosion surface at the top of the bed.

10 m

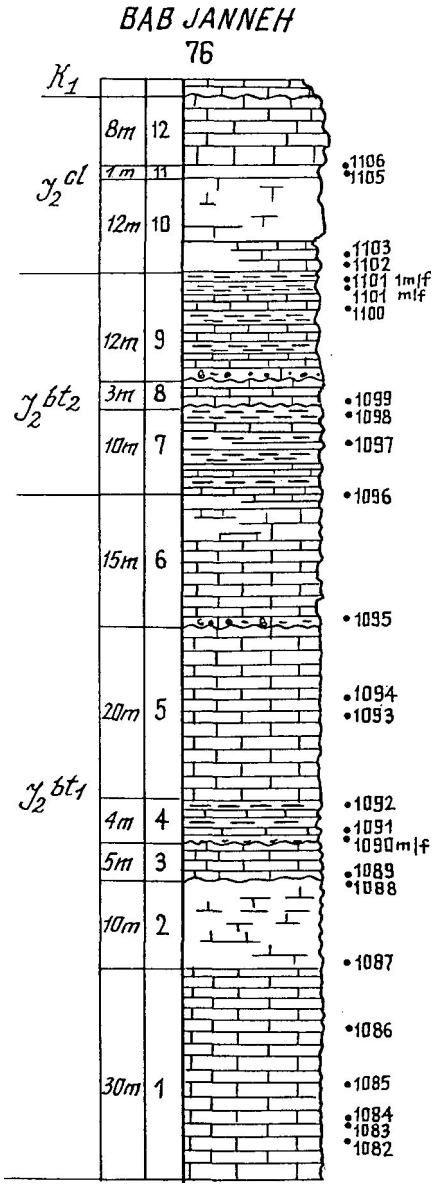

FIGURE 2.17 Coastal Mountains. Section at Bab Janneh village (exposure 76).

Bed 3 Along a distinct erosion boundary a cryptocrystalline, medium-bedded (0.7–0.9 m) limestone is exposed. It contains worm burrows and piles of fine detritus and shows ferruginous staining. It is cavernous and shows karstic weathering. It contains the foraminifera *Haurania deserta* Henson, *Redmondoides* sp. and *Riyhadella* sp.

5 m

Bed 4 Calcareous, yellowish grey, plastic clay, intercalated with pale-grey cryptocrystalline limestone; the clay contains a rich foraminiferal assemblage: *Ammobaculites agglutinans* d'Orb., *Nautiloculina oolithica* Mohl., *Verneuilinoides mauritii* (Terq.), *Haurania deserta* Henson, *Riyadhella arabica* Redm., *Redmondoides lugeoni* (Sept.), *R. inflatus* (Redm.), *Palaeogaudryina magharaensis* Said at Bar., *Epistomina turgidula* Pazdro and *Globuligerina bathoniana* (Pazdro).

4 m

Bed 5 Cryptocrystalline, pale-grey limestone, obscurely bedded, cavernous and showing karstic weathering, with an erosion surface at top of the bed.

20 m

Bed 6 Argillaceous, grey limestone locally rich in fine shelly detritus, grading into argillaceous, dense, cryptocrystalline, thickly bedded (2.5 m) limestone; when weathered it forms scree. It also shows unusual mushroom-like topographic formations.

15 m

The upper Bathonian

Bed 7 Argillaceous, medium-bedded, pale-grey to white limestone, intercalated with marl. The limestone yields accumulations of lamellibranchs, gastropods, oysters, corals and ostracods. There is an erosion surface at the top of the bed. The following foraminifera are recorded: *Kilianina blancheti* Pfender, *Palaeogaudryina textularioides* (Reuss), *Redmondoides medius* (Redm.), *R. reflexus* (Redm.), *Nautiloculina oolithica* Mohl., *Trocholina palastiniensis* Henson and *Dhrumella evoluta* Redm.

10 m

Bed 8 Argillaceous, grey, brecciated (nodular), medium-bedded limestone. The top of the bed displays an erosion surface, containing numerous worm burrows, corals, oysters, and large subrounded lamellibranchs. The

limestone yields a foraminiferal fauna similar in composition to that of Bed 7.

3 m

The Callovian

Bed 9 Argillaceous grey limestone, intercalated with calcareous greenish grey clay with the foraminifera *Palaeopfenderina trochoidea* (Smout et Sugden), *Redmondoides lugeoni* (Sept.), *Kurnubia bramkampi* Redm., *K. variabilis* Redm. and *Verneuilinoides mauritii* (Terq.).

12 m

Bed 10 Bioclastic, obscurely bedded, pale-grey, dense limestone, which forms a cliff in the topography.

12 m

Bed 11 Calcareous and yellowish grey, "plastic" clay, containing foraminifera *Redmondoides lugeoni* (Sept.), *Steinekella steineki* Redm., *Sanderella laynei* Redm., *Kurnubia bramkampi* Redm. and *K. morrisi* Redm.

1 m

Bed 12 Oolithic–bioclastic limestone, with abundant fragments and intact shells of lamellibranchs and brachiopods, corals and stromatoporoids. Foraminifera are similar in composition to those of Bed 9.

8 m

Carbonate-free green clay of the Bab Janneh Formation (Lower Cretaceous) crops out up section, following the disappearance of exposure for 2–3 m.

2.2.6 Nicola Quarry

2.2.6.1 Exposure 38

The following rocks are exposed in this quarry, 0.5 km south-east of Marmarita village (near St George Convent) (Fig. 2.14):

Bed 1 Dense cryptocrystalline, obscurely bedded, pale-grey limestone, containing shell fragments of lamellibranchs, gastropods and brachiopods, forming banks with rounded and oval dark inclusions.

The limestone has rare, thin (0.1–0.12 m) seams of shaly brown marl. The following foraminiferal assemblage was reported from the limestone: *Meyendorffina bathonica* Aurouze et Bizon, *Kilianina* sp., *Palaeopfenderina* cf. *salernitana* (Sart. et Cresc.) *Limognella mesojurassica* Maync, *Mesoendothyra* sp., *Ophthalmidium martonum* (Farinacci), *Quinqueloculina occulta* (Anton.) and *Sigmoilina* sp.

1 m

Bed 2 Pale-grey, thinly bedded marl, containing the foraminifera: *Pseudocyclammina* sp., *Kurnubia bramkampi* Redm. and *Nautiloculina oolithica* Mohl.

6 m

Bed 3 Dense, cryptocrystalline, pale-grey limestone, containing the foraminifera *Meyendorffina bathonica* Aurouze et Bizon and *Palaeopfenderina*. sp.

0.5 m

Bed 4 Brown, carbonate-free, thinly bedded and finely laminated, friable clay.

0.1 m

The Callovian

The following rocks are exposed along a distinct boundary.

Bed 5 Dense, cryptocrystalline, obscurely bedded limestone: the lower 0.5 m contains abundant algae and lime nodules. Foraminifera are: *Redmondoides rotundatus* (Redm.), *Protopeneroplis striata* Weynsch., *Palaeopfenderina* cf. *salernitana* (Sart. et Cresc.), *P. trochoidea* (Smout et Sugden) and *Kurnubia bramkampi* Redm.

5.5 m

Bed 6 Dense, cryptocrystalline, grey, thickly bedded limestone (2–3 m), intercalated with thinly bedded limestone (0.3 m), well jointed, with calcite crusts along the bedding planes. The following foraminifera were recorded: *Kilianina blancheti* Pfender, *Praekurnubia crusei* Redm., *Protopeneroplis striata* Weynsch., *Redmondoides primitivus* (Redm.), *Redmondoides* sp., *R. rotundatus* (Redm.), *Palaeopfenderina salernitana* (Sart. et Cresc.), and *Nautiloculina oolithica* Mohler.

15 m

Bed 7 Dense, cryptocrystalline, grey limestone, obscurely bedded.

10 m

Bed 8 Dense, cryptocrystalline, cream-coloured limestone, with calcite streaks.

3 m

The Oxfordian

Bed 9 Bluish grey, dolomitized clay.

0.5 m

Bed 10 Yellowish grey, lumpy clay, containing seams of argillaceous limestone (0.1–0.15 m). Foraminifera are: *Ammobaculites* sp., *Kurnubia wellingsi* Henson, *Pseudocyclammina* sp. and *Alveosepta* cf. *jaccardi* (Schrödt).

1.5 m

Bed 11 Cryptocrystalline, locally fine-grained, grey, jointed, medium-bedded limestone, with rare tests of *Pseudocyclammina* sp. and *Alveosepta jaccardi* (Schrödt).

3.5 m

Bed 12 Yellow, lumpy clay, containing seams and lenticular inclusions of cryptocrystalline limestone (up to 0.3 m thick), with the foraminifera: *Alveosepta jaccardi* (Schrödt), *Everticyclammina* sp. and *Nautiloculina oolithica* Mohler.

0.8–1 m

Bed 13 Dense, cryptocrystalline, thickly bedded, pale-grey limestone, with rare tests of *Kurnubia* sp.

6 m

Bed 14 Yellowish brown, lumpy, poorly consolidated clay, containing rare tests of the foraminifera *Verneuilinoides* cf. *osowiensis* Biel. and *Marssonella dumortieri* (Schwag.)

0.2 m

Bed 15 Dense, cryptocrystalline, pale-grey limestone.

1 m

Bed 16 Yellowish grey clay (0.15–0.2 m), intercalated with dense, cryptocrystalline pale-grey limestone (0.3–0.4 m). Foraminiferal assemblage similar to that of Bed 14.

2.5 m

Bed 17 Dense, cryptocrystalline, thickly bedded, grey limestone, weathered yellow, also with fragments of lamellibranch and brachiopod shells containing seams of marl (0.15–0.2 m), (Fig. 2.18). In the upper bed, the limestone is rich in argillaceous material and forms rubbly jointing when weathered. A band of breccia conglomerate (0.2–0.25 m) occurs at the top.

4 m

The Kimmeridgian

Bed 18 Plastic, yellowish-brown clay, with conchoidal fracture in the upper part grading into soft, chocolate-coloured clay with the foraminifera: *Alveosepta* cf. *personata* (Tobler), *Glomospirella* sp., *Pseudocyclammina* sp., *Ammobaculites magharaensis* Said et Barakat, *Ammomarginulina pellucida* Said et Barakat.

2.5 m

(a) The Lower Cretaceous

The Neocomian

The following rocks crop out along the distinct erosion boundary:

Bed 20 Yellowish brown, lumpy clay, yielding the foraminifera *Pseudocyclammina* sp., *Choffatella decipiens* Schlumb. and *Haplophragmoides vocontianus* Moullade.

0.5 m

Bed 21 Dense, cryptocrystalline, grey, thin-bedded to medium-bedded limestone.

1.5 m

2.2.7 The eastern Maareen

2.2.7.1 Exposure 69

The following rocks are exposed along the wadi between Kharaib Salem village and the eastern Maareen (Fig. 2.19).

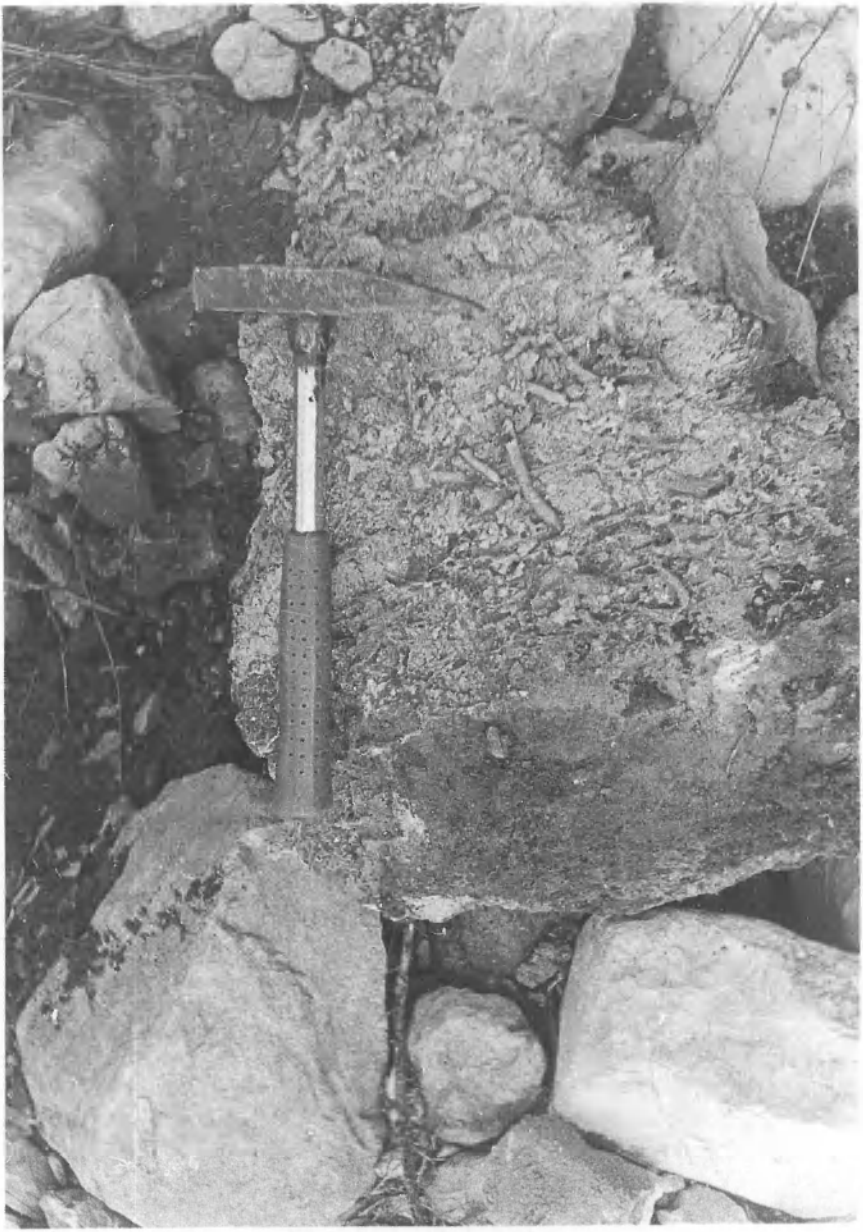

FIGURE 2.18 Coastal Mountains. Section at Ain Khlakem village (exposure 20). Erosion surface of Oxfordian limestones showing worm burrows (photo by K. Kuznetsova).

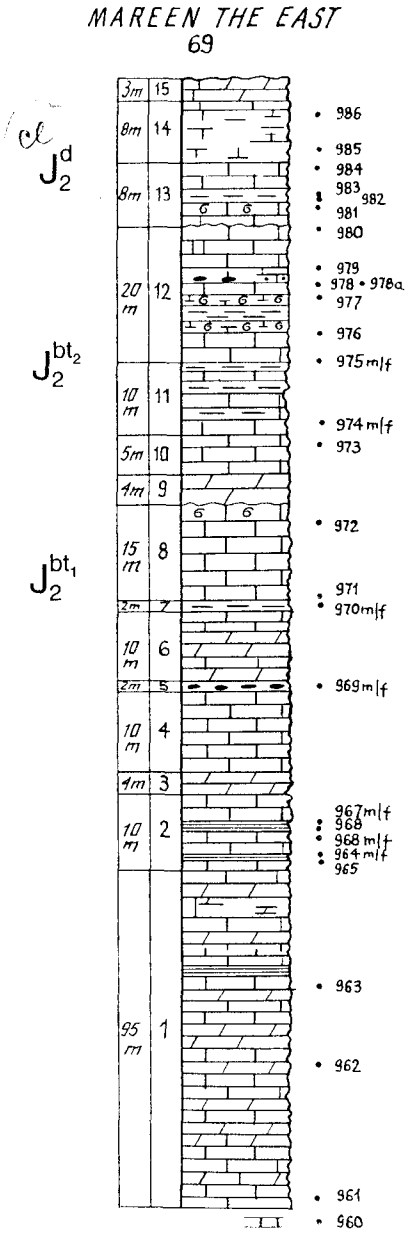

FIGURE 2.19 Coastal Mountains. Section at Maareen (exposure 69).

The lower Bathonian

Bed 1 Cryptocrystalline, cream-grey limestone, rich in fine shelly detritus, intercalated with grey and dark-grey, saccaroidal thickly-bedded dolomite (1–2.5 m). In the upper part of the bed, the limestone becomes cavernous, karst-weathered and stained with red iron oxide. The limestone contains the foraminifera: *Redmondoides lugeoni* (Sept.), *Pseudomarssonella bipartita* Redm., *Pseudomarssonella* sp., *Protopeneroplis striata* Weyn. and *Lenticulina* sp.

95 m

Bed 2 Grey and creamy-grey, medium-bedded limestone (0.7–1 m), containing occasional seams of greenish grey, friable clay (0.1–0.15 m).

10 m

Bed 3 Dark-grey, saccharoidal, obscurely bedded dolomites.

4 m

Bed 4 Dense, cryptocrystalline, cream-coloured limestone, containing the foraminifera: *Haurania deserta* Henson, *Redmondoides primitivus* (Redm.), *R. rotundatus* (Redm.) and *R. lugeoni* (Sept.).

10 m

Bed 5 Dense, cryptocrystalline limestone, locally with a high clay content, intercalated with grey calcareous clay, containing the foraminifera: *Haurania deserta* Henson, *Amijiella amiji* (Henson), *Redmondoides primitivus* (Redm.), *R. rotundatus* (Redm.) and *R. lugeoni* (Sept.).

2 m

Bed 6 Dense, creamy-grey limestone, including bands of grey, saccharoidal, thickly bedded dolomite.

10 m

Bed 7 Greenish grey, chipping marl, with shell-like, rounded inclusions of argillaceous limestone, containing the foraminifera: *Kilianina blancheti* Pfender, *Haurania deserta* Henson, *Amijiella amiji* (Henson), *Dhrumella evoluta* Redm., *Riyadhella regularis* Redm., *Paracoskinolina occitanica* Peyb., *Epistomina* sp. and *Paulina paula* (Pazdro).

0.2 m

Bed 8 Cryptocrystalline, creamy-grey, medium-bedded limestone (0.5–1 m), with a distinct erosion surface at the top of the bed, containing many lamellibranch fragments, burrows and echinoderm

fragments. Foraminifera are represented by *Haurania deserta* Henson, *Redmondoides lugeoni* (Sept.), *Redmondoides* sp. and *Protopeneroplis striata* Weynsch.

15 m

The upper Bathonian

Bed 9 Dark-grey, saccharoidal, obscurely bedded dolomite.

4 m

Bed 10 Cryptocrystalline, creamy-grey, medium-bedded limestone (0.3–0.8 m), locally grading into argillaceous limestone, broken down into rounded joints when weathered. The foraminiferal species composition is the same as that of Bed 8.

5 m

Bed 11 Calcareous, greenish-grey clay, locally yellow, ochreous and lumpy with lenticular inclusions of grey argillaceous limestone. The following foraminifera were reported: *Nautiloculina oolithica* Mohl., *Riyadhella arabica* Redm., *R. elongata* Redm., *Redmondoides inflatus* (Redm.), *R. lugeoni* (Sept.) and *Pseudomarssonella bipartita* Redm.

10 m

Bed 12 Cryptocrystalline, creamy-grey, medium-bedded limestone (0.5–0.8 m), strongly cavernous and showing karst weathering, containing bands of thinly bedded (0.1–0.15 m), jointed limestone, with siliceous nodules and lenticular inclusions. There is an erosion surface of the top of the bed.

20 m

The Callovian

Bed 13 Along a sharp erosion boundary an argillaceous, grey limestone is exposed, containing many fragments and impressions of fauna and burrows. Locally the rock contains abundant shell debris and banks of intact shells of lamellibranchs, brachiopods and echinoderms. Up section, the deposits become less fossiliferous and the argillaceous limestone grades into cryptocrystalline limestone, with occasional calcite lenses and streaks, and rare partings of clay, covered by soil and grass on the slope.

8 m

Bed 14 Cryptocrystalline, creamy, massive limestone, which forms a cliff in the topography. The following foraminifera were reported: *Nautiloculina oolithica* Mohl., *Palaeopfenderina salernitana* (Sart. et

Cres.), *P. trochoidea* (Smouth et Sugden) and *Kurnubia palastiniensis* Henson.

8 m

Bed 15 Cryptocrystalline, grey limestone, locally strongly dolimitized, grading into loose, yellowish grey, saccharoidal dolomite. There is an erosion surface at the top of the bed.

3 m

2.2.8 Qadmous

2.2.8.1 Exposure 91

The following rocks are exposed along an asphalt road near the bridge across a deep wadi, 2.5 km south-west of Beit Al-Sindianeh village (Fig. 2.20).

The Bathonian

Bed 1 Cryptocrystalline, thickly bedded, pale-grey to almost white, cavernous, limestone showing karstic weathering, with stylolites and irregular piles of fine detritus. The limestone forms cliffs in the topography. A seam (0.07 m) of white chalky marl lies 10 m from the wadi bottom, 1.8 m higher there is a band (0.1 m) of dense, pale-grey marl, containing *Riyadhoides mcclurei* (Redm.) and *Redmondoides primitivus* (Redm.).

Apparent thickness 18 m

Bed 2 Cryptocrystalline, pale-grey and creamy-grey, medium-bedded, limestone, showing karstic weathering, with siliceous grey and greyish pink nodules and calcareous worm tubes, piles of fine detritus and colonial corals. The limestone contains thin (0.05–0.1 m) seams of pale-yellow friable marl, impersistent along the strike. The marl yields the foraminifera: *Kilianina blancheti* Pfender, *Kurnubia bramkampi* Redmond, *Praekurnubia crusei* Redmond, *Redmondoides inflatus* (Redm.) and *R. rotundatus* (Redm.).

10 m

Bed 3 Argillaceous, dense, grey, obscurely bedded limestone, crowded with calcareous worm tubes, piles of detritus and occasional impersistent partings of greenish grey cloddy clay.

9 m

Bed 4 Cryptocrystalline, grey, dense, massive limestone, which forms a cliff in the topography.

6 m

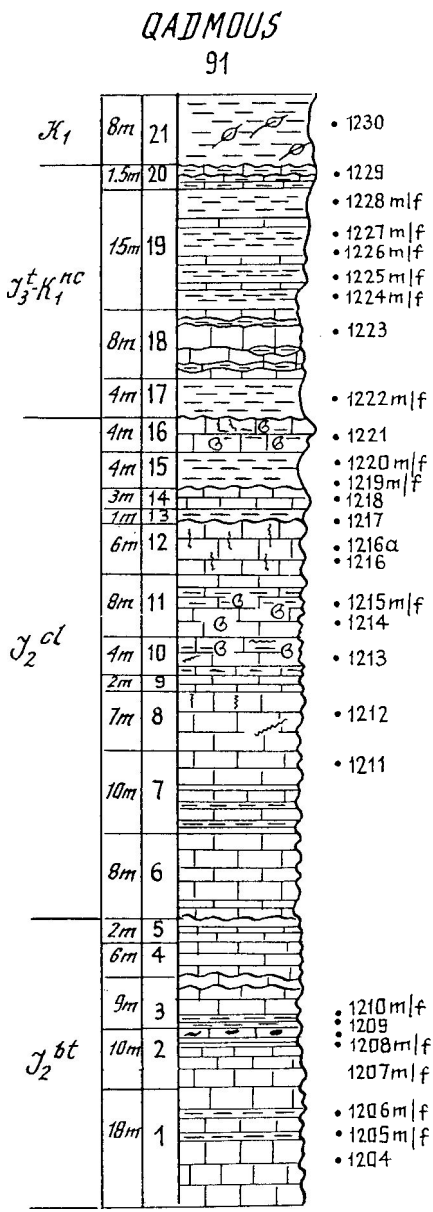

FIGURE 2.20 Coastal Mountains. Section at Qadmous village (exposure 91).

Bed 5 Pale-grey limestone, with low clay content, thinly bedded, iron oxide stained, showing minor scattered detritus. There is an erosion surface with worm burrows at the top of the bed.

2 m

The Callovian

Bed 6 Cryptocrystalline, grey and creamy-grey, very dense, medium-bedded limestone.

8 m

Bed 7 Cryptocrystalline, cream-coloured, medium-bedded, karst-weathered limestone, with piles of detritus and rare partings of clay and argillaceous marl (0.1–0.2 m).

10 m

Bed 8 Cryptocrystalline, very dense, creamy, massive limestone, forming a cliff in the topography. The upper part of the bed contains piles of detritus and burrows.

7 m

Bed 9 Argillaceous, grey, thinly bedded (0.1–0.15 m).

2 m

Bed 10 Aphanitic, massive, cream-coloured limestone, locally with a low clay content, massive; the upper part of the bed contains numerous brachiopod shells, corals and burrows.

4 m

Bed 11 Argillaceous, grey, lumpy, jointed limestone, with bands of argillaceous, yellowish grey, nodular limestone and thinly bedded brownish grey clay (0.1 m), containing the foraminifera *Steinekella crusei* Redmond and minute ostracods.

8 m

Bed 12 Cryptocrystalline, dense, cream-coloured, massive limestone, which forms a cliff in the topography. The upper part of the bed is composed of jointed karst-weathered limestone with abundant coral remains and fragments and burrows. There is an erosion surface with deep hollows at the top of the bed.

6 m

Bed 13 Finely laminated, greenish brown clay, with a band, impersistent along strike, of argillaceous, grey, lumpy limestone in the middle part of the bed. The clay infills the depressions in the erosion surface of Bed 12.

1 m

Bed 14 Cryptocrystalline, dense, cream-coloured obscurely bedded limestone. There is an erosion surface at the top of the bed.

3 m

Bed 15 Finely laminated, greenish grey clay, weathered brown.

4 m

Bed 16 Argillaceous, grey, obscurely bedded limestone, crowded with fine detritus, shell fragments and remains. There is an erosion surface at the top of the bed.

4 m

The Tithonian–Neocomian

The following rocks are observed along a sharp erosion boundary:

Bed 17 Sandy, yellowish grey, lumpy clay, containing the foraminifera: *Ammobaculites* sp., *Pseudocyclammina sulaiyana* Redm., *P. cylindrica* Redm., *Stomatostoecha* aff. *enisalensis* Gorb., *Melathrokerion eospirialis* Gorb., *Charentia* aff. *evoluta* Gorb., *Choffatella decipiens* Schlumb. and *Bramkampella arabica* Redm.

4 m

Bed 18 Dense, pinkish grey, silicified, very hard, thickly bedded limestone (1.2–1.5 m), containing bands of argillaceous lumpy, nodular limestone (0.25–0.4 m)

8 m

Bed 19 Yellowish grey, poorly consolidated, lumpy clay (0.5–0.7 m), intercalated with grey, medium-bedded limestone (0.5–1 m). In the upper part of the bed, the clay contains a rich foraminiferal assemblage, similar in composition to that of Bed 17.

15 m

Bed 20 Cryptocrystalline, creamy-grey limestone, obscurely bedded, containing bands of argillaceous nodular limestone (0.3–0.4 m). There is an erosion surface at the top of the bed.

1.5 m

(a) The Lower Cretaceous

Along a sharp erosion boundary, there occurs:

Bed 21 Brownish grey and chocolate-coloured, finely-laminated clay, with abundant plant remains, large fragments of charred wood and coal, locally with coal seams (up to 0.05 m thick), impersistent along the strike.

Apparent thickness 8 m

2.3 THE KURD-DAG

2.3.1 Smalek

2.3.1.1 Exposure 68

The following rocks are exposed on the northern hillside, 1.5 km south-west of Smalek village (Fig. 2.21).

The Bathonian

Bed 1 Cryptocrystalline, medium-bedded dark-grey limestone, with calcite streaks and pockets, locally karst weathered.

Apparent thickness 50 m

Bed 2 Dark-grey, dense, saccharoidal dolomite, obscurely bedded.

30 m

Bed 3 Cryptocrystalline, pale-grey, medium-bedded limestone (0.5–1 m), containing the foraminifera: *Palaeopfenderina trochoidea* (Smout et Sugd.), *Dhrumella evoluta* Redm. *Haurania deserta* Henson and *Riyadhella* sp.

40 m

The Callovian

Bed 4 Pale-grey, medium- to thinly-bedded limestone. The upper part is cavernous, karst-weathered and iron oxide stained, containing occasional siliceous nodules. There are isolated bands, impersistent in strike, containing iron-stained algal remains. Rare foraminifera are represented by *Redmondoides lugeoni* (Sept.) and *Kurnubia* cf. *palastiniensis* Henson.

5 m

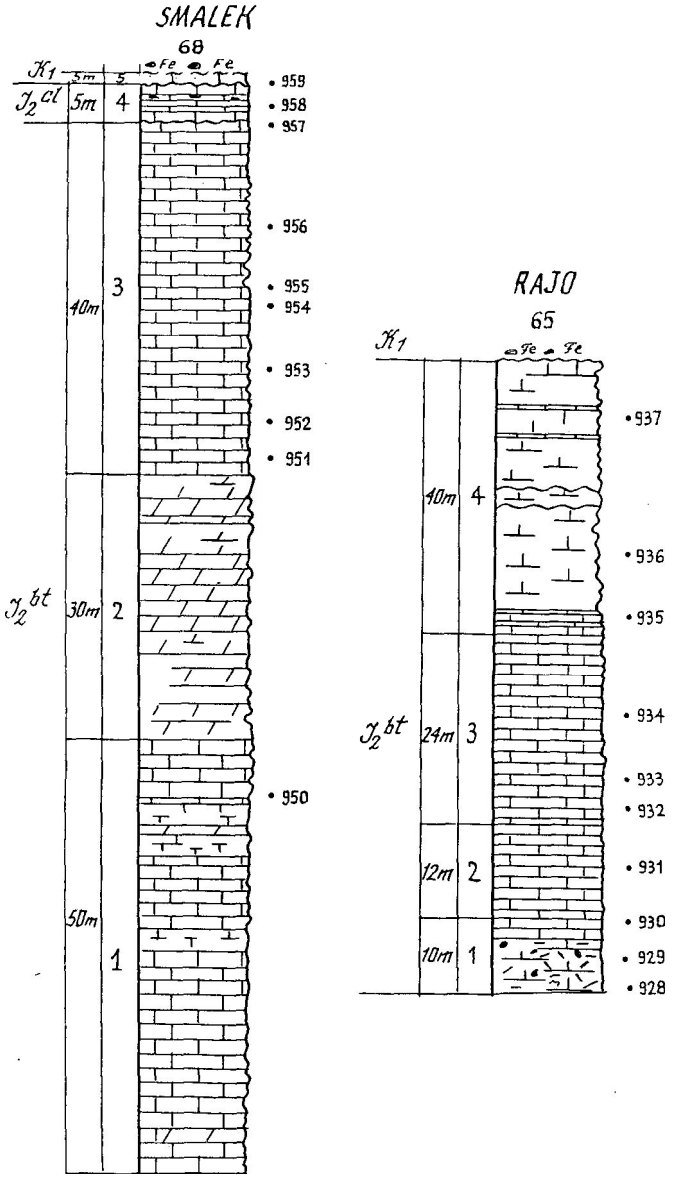

FIGURE 2.21 Kurd-Dag. Section at the villages of Smalek (exposure 68) and Rajo (exposure 65).

(a) The Lower Cretaceous

The Aptian

Along the sharp erosion boundary is exposed:

Bed 5 Quartzose sandstone with a carbonate cement, iron oxide stained, with iron ore occurring as oolites and small nodules.

Apparent thinckness 5 m

2.3.2 Rajo

2.3.2.1 Exposure 65

The Bathonian

Bed 1 Cryptocrystalline limestone, thickly and obscurely bedded, pale-grey and dark-grey, with calcite streaks, masses of worm burrows and occasional corals. Under the microscope, the limestone is fine grained, locally lumpy and pseudo-oolitic, with a basal cement; the joints are infilled with fine-grained calcite and iron hydroxides. Also present are rare scanty stylolites and recrystallized detritus. The fossils comprise algae, ostracod valves and the foraminifera: *Ammobaculites* sp., *Redmondoides primitivus* (Redm.), *R. inflatus* (Redm.), *Lenticulina* sp. and *Pseudobolivina* sp.

Apparent thickness 10 m

Bed 2 Cryptocrystalline, grey, medium- to thinly bedded limestone, with calcite infilling joints; microscopy has revealed abundant masses and fragments of algae, pelitic material, organic detritus and the foraminifera: *Ammobaculites* sp., *Redmondoides primitivus* (Redm.).

12 m

Bed 3 Cryptocrystalline grey limestone, locally grading into bioclastic, thickly bedded (0.8–1.3 m), karst-weathered, cavernous limestone, with numerous coral, gastropod and lamellibranch fragments. Foraminifera are: *Kurnubia* sp. (*ex gr. palastiniensis* Henson), *Palaeopfenderina* sp., *Redmondoides inflatus* (Redm.), *Dorothia*(?) sp., *Textularia* sp. and *Timidonella*(?) sp.

24 m

Bed 4 Cliff, composed of cryptocrystalline, grey, unevenly and obscurely bedded limestone (0.1–2 m). Under the microscope, the limestone is medium-to finely clastic, coprolitic and strongly jointed with

the joints infilled with fine-grained calcite. The cement forms films around grains and is locally basal. There are abundant masses and patches of algae, detritus and the foraminifera *Dhrumella evoluta* Redm., *Palaeopfenderina trochoidea* (Smout et Sugd.), *Haurania deserta* Henson and *Protopeneroplis striata* Weynsch.

40–42 m

2.4 THE PALMYRIDES

2.4.1 Al-Zbeidi

2.4.1.1 Exposure 93

(a) The Middle(?) Jurassic

The following rocks crop out on the south slope of the Dmer Range along the Damascus–Palmyra Highway, 18 km north-east of Abu Ach Shamad, at Jebel Zbeidi, 74 km north-east of Damascus (Fig. 2.22).

Bed 1 Medium-bedded, grey and brownish grey, dense, cryptocrystalline limestone, containing bands of grey crystalline limestone. Some 6 metres from the base, the limestone band is very thinly bedded, grey and dense. The limestone is locally "variegated" (bluish and lemon-coloured, with calcite streaks). In places, the cryptocrystalline limestone is replaced by a coarsely crystalline variety. In the upper 20–25 m, the limestone is nodular.

Apparent thickness 35–40 m

Bed 2 Grey and dark grey, subargillaceous limestone, nodular in the lower part, and, higher up cryptocrystalline, medium-bedded limestone.

6 m

Bed 3 Grey, medium-bedded, cryptocrystalline limestone, intercalated with very thinly bedded argillaceous limestone. Bands of the cryptocrystalline and the argillaceous limestone are 0.5–0.7 m and 0.3–0.4 m thick, respectively. The lower part contains two bands of very hard, friable limestone, locally rich in fine detritus.

14 m

Bed 4 Stromatoporoid, grey dense limestone.

1.5 m

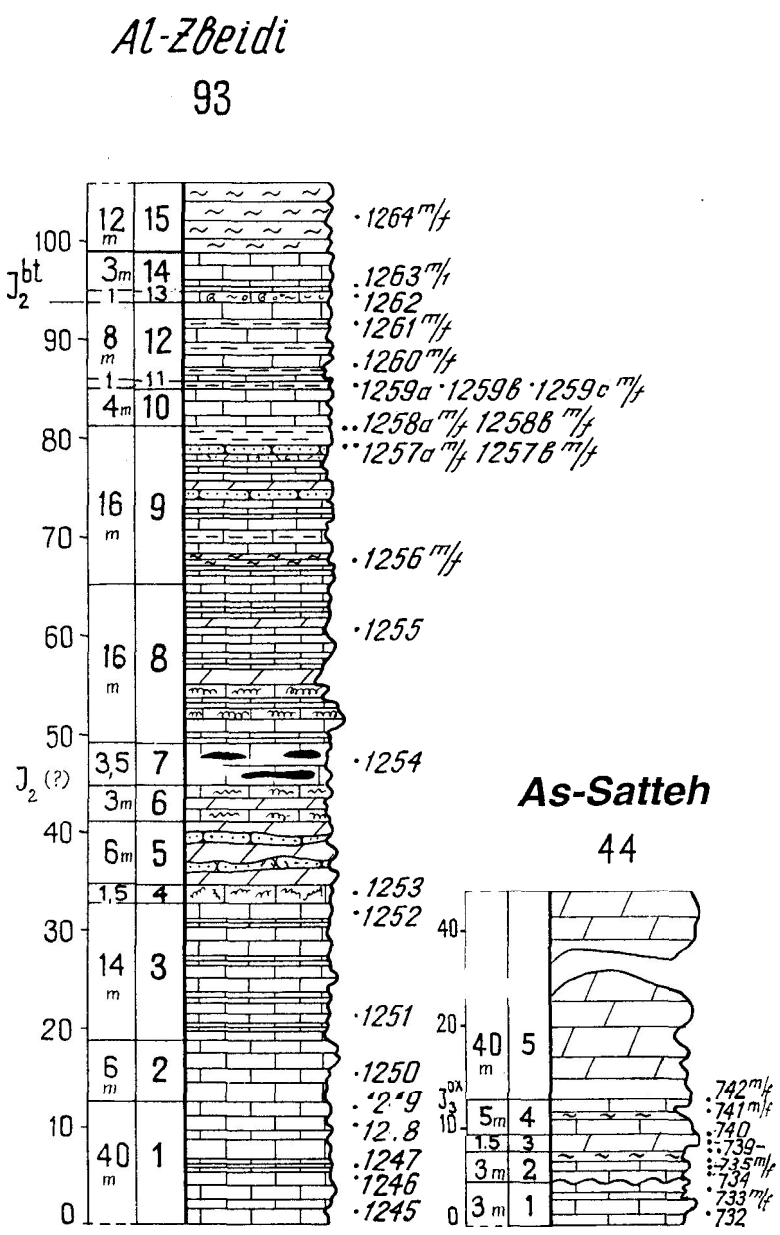

FIGURE 2.22 Palmyrides. Sections at Al-Zbeidi (exposure 93) and As-Satteh (exposure 44).

Bed 5 Greyish yellow dolomite, with bands of quartzose medium-grained, poorly consolidated sandstone (0.1–0.2 m).

6 m

Bed 6 Stromatoporoid, grey, dense limestone, with bands of grey dolomite and argillaceous crushed limestone, 0.6 m and 0.3 m thick, respectively.

3 m

Bed 7 Pale-grey, cryptocrystalline limestone, obscurely bedded in the lower part and medium-bedded higher, containing bands of argillaceous limestone, lenses and impersistent bands of silicified, very dense, grey limestone and silica.

3.5 m

Bed 8 Thinly bedded, grey limestone, containing interbeds of dolomitized limestone, yellow dolomite and stromatoporoid limestone. In the upper part of the bed, the limestone is medium grained, grey and nodular.

16 m

Bed 9 Obscurely bedded, medium- to thinly bedded, dense limestone, intercalated with argillaceous limestone and marl. Some 10 m from the base, the limestone contains bands of dense, medium-grained, reddish buff sandstone (0.8–1 m), yellowish grey, saccharoidal dolomite (0.7 m), nodular argillaceous limestone, thinly bedded limestone, sandstone greenish grey, loose, lumpy clay (0.5 m), dense crystalline limestone (0.5–0.7 m) and greenish grey clay.

16 m

Bed 10 Dark-grey, crystalline limestone, with calcite streaks.

4 m

Bed 11 Argillaceous, white, friable limestone.

1 m

Bed 12 Oolitic, bright yellow limestone, with ironstone concretions and seams of dense, greenish yellow, friable clay.

8 m

Bed 13 Detrital, yellow limestone.

1 m

The Bathonian

Bed 14 Oolitic, yellow limestone, locally poorly consolidated, yielding the foraminifera *Haurania deserta* Henson, *Amijiella amiji* (Henson), *Redmondoides lugeoni* (Sept.), *R. primitivus* (Redm.), *R. plicatus* (Redm.), *R. medius* (Redm.), *R. reflexus* (Redm.), *Paulina paula* (Pazdro), *Kilianina blancheti* Pfend., *Ammobaculites agglutinans* Orb. and *Nautiloculina oolithica* Mohler.

3 m

Bed 15 Argillaceous, grey, conchoidally fractured, friable marl.

Apparent thickness 12 m

A foraminiferal assemblage recorded from Bed 14 contains species characteristic of the Bathonian, which are most common in its lower part (*Haurania deserta* (Hens.), *Amijiella amiji* (Hens.)). Foraminifera have not been reported from either the underlying or the overlying rocks. The same section and the same horizon yielded the brachiopods *Dahanirhynchia subversabilis* (Weir.), *Kallirhynchia concinna* Sow., *Burminrhynchia* aff. *tumida* Buckm., suggesting a Bathonian age for the enclosing rocks.

Beds 1 to 13 inclusive are unfossiliferous. Their age can be determined tentatively as mid-Jurassic, based on their position in the succession, below the Bathonian deposits.

2.4.2 As-Satteh

2.4.2.1 Exposure 44

The following rocks are exposed in the core of an anticline in the floor of the dry Wadi Hayan Valley.

The Oxfordian

Bed 1 Cryptocrystalline, grey, thinly bedded limestone (0.1–0.3 m), very dense, intercalated with argillaceous, grey, dense limestone, breaking down into rounded joint block.

3 m

Bed 2 Grey, argillaceous limestone, intercalated with medium-bedded (0.3–0.7 m), dense, friable, pale-grey marl. Up section, the marl bands increase in thickness up to 0.5–0.8 m; the rock becomes greenish- and yellowish-grey. The marl contains the foraminifera: *Reophax* sp., *Everticyclammia virguliana* (Koechlin), *Ammobaculites coprolithiformis*

Schwager, *Palaeogaudryina magharaensis* Said et Barakat, *Verneuilinoides minuta* Said et Barakat, *Lenticulina subalata* (Reuss), *Planularia beierana* (Gümbel), *Marginulinopsis* sp., *Globulina oolithica* Terquem, *Eoguttulina* sp., *Conorboides* sp., *Patellina douvillei* Said et Barakat and *Globuligerina oxfordiana* (Grigelis), and the ostracods *Cytheropteron* (*Cytheropteron*) *bispinosum bispinosum* Schmidt, *Lophocythere ex gr. cruciata* subsp. Triebel and *Bisulcocypris undulatus* Dobrova.

3 m

Along a sharp erosion boundary are exposed:

Bed 3 Pale-grey, dense, obscurely bedded dolomite, locally grading into dolomitized limestone.

1.5 m

Along a sharp erosion boundary are exposed:

Bed 4 Marly, grey, medium-bedded limestone, intercalated with slaty, friable, pale-grey marl.

5 m

Bed 5 Yellowish-grey, dense, massive dolomite, forming a cliff in the topography.

40 m

CHAPTER 3
THE STRATIGRAPHY OF THE JURASSIC SEDIMENTS

3.1 INTRODUCTION

Natural exposures of Jurassic sediments in the western, and, in part, the central parts of Syria, are located in mountainous areas, namely the Anti-Lebanon, the Coastal Mountains, the Kurd-Dag and the Palmyrides (Fig. 2.1). Over the remainder of the area, the Jurassic is overlain by younger sediments and can be encountered in boreholes, where the Jurassic is correlated on the basis of geophysical data, and the age is determined from identification of the rare microfauna in thin sections made from cores, or on the basis of the stratigraphic position in the section. The Jurassic sediments in the areas of good exposure can be dated to the level of stage and substage, but those in areas of poor exposure can be dated to the level of series only. This book gives the results of the exploration of Jurassic deposits of Syria in naturally occurring exposures. Subsurface data have not been used in the description of the stratigraphic sections.

The Jurassic of Syria is represented by three series, which can be subdivided into stages substages and foraminiferal zones (or faunal marker beds).

The methods of analysis and recognition of foraminiferal zones are based on both the general principles of zonal stratigraphy (Hedberg, 1976; Stepanov and Mesezhnikov, 1979) and special schemes applied to Jurassic foraminifera (Grigelis, 1985; Grigelis and Kuznetsova, 1987; Krymgolts, 1982; Kuznetsova, 1989, 1991).

From studying of the foraminifera and microbiofacies, the authors worked out a new scheme for the zonation of the Jurassic sediments of Syria. Zonal subdivision is given for four major Jurassic terrains (Fig. 3.1). The stratigraphic ranges for entire foraminiferal fauna studied are given in Table 3.1.

In terms of their faunal composition, the Jurassic foraminiferal zones of Syria are classified into coenozones, ecozones and faunal marker beds. A coenozone (assemblage zone) groups together sediments that contain distinctive natural assemblage of fossils that differ from those contained in the under- and overlying rocks. An ecozone groups together strata in which fossil assemblage is clearly related to particular environmental conditions at the time of deposition (biofacies). Faunal marker beds are bounded by erosion surfaces – stratigraphic breaks or deposits, containing no faunal remains.

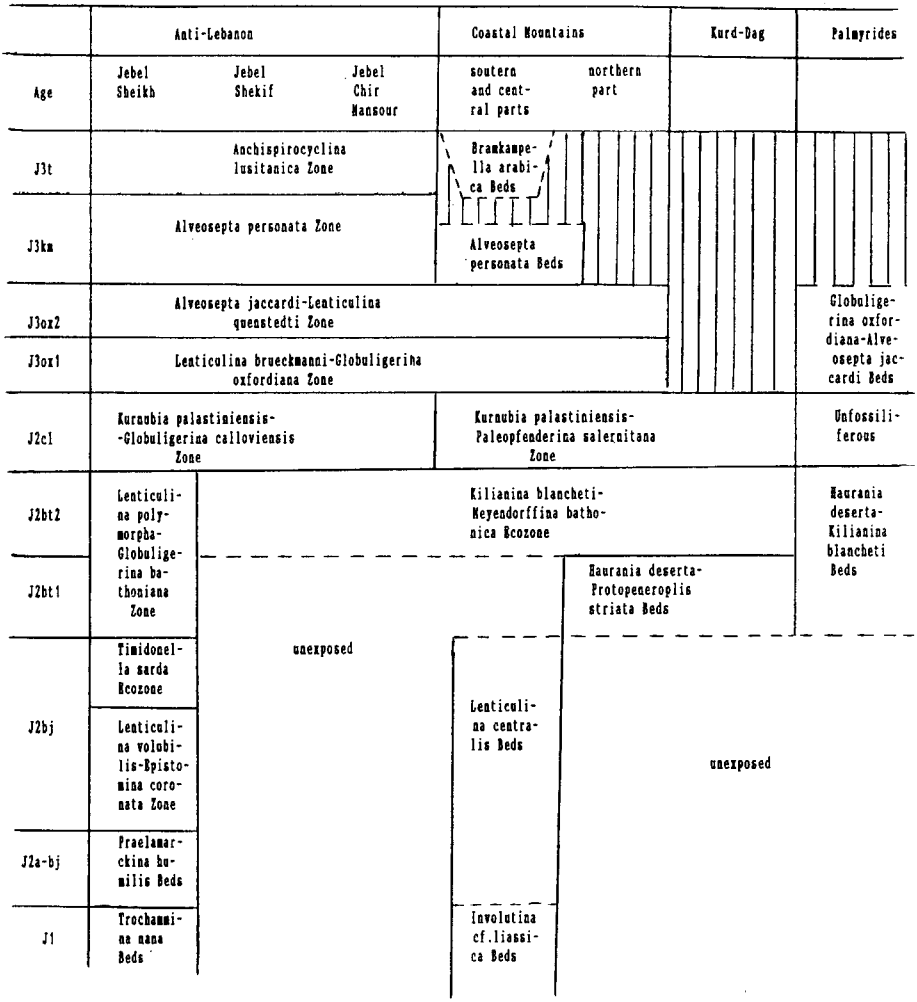

FIGURE 3.1 Foraminiferal stratigraphy of the Jurassic Sediments of Syria.

Table 3.1 The Stratigraphic range of Jurassic and Neocomian foraminifera in Syria.

Family, genus, species	LIAS.	AALE.	BAJO.	BATH.		CALL.		OXFO.		KIMM.	TITH.	NEOC.
				L	U	L	U	L	U			
	1	2	3	4	5	6	7	8	9	10	11	12
Fam. Rhizamminidae Rhumbler, 1895												
Rhizammina rudis Kaptarenko						———						
Fam. AMMODISCIDAE Reuss, 1862												
Ammodiscoides magharaensis Said et Barakat				———								
Fam. TOLYPAMMINIDAE Cushman, 1928												
Lituotuba nodus Kosyreva						———						
Fam. REOPHACIDAE Cushman, 1927												
Reophax barnardi Said et Barakat												———
R. difflugiformis (Brady)				———								
R. folkestoniensis Chapman												———
R. horridus (Schwager)								———				
R. hounstoutensis Lloyd										———		
R. metensis Franke				———								
R. sterkii Haeusler									———	———		
R. ex gr. toarcensis Makarjeva								———				
Fam. HAPLOPHRAGMOIDIDAE Maync, 1952												
Haplophragmoides nonioninoides (Reuss)										———	———	———

Table 3.1 *Continued.*

Family, genus, species	LIAS.	AALE.	BAJO.	BATH.		CALL.		OXFO.		KIMM.	TITH.	NEOC.
				L	U	L	U	L	U			
	1	2	3	4	5	6	7	8	9	10	11	12
H. cf. rotundatus Barnard								———				
H. sp. 1								———				
Evolutinella evoluta (Alekseeva)												———
E. sp. 1							———	———	———			
Fam. LITUOLIDAE de Blainville, 1825												
Ammobaculites agglutinans d'Orbigny				———								
A. cobbani Loeblich et Tappan				———								
A. coprolithiformis (Schwager)								———				
A. fontinensis Terquem				———								
A. hagni Bhalla et Abbas								———				
A. sequanus Mohler								———				
A. sp. 5											———	
A. suprajurassicus (Schwager)								———				
A. tobolskensis Levina								———				
Ammomarginulina subcretacea (Cushman et Alexander)												———
Kutsevella albustanensis sp. nov.												———
K. ex gr. infravolgensis (Mjatliuk)										———		
Flabellammina alexandri (Cushman)												———
Triplasia elegans (Mjatliuk)										———		

Table 3.1 *Continued.*

Family, genus, species	LIAS.	AALE.	BAJO.	BATH.		CALL.		OXFO.		KIMM.	TITH.	NEOC.
				L	U	L	U	L	U			
	1	2	3	4	5	6	7	8	9	10	11	12
Lituola aff. *compressa* Cushman et Glazewski												———
L. podolica Cushman et Glazewski								———				
Debarina sp. 1												———
Fam. NAUTILOCULINIDAE Loeblich et Tappan, 1985												
Nautiloculina oolithica Mohler				———	———	———	———	———	———	———	———	———
N. circularis Said et Barakat				———								
N. sp. 1											———	
Fam. MAYNCINIDAE Loeblich et Tappan, 1985												
Phenacophragma sp.											———	———
Stomatostoecha compressa Gorbatchik											———	———
Fam. PLACOPSILINIDAE Rhumbler, 1913												
Placopsilina sp. 1								———				
Fam. AMMOSPHAEROIDINIDAE Cushman, 1927												
Recurvoides barttouxi Said et Barakat				———								
R. concavus (Bartenstein et Brand)												———

Table 3.1 *Continued.*

Family, genus, species	LIAS.	AALE.	BAJO.	BATH.		CALL.		OXFO.		KIMM.	TITH.	NEOC.
				L	U	L	U	L	U			
	1	2	3	4	5	6	7	8	9	10	11	12
Recurvoides sp.				———								
Fam. HAPLOPHRAGMIIDAE Eimer et Fickert, 1889												
Haplophragmium aequale (Roemer)									———			
H. inconstans erectum Bartenstein et Brand												———
H. lutzei Hanzlikova								———				
H. ex gr. monstratus (Dain)								———				
H. subaequale (Mjatliuk)								———				
Haplophragmium sp. 1								———				
Fam. CHARENTIIDAE Loeblich et Tappan, 1985												
Charentia evoluta (Gorbatchik)											———	
Ch. arabica sp. nov.								———				
Melathrokerion eospirialis Gorbatchik											———	
M. spirialis Gorbatchik											———	
M. sp. 1								———				
Fam. ORBITOPSELLIDAE Hottinger et Caus, 1982												
Labyrinthina recoarensis (Cati)						———						

Table 3.1 *Continued.*

Family, genus, species	LIAS.	AALE.	BAJO.	BATH.		CALL.		OXFO.		KIMM.	TITH.	NEOC.
				L	U	L	U	L	U			
	1	2	3	4	5	6	7	8	9	10	11	12
Fam. MESOENDOTHYRIDAE Voloshinova, 1958												
Mesoendothyra croatica Gusić										———		
M. izjumiana Dain								———				
Feurtillia frequens Maync											———	———
Fam. HOTTINGERITIDAE Loeblich et Tappan, 1985												
Alveosepta jaccardi (Schrödt)								———	———			
A. personata (Tobler)										———		
A. powersi (Redmond)											———	
Fam. CYCLAMMINIDAE Marie, 1941												
Bramkampella arabica Redmond										———		
Pseudocyclammina lituus (Yokoyama)											———	———
P. calloviensis sp. nov.						———	———					
P. maynci Hottinger								———	———			
P. parvula Hottinger										———		
P. sphaeroidalis Hottinger									———	———		
P. sulayiana Redmond										———	———	
Choffatella decipiens Schlumberger										———	———	
Ch. alkarnensis sp. nov.										———		
Ch. tingitana Hottinger								———	———			

Table 3.1 *Continued.*

Family, genus, species	LIAS.	AALE.	BAJO.	BATH.		CALL.		OXFO.		KIMM.	TITH.	NEOC.
				L	U	L	U	L	U			
	1	2	3	4	5	6	7	8	9	10	11	12
Torinosuella peneropliformis (Yabe et Hanzawa)									———			
Dhrumella evoluta Redmond				———								
Everticyclammina virguliana (Koechlin)								———				
Flabellamminopsis variabilis Malecki				———								
Fam. HAURANIIDAE Septfontaine, 1988												
Amijiella amiji (Henson)				———								
Anchispirocyclina lusitanica lusitanica (Egger)										———		
Limognella dufaurei Pellisié et Peybernes				———								
L. mesojurassica Maync				———								
Hauranía deserta Henson			———									
Timidonella sarda Bassoulet and Chabrier et Fourcade		———	———									
Fam. SPIROPLECTAMMINIDAE Cushman, 1927												
Spiroplectammina obscura Said et Barakat												———

Table 3.1 *Continued.*

Family, genus, species	LIAS.	AALE.	BAJO.	BATH.		CALL.		OXFO.		KIMM.	TITH.	NEOC.
				L	U	L	U	L	U			
	1	2	3	4	5	6	7	8	9	10	11	12
Fam. DOROTHIIDAE Balakhmatova, 1972												
Eomarssonella querdahensis sp. nov.				———								
Eomarssonella sp. 1				———								
Eomarssonella sp. 2				———								
Marssonella dumortieri (Schwager)								———				
M. donenziana Dain										———	———	
M. haeusleri (Groiss)										———		
M. jurassica Mitjanina								———				
M. metaeformis Espitalié et Sigal								———				
M. oxycona Reuss											———	
Dorothia praehauteriviana Dieni et Massari												———
Fam. CHRYSALIDINIDAE Neagu, 1968												
Riyadhella arabica Redmond				———								
R. inflata Redmond				———		———						
R. elongata Redmond				———								
R. regularis Redmond				———		———						
Redmondoides medius (Redmond)				———								
R. inflatus (Redmond)				———		———						
R. primitivus (Redmond)				———								

Table 3.1 *Continued.*

Family, genus, species	LIAS.	AALE.	BAJO.	BATH.		CALL.		OXFO.		KIMM.	TITH.	NEOC.
				L	U	L	U	L	U			
	1	2	3	4	5	6	7	8	9	10	11	12
R. rotundatus (Redmond)				———								
R. lugeoni (Septfontaine)				———								
Riyadhoides mcclurei (Redmond)				———								
Pseudomarssonella plicata Redmond				———								
P. bipartita Redmond				———	———	———						
P. maxima Redmond				———								
Fam. CUNEOLINIDAE Saidova												
Cuneolina sp.												———
Fam. PFENDERINIDAE Smout et Sugden, 1962												
Palaeopfenderina salernitana (Sartoni et Crescenti)				———	———	———	———					
P. gracilis (Redmond)				———								
P. trochoidea (Smout et Sugden)				———	———	———	———					
Pfenderalla arabica Redmond				———	———	———	———					
Sanderella laynei Redmond						———	———					
Satorina apuliensis Fourcade et Chorowitz				———								
Steinekella steinekei Redmond						———	———					
Praekurnubia crusei Redmond					———	———						

Table 3.1 *Continued.*

Family, genus, species	LIAS.	AALE.	BAJO.	BATH.		CALL.		OXFO.		KIMM.	TITH.	NEOC.
				L	U	L	U	L	U			
	1	2	3	4	5	6	7	8	9	10	11	12
Kurbubia bramkampi Redmond				———								
K. jurassica (Henson)										———	———	———
K. morissi Redmond							———	———	———			
K. palastiniensis Henson				———	———	———	———	———	———	———	———	
K. variabilis Redmond						———	———					
K. wellingsi Henson								———	———			
Fam. TEXTULARIOPSIDAE Loeblich et Tappan, 1982												
Arenovirgulina aegyptica Said et Barakat								———	———			
Fam. VERNEULINIDAE Cushman, 1911												
Gaudryina chettabaensis Sigal												———
G. neocomiana Chalilov												———
G. richteri Grabert												
G. vadazi Cushman et Glażewski										———		
Verneuilina angularis Gorbatchik											———	———
V. polonica Cushman et Glażewski						———	———					
Verneuilinoides kirillae Dain										———		
V. attenuata Said et Barakat						———	———					
V. mauritii (Terquem)				———	———	———	———					

Table 3.1 *Continued.*

Family, genus, species	LIAS.	AALE.	BAJO.	BATH.		CALL.		OXFO.		KIMM.	TITH.	NEOC.
				L	U	L	U	L	U			
	1	2	3	4	5	6	7	8	9	10	11	12
V. minuta Said et Barakat								———	———	———		
V. osowiensis (Bielecka)								———	———			
V. subminuta (Gorbatchik)											———	———
V. jannamensis sp. n.								———	———			
V. sp. 1								———	———			
Belorussiella taurica Gorbatchik											———	———
B. textularioides (Reuss)												———
Paiaeogaudryina magharaensis Said et Barakat						———	———					
P. varsoviensis (Bielecka et Pozaryski)								———	———			
Fam. TRITAXIIDAE Plotnikova, 1978												
Tritaxia pyramidata Reuss								———	———			
Fam. DICTYOCONIDAE Moullade, 1965					———							
Kilianina blancheti Pfender					———							
Meyendorffina bathonica Aurouze et Bizon					———							
Paracoskinolina occitanica Peybernes				———	———							
Fam. ORBITOLINIDAE Martin, 1890												
Palorbitolina lenticularis (Blumenbach)												———

Table 3.1 *Continued.*

Family, genus, species	LIAS.	AALE.	BAJO.	BATH.		CALL.		OXFO.		KIMM.	TITH.	NEOC.
				L	U	L	U	L	U			
	1	2	3	4	5	6	7	8	9	10	11	12
Fam. PALAEOTEXTULARIIDAE Galloway, 1933												
Palaeotextularia? crimica (Gorbatchik)											—	
Fam. INVOLUTINIDAE Bütschli, 1880												
Globospirillina sp.						—						
G. caucasica (Hoffman)											—	—
G. neocomiana (Moullade)											—	—
Involutina cf. *liassica* (Jones)	—											
Fam. TROCHOLINIDAE Kristan-Tollmann, 1963												
Trocholina conosimilis Subbotina et Srivastava				—	—							
T. palastiniensis Henson				—	—							
T. transversarii Paalzow								—	—			
Fam. VENTROLAMINIDAE Weynschenk, 1950												
Protopeneroplis striata Weynschenk				—	—	—						
Fam. OPHTHALMIDIDAE Wiesner, 1920												
Ophthalmidium inflatus (Antonova)							—	—	—			
O. martonum (Farinacci)				—	—							

Table 3.1 *Continued.*

Family, genus, species	LIAS.	. AALE.	BAJO.	BATH.		CALL.		OXFO.		KIMM.	TITH.	NEOC.
				L	U	L	U	L	U			
	1	2	3	4	5	6	7	8	9	10	11	12
O. sagittum (E. Bykova)								—				
Fam. HAUERINIDAE Schwager, 1876												
Quinqueloculina frumenta Azbel et Danitch						—						
Q. jurassica Bielecka et Styk							—	—				
Q. semisphaeroidalis Danitch						—						
Pseudosigmoilina amphoroidale (Danitch)				—								
P. miliolinformis (Paalzow)								—	—	—		
P. sp. 1						—						
Fam. SPIRILLINIDAE Reuss et Fritsch, 1861												
Spirillina eichbergensis (Kübler et Zwingli)						—						
S. kuebleri Mjatliuk								—	—			
S. polygyrata Gümbel								—	—	—		
S. tenuissima Gümbel								—	—	—		
Spirillina sp. 1											—	
Turrispirillina amoena Dain								—	—	—		

Table 3.1 *Continued.*

Family, genus, species	LIAS.	AALE.	BAJO.	BATH.		CALL.		OXFO.		KIMM.	TITH.	NEOC.
				L	U	L	U	L	U			
	1	2	3	4	5	6	7	8	9	10	11	12
Conicospirillina basiliensis Mohler											———	
Fam. PATELLINIDAE Rhumbler, 1906												
Patellina subcretacea Cushman et Alexander												———
Fam. PLACENTULINIDAE Kassimova *et al.*, 1980												
Paalzowella feifeli (Paalzow)								———				
Fam. ICHTHYOLARIIDAE Loeblich et Tappan, 1986												
Ichthyolaria distorta (Brückmann)				———								
I. lignaria (Terquem)				———								
Geinitzinita wolinensis Bielecka								———				
Geinitzinita sp.								———				
Prodentalina brueckmanni (Mjatliuk)								———				
Fam. NODOSARIIDAE Ehrenberg, 1838												
Dentalina crenata Schwager								———				
D. ventriosa Franke								———				
Pseudonodosaria hofkeri (Said et Barakat)										———		

Family, genus, species	LIAS.	AALE.	BAJO.	BATH.		CALL.		OXFO.		KIMM.	TITH.	NEOC.
				L	U	L	U	L	U			
	1	2	3	4	5	6	7	8	9	10	11	12
P. vulgata (Bornemann)										———		
Fam. LENTICULINIDAE Chapman *et al.*, 1938												
Lenticulina veta (Hoffman)			———									
L. polymorpha (Terquem)				———								
L. centralis (Terquem)			———									
L. protracta (Bornemann)		———	———									
L. varians (Bornemann)			———									
L. polonica (Wisniowski)						———						
L. nuda (Reuss)												———
L. subalata (Reuss)												———
L. suturalis Bielecka et Pożaryski						———						
L. primaformis Mjatliuk								———				
L. hebetata (Schwager)								———				
L. tympana Grigelis								———				
L. audax Loeblich et Tappan				———								
L. sublenticularis (Schwager)								———				
L. attenuata (Kübler et Zwingli)								———				
L. nostra Grigelis								———				
L. russiensis (Mjatliuk)								———				

Table 3.1 *Continued.*

Family, genus, species	LIAS.	AALE.	BAJO.	BATH.		CALL.		OXFO.		KIMM.	TITH.	NEOC.
				L	U	L	U	L	U			
	1	2	3	4	5	6	7	8	9	10	11	12
L. kuznetsovae Umanskaja									———	———		
L. quenstedti (Gümbel)								———	———			
L. brueckmanni (Mjatliuk)								———	———			
L. suturalis-costata (Franke)								———	———			
Astacolus folium (Wisniowski)								———	———			
A. vacillantes Espitalié et Sigal								———	———			
A. aff. *incurvatus* (Reuss)												———
A. limataeformis (Mitjanina)								———	———			
Astacolus sp. 1											———	
Saracenaria tsaramandrosoensis Espitalié et Sigal								———	———			
Planularia beierana (Gümbel)								———	———			
P. madagascariensis Espitalié et Sigal								———	———			
P. angustissima (Wisniowski)						———	———	———	———			
P. deeckei (Wisniowski)						———	———	———	———			
P. tricarinella (Reuss)								———	———	———		
P. cordiformis (Terquem)								———	———			
P. haeuslezi (Paalzow)								———	———	———		
P. sp. 1								———	———			

Table 3.1 *Continued.*

Family, genus, species	LIAS.	AALE.	BAJO.	BATH.		CALL.		OXFO.		KIMM.	TITH.	NEOC.
				L	U	L	U	L	U			
	1	2	3	4	5	6	7	8	9	10	11	12
P. sp. 2				———								
Fam. VAGINULINIDAE Reuss, 1860												
Citharina chlatrata (Terquem)		———	———									
C. heteropleura (Terquem)			———									
C. inconstans (Terquem)			———									
C. biangulata (Terquem)			———	———								
C. elegantica Sossipatrova et Rohalli			———									
C. pseudoflabellata Sossipatrova et Rohalli			———									
C. proxima (Terquem)				———	———							
C. colliezei (Terquem)			———	———	———							
C. macilenta (Terquem)			———	———	———							
C. sokolovae (Mjatliuk)								———	———			
C. lepida (Schwager)								———	———			
C. entypomatus Loeblich et Tappan							———	———	———			
C. paralella (Bielecka et Pożaryski)								———	———			
C. zaglobensis (Bielecka et Pożaryski)							———	———	———			

Table 3.1 *Continued.*

Family, genus, species	LIAS.	AALE.	BAJO.	BATH.		CALL.		OXFO.		KIMM.	TITH.	NEOC.
				L	U	L	U	L	U			
	1	2	3	4	5	6	7	8	9	10	11	12
C. flabellata (Gümbel)								———	———			
C. pauperata (Terquem)		———	———									
C. implicata (Schwager)								———				
Marginulinopsis irretitus (Schwager)								———				
M. suprajurassicus (Schwager)								———				
M. sp.				———								
Fam. PLECTOFRONDICULARIIDAE Cushman, 1927												
Berthelinella paradoxa (Berthélin)				———								
Fam. POLYMORPHINIDAE d'Orbigny, 1839												
Eoguttulina polygona (Terquem)			———									
E. bilocularis (Terquem)								———				
E. cruciata (Terquem)								———				
E. sp. 1								———				
E. triloba (Terquem)				———								
E. inovroclaviensis (Bielecka et Pożaryski)						———						
E. anglica Lloyd						———						
E. althi Lloyd						———						

Table 3.1 *Continued.*

Family, genus, species	LIAS.	AALE.	BAJO.	BATH.		CALL.		OXFO.		KIMM.	TITH.	NEOC.
				L	U	L	U	L	U			
	1	2	3	4	5	6	7	8	9	10	11	12
E. metensis (Terquem)						———						
E. liassica (Strickland)						———						
Globulina oolithica (Terquem)								———	———	———		
Bullopora rostrata Quenstedt												———
Fam. CONORBOIDIDAE Thalmann, 1952												
Conorboides marginata Lloyd						———						
C. paraspis (Schwager)						———						
C. querdahensis sp. nov.								———	———			
C. scutuliformis (Seibold et Seibold)						———	———	———	———			
C. paravalendisensis Reiss, in Maync, 1966								———	———			
Fam. CERATOBULIMINIDAE Cushman, 1927												
Ceratolamarckina subspeciosa Bogdanowich et Makarjeva								———	———			
Cancrisiella rowdaensis sp. nov.								———	———			
Paulina paula (Pazdro)				———	———							
P. furssenkoi Grigelis								———	———			
Praelamarckina humilis Kaptarenka			———									
Pseudolamarckina hadari sp. nov.								———	———			
Lamarckella media Kaptarenko			———									

Table 3.1 *Continued.*

Family, genus, species	LIAS.	AALE.	BAJO.	BATH.		CALL.		OXFO.		KIMM.	TITH.	NEOC.
				L	U	L	U	L	U			
	1	2	3	4	5	6	7	8	9	10	11	12
L. antiqua Kaptarenko				———								
L. plana Kaptarenko			———									
Reinholdella crebra Pazdro			———									
Fam. EPISTOMINIDAE Wedekind, 1937												
Epistomina parastelligera (Hofker)								———				
E. coronata Terquem			———									
E. depressa Said et Barakat						———						
E. uhligi Mjatliuk								———				
E. volgensis Mjatliuk								———				
E. nemunensis Grigelis								———				
E. paralimbata Grigelis								———				
E. stelligeraeformis Mjatliuk								———				
E. sp. 1			———									
E. turgidula Pazdro				———								
Fam. GLOBULIGERINIDAE Loeblich et Tappan, 1984												
Globuligerina bathoniana (Pazdro)				———								
G. calloviensis K. Kuznetsova						———						
G. oxfordiana (Grigelis)								———				
G. meganomica K. Kuznetsova				———								

Like other types of zonation foraminiferal zones are named after their index species, but they may also contain diagnostic faunal assemblage.

3.2 THE LOWER JURASSIC

The Lower Jurassic is known to occur in the south-west of Syria: in the Hermon Mountains (Jebel Sheikh) — at the village of Arneh; in the Coastal Mountains in the Abu–Qubeis area; and in the Palmyrides — on the north-western slope of the Naknakien Ridge.

In a section at the village of Arneh in the Hermon Mountains, the Lower Jurassic is represented by a sequence of intercalated thinly bedded, black, compact limestone, dolomitized limestone, clay, shale, and marl, 148–150 m in aggregate thickness. The clay contains rare tests of the foraminifera *Trochammina nana* (Brady) and the ostracods: *Limnocythere alata* Dobrova, *L. lobata* Dobrova, *L. improcera* Dobrova, *L. cribellata* Dobrova, *Aphelocythere kuhni* Triebel and Klingler, *Procytheridea sermoisensis* Apostolescu, *P. vermiculata* Apost., *P.* aff. *magnicoutensis* Apost. and *Progonocythere stilla* Sylvester-Bradley. Most of the above-mentioned ostracods are typical of the Pliensbachian–Toarcian of Western Europe and Sinai; other forms survived to the Aalenian and Bajocian. *Trochammina nana* (Brady), common in the Lias of Western Europe, is also typical of the Lower Jurassic. Near Arneh, the Lower Jurassic section is overlain by massive dolomite (up to 80–100 m), which has eroded to form a cliff. According to Dubertret (1945), the base of the massive dolomite marks the beginning of the Bajocian. The described part of the Lower Jurassic section in the Anti-Lebanon can be defined in the zonal foraminiferal scheme as the *Trochammina nana* Beds (see Fig. 3.1).

In the Coastal Mountains, the Lower Jurassic rocks were studied in the Abu-Qubeis section near the village of Jdaida. A thick unit of intercalated dolomitized clay, dolomitized finely laminated limestone and dolomite, is exposed there along the Hama–Latakiah road. The clay contains rare tests of *Involutina* cf. *liassica* (Jones), a species typical of the Lias of Western Europe. However, the poor preservation of the dolomitized tests prevents more precise identification of the foraminifera. The apparent thickness of the strata assigned here to the Lower Jurassic is about 200 m. They can be recognized tentatively as the *Involutina* cf. *liassica* Beds.

In the Palmyrides, the Lower Jurassic deposits are exposed on the north-western slope of the Naknakieh Ridge, where they are represented by dark-grey, red and buff–yellow dolomites, up to 65–70 m thick. The rocks are unfossiliferous, and therefore their age is determined by comparison with Lower Jurassic sediments in Iraq, i.e. the Butma and the Muss formations.

3.3 THE MIDDLE JURASSIC

Middle Jurassic sediments are known to crop out from the extreme south-west of the Anti-Lebanon to the Kurd-Dag, as well as in most sections of the Coastal Mountains and in the Palmyrides. In Syria, the Middle Jurassic is represented by the Bajocian, Bathonian and Callovian. The Aalenian is recognized only tentatively. No Aalenian has been found in Syria so far.

3.3.1 The Aalenian and the Bajocian

Deposits, tentatively assigned to the undifferentiated Aalenian/Bathonian, are present in the south-western Anti-Lebanon, in the piedmont area of Jebel Sheikh near Arneh villge (exposures 77 and 92). Tuff-breccia and basalt, intercalated with dolomitized clay, dolomite and limestone, occur here at the base of the section. Sporadic foraminifera, including *Proteonina difflugiformis* (Brady), *Lituola* sp., *Reophax* sp., *Ammobaculites* cf. *cobbani* Loebl. and Tappan, *Praelamarckina humilis* Kapt., *Lenticulina protracta* (Born.), were found in the limestone. As the lower boundary of the deposits cannot be fixed, i.e. the underlying deposits are unfossiliferous, they are recognized as the *Praelamarckina humilis* Beds. *P. humilis* Kaptarenko is known from the Aalenian of the south of the European part of the former USSR (Dnieper–Donets Basin).

Undifferentiated Aalenian–Bajocian deposits of the Shusha Formation were recognized within Sinai, in the Jebel Maghara section and confirmed by the presence of *Palaeonuculina tenuistriata* Dauv., *P. lateralis* Terquem et Jourdy, *Pholadomya decorata* Hartmann (Golberg *et al.*, 1971), ostracods and various plant remains such as *Marattina cuvineris* Lorch., *Todites williamsoni* Seward, *Phlebopteris polypodioides* Brogniart and *Stenopteris fittoni* Seward.

3.3.2 The Bajocian

Bajocian deposits crop out in the Anti-Lebanon, the Coastal Mountains and the Palmyrides. In most sections of the area under study, the lower Bajocian boundary is drawn tentatively, as basal Bajocian deposits (Lower Jurassic dolomite and dolomitized limestone) contain no fossils or, as in the Hermon Mountains near Arneh, contain only rare foraminifera and ostracods. Moreover, in most of the studied sections, the Bajocian rocks are also highly dolomitized and unfossiliferous.

This stratigraphic interval is best characterized by a section near Arneh village in the Coastal Mountains. There an interbed of brecciated tuff and basalt is overlain by a unit of intercalated clay, dolomite, light-grey bioclastic and cryptocrystalline

limestones, locally containing bands of dark grey and black cryptocrystalline limestone and marl. The above-mentioned Aalenian–Bajocian assemblage of foraminifera was found in the lower part of the unit. Higher up, the rocks are similar in lithology (exposure 71) and yield a typical Bajocian foraminiferal assemblage, comprising: *Reophax* sp., *Involutina magharaensis* Said et Barakat, *Trochammina bartensteini* Said and Barakat, *Verneuilinoides mauritii* (Terq.), *Ammobaculites cobbani* Loebl. et Tapp., *A. agglutinans* Orb., *Citharina hechti* Bart., *C. maorica* (Terq.), *C. pseudoflabellata* Sossip. et Rahhali, *Lenticulina varians* (Born.), *L. protracta* (Born.), *L. veta* (Hoffm.), *L. volubilis* Dain, *Planularia instabilis* (Terq.), *Lamarckella media* Kaptar., *Epistomina coronata* Terq., *Epistomina* sp., *Quinqueloculina bajociana* (Terq.), *Citharina ksibiensis* Sossip. et Rohhali, *Astacolus strilla* (Terq.), *Dentalina crenata* Schwag., *D. ventriosa* Franke, *Eoguttulina polygona* (Terq.). Some species in the assemblage, such as *Lenticulina volubilis*, *Lamarckella media* and *Epistomina coronata* suggest a Bajocian age. The *Lenticulina volubilis–Epistomina coronata* Zone is recognized.

In the same area of the Jebel Sheikh, the interbedded limestone and clay occur above the *Lenticulina volubilis–Epistomina coronata* Zone in outcrops near Arneh. The rocks display a rich foraminiferal assemblage, including *Timidonella sarda* Bassoulet, Chabrier et Fourcade, *Citharina clathrata* (Terquem), *C. pauperata* (Terq.), *C. biangulata* (Terq.) and *Eoguttulina polygona* (Terq.). This unusual assemblage, with abundant *Timidonella* and rare well-preserved *Citharina*, is recognized as the *Timidonella sarda* Ecozone. The lower boundary is delineated by the underlying basalt flow, and the upper boundary is postulated from the observation of a change of foraminiferal assemblage.

Most of the above-mentioned species are typical of the Bajocian of France, Egypt, Iran and the south of the European part of the former USSR. However, the range of *Timidonella sarda* Bassoullet *et al.*, described from the Aalenian of France, is limited by the Aalenian/Bajocian.

The aggregate thickness of the Bajocian in the section at Arneh village is 950 m.

In the Coastal Mountains, Bajocian rocks were examined in a section at the village of Jdaida, where they are represented by a thick sequence of dolomitized limestone, yellowish grey, massive dolomite and cryptocrystalline and bioclastic limestones. The sequence (up to 200 m in aggregate thickness) contains separate partings of clay, mainly dolomitized. The sequence yields the foraminifera *Lenticulina* cf. *veta* Hoffman, *L. centralis* (Terq.), *Globuligerina*(?) sp., *Pseudobolivina* sp., ostracods, algae and bivalve fragments.

In the section along the wadi between Kharaib-Salem and the eastern Maareen, the Bajocian deposits are composed of dolomites, (massive in the lower part of the section), dolomitized limestone, aphanitic limestone, thinly flaggy dolomitized marl, and finely laminated, dolomitized clay. Foraminifera are rare and poorly preserved. They are represented by the following species: *Lenticulina centralis* (Terq.), *Nodosaria mutabilis* Terq. and *Marginulina solida* Terq. The apparent

thickness of the Bajocian deposits in the section is about 200 m. Both sequences can be recognized as the *Lenticulina centralis* Beds.

In the Palmyrides, Bajocian deposits are composed of unfossiliferous clay–gypsum-bearing sediments. They are known to occur in a section of the Naknakieh Ridge where their thickness is under 80 m.

3.3.3 The Bathonian

Bathonian deposits are very widely developed and fossiliferous. The rich assemblages of foraminifera and changes in the species composition through the section enable the recognition of the whole of the Bathonian its division into the lower and up per parts based on the microfaunal zones and faunal marker beds correlation with coeval units in Europe and elsewhere in the Middle East.

As a rule, the lower Bathonian boundary is at the appearance of an abundant fossil fauna, in which the rocks are locally crammed full of fossils forming a bioclastic limestone or an almost continuous accumulations of tests and shells of lamellibranch, brachiopods, gastropods, corals, foraminifera and ostracods. This is most in evidence in the section at Arneh (in the Anti-Lebanon), where rusty-yellow oolitic–detrital and bioclastic limestones occur along a sharp erosion boundary directly above a unit of intercalated clay and various limestones (oolitic, cryptocrystalline or argillaceous). The limestone contains abundant fragments and intact molluscan shells and foraminiferal tests. The foraminifera include the following species: *Reophax metensis* Franke, *R. difflugiformis* (Brady), *Recurvoides bartouxi* Said et Barakat, *Ammobaculites suprajurassicus* (Schwager), *A. hermonensis* sp. nov., *A. fontinensis* (Terquem), *Lenticulina polymorpha* (Terquem), *Citharina clathrata* (Terquem), *C. macilenta* (Terquem), *C. colliezi* (Terquem), *C. proxima* (Terquem), *Dentalina vetustissima* Orb., *Eoguttulina triloba* (Terquem), *Quinqueloculina occulta* Antonova, *Lamarckella antiqua* Kaptarenko and *Globuligerina bathoniana* (Pazdro).

The assemblage allows the *Lenticulina polymorpha–Globuligerina bathoniana* Zone to be recognized. Most of the above-mentioned species are typical of the Bathonian deposits of Saudi Arabia, France, Sinai, West India, the south of the European part of the former USSR (Dnieper–Donets Basin), south-western Germany, and the northern Caucasus. It is notable that there is a complete absence of typical tropical genera such as *Pfenderina, Kurnubia, Haurania, Amijiella, Dhrumella, Paracoskinolina, Riyadhella, Redmondoides, Pseudomarssonella,* and others that are common in the Bathonian of the Coastal Mountains and the Kurd-Dag. The thickness of the Bathonian sediments in the Arneh section is 160–170 m.

In the Coastal Mountains, Bathonian deposits occur in many sections, of which the sections in the area of Bab Janneh, Shuekha, Braj, Wadi Shkeir, the eastern Maareen, Jdaida, Wadi Jahannam and Nicola Quarry are the most fossiliferous and

studied in the most detail. This part of the Jurassic section in the Coastal Mountains is essentially made up of carbonate rocks, namely, microcrystalline, argillaceous, and, less commonly, oolitic–detrital and dolomitized limestone. Partings of clay and marl are subordinate, but are present in practically all of the sections studied. Foraminiferal assemblages — encountered in this stratigraphic interval in both the carbonate and terrigenous–carbonate rocks — are very rich. In some of the most complete sections (Bab Janneh, the eastern Maareen, Wadi Jahannam and Jdaida), a change of specific associations allows subdivision of the Bathonian into the lower and the upper Bathonian, with foraminiferal zones recognized within them.

3.3.3.1 The lower Bathonian

The lower Bathonian is known in the Anti-Lebanon (sections near Arneh), the Coastal Mountains (Bab Janneh, the eastern Maareen, Wadi Jahannam, Jdaida sections), the Kurd-Dag (section near the village of Rajo) and the Palmyrides (Al-Zbeidi section). The deposits are variable in lithology and represented by both carbonate rocks (microcrystalline, bioclastic, argillaceous, dolomitic limestones and dolomite) and terrigenous–carbonate strata (clay, marl and shale). In the Palmyrides, the Bathonian deposits contain gyprock.

In most sections of the Coastal Mountains, the lower part of the Bathonian deposits is represented either by a unit of intercalated clay and limestone with a varying thickness ratio of clay to limestone or includes separate clay and clay marl partings, not always persistent along strike; clay and clay marl are subordinate in thickness to the carbonate rocks. The lower Bathonian terrigenous–carbonate rocks yielded a rich and characteristic foraminiferal assemblage, including the species *Haurania deserta* Henson, *Amijiella amiji* (Henson), *Dhrumella evoluta* Redmond, *Palaeopfenderina trochoidea* (Smout et Sugden), *Protopeneroplis striata* Weynsch., *Redmondoides lugeoni* (Sept.), *Redmondoides primitivus* (Redm.), *Riyadhella arabica* Redm., *R. regularis* Redm. and others. This part of the Bathonian can be recognized as the *Haurania deserta–Protopeneroplis striata* foraminiferal Zone (Ecozone) whose deposits are most completely represented in the sections at Bab Janneh and the eastern Maareen. The zone corresponds with Zone "a" and part of Zone "b" after Mouty (1976). Zone "a", named the *Hauranian amijideserta* Zone by M. Mouty, is invalid and cannot be applied for nomenclatural reasons, as it uses *two* specific names, united together, the first of which *amiji*, is a specific name of a type species of the genus *Amijiella*, instituted by Loeblich and Tappan in 1985. As for the *Pfenderina salernitana–trochoidea* Zone (Zone "b" in the sense of Mouty), it also cannot be used because of the doubled specific name. Besides this, the species *Palaeopfenderina salernitana* (Sartoni and Crescenti) and *Palaeopfenderina trochoidea* (Smout and Sugd.), used by Mouty as index species of Zone "b", have a wider stratigraphic range and occur in most of the samples, starting with Zone "a" of the lower Bathonian to lower Callovian. The thickness

of the lower Bathonian deposits in the sections of the Coastal Mountains is about 130 m.

In the Palmyrides, the Bathonian deposits are present in the Al-Zbeidi section, where they are made up of thinly bedded dolomite and dolomitic limestone, giving way up section to massive and thickly bedded microcrystalline limestone with rare bands of sandstone and with oolitic and bioclastic limestones and clays which yield a typical Bathonian foraminiferal assemblage: *Haurania deserta* Hens., *Amijiella amiji* (Hens.), *Paulina paula* (Pazdro), *Kilianina* cf. *blancheti* Pfend., *Ammobaculites agglutinans* Orb., *Nautiloculina oolithica* Mohl., *Redmondoides lugeoni* (Septf.), *R. medius* (Redm.), *R. plicatus* (Redm.), etc. This part of the section is equivalent to the *Haurania deserta–Kilianina blancheti* Beds.

The boundary with the underlying strata is uncertain, as the fauna was encountered in the yellow oolitic limestone, i.e. in the upper part of the sequence only. However, the presence of the brachiopods *Dahanirhynchia subversabilis* (Weir.), *Kallirhynchia concinna* Sowerby, *Burminrhynchia* aff. *tumida* Buckman in the rocks underlying the limestone, also suggests a Bathonian age. The thickness of the Bathonian is very variable in the Palmyrides, depending on the depth of pre-Cretaceous erosion. In places, the Bathonian is completely absent (Jebel As-Satteh); in other sections, where it has survived, it is as thick as 100–150 m (Al-Zbeidi and Al-Mazar sections).

In the Kurd-Dag, the Bathonian deposits vary in lithology. Terrigenous poorly consolidated rocks completely disappear; they are replaced by essentially cryptocrystalline and bioclastic and oolitic–bioclastic limestones, containing isolated accumulations of corals, algae, bivalve fragments, and other fossils. Sections at the villages of Rajo and Smalek are the most complete and representative; however, the boundary with the underlying Bajocian deposits has not been observed in any of the sections. The Bathonian is represented there by cryptocrystalline, pseudo-oolitic and bioclastic limestones, the lower part of which yields a foraminiferal assemblage with the following species composition: *Limognella dufaurei* Pell. et Peyb., *Redmondoides primitivus* (Redm.), *R. inflata* (Redm.), *Dhrumella evoluta* Redmond, *Protopeneroplis striata* Weynschenk, *Dorothia* sp. and *Globuligerina*(?) sp. The presence of the above-mentioned forms allows us to recognize this part of section as the *Haurania deserta–Protopeneroplis striata* Beds. The apparent thickness of the lower Bathonian is 120 m.

3.3.3.2 The upper Bathonian

The upper Bathonian is represented in sections in the Coastal Mountains (the eastern Maareen, Wadi Jahannam, Jdaida, Nicola Quarry, Shuekha, Braj and Wadi Shkeir), and in the Kurd-Dag, in the north-west of Syria. This part of section is made up of bioclastic, oolitic, pseudo-oolitic, argillaceous microcrystalline, dolomitized limestones. In sections of the Coastal Mountains, the upper Bathonian deposits

are made up of clay, clay marl and marl, intercalated with dense carbonate rocks in some sections (the eastern Maareen, Wadi Jahannam Shuekha).

The upper Bathonian deposits of the Coastal Mountains, recognized as the *Kilianina blancheti–Meyendorffina Bathonica* Zone, are characterized by the following foraminiferal assemblage: *Paracoskinolina occitanica* Peyb., *Praekurnubia crusei* Redm., *Kurnubia bramkampi* Redm., *Berthelinella paradoxa* (Berthelin), *Kilianina blancheti* Pfen., *Meyendorffina bathonica* Aurouze et Bizon, *Limognella dufaurei* Pell. et Peyb., *Mesoendothyra croatica* Gusic, *Pseudomarssonnella bipartita* Redm. and *Globuligerina bathoniana* (Pazdro).

The thickness of the upper Bathonian in the Coastal Mountains varies from 90 to 150 m.

In the Kurd-Dag (Rajo and Smalek sections), the upper Bathonian rests conformably on the lower Bathonian and consists of limestones, similar in composition, locally containing coral, bivalve and algal remains. This part of the section yields foraminifera which, like the macrofaunal ramains, are unevenly distributed in the rock. The following species were recorded there: *Paracoskinolina occitanica* Peyb., *Kilianina blancheti* Pfend., *Meyendorffina bathonica* Aurouze and Bizon, *Labyrinthina* sp., *Pseudomarssonella bipartita* Redm. and *Pseudomarssonella* sp., *Palaeopfenderina salernitana* (Sartoni et Crescenti) and others. The thickness of the upper Bathonian in the Kurd-Dag is 50–60 m, with a maximum thickness of 100 m recorded in the Smalek section. This part of the section in the Kurd-Dag can be regarded as the equivalent of the *Kilianina blancheti–Meyendorffina* Bathonica Zone, distinguished in the Coastal Mountains.

The boundary of the Bathonian with the overlying Callovian can be observed in the section at Smalek village, where compact karst-weathered limestone with siliceous concretions, horizons of iron-stained algae and foraminifera, typical of the Callovian, lies directly on the upper Bathonian microcrystalline, light-grey limestone.

In other sections of the Kurd-Dag, the upper Bathonian limestone is overlain by Lower Cretaceous sandstone, containing ironstone concretions along an erosional unconformity.

The aggregate thickness of the Bathonian in the Kurd-Dag is 160 m.

3.3.4 The Callovian

The Callovian is exposed in the Anti-Lebanon, the Coastal Mountains, the Kurd-Dag, and as isolated outcrops in the Palmyrides. In most sections, the Callovian is characterized by foraminifera, ostracods, molluscs and corals. In places, the fauna is very abundant. Some of this fauna is well preserved and is used in the detailed subdivision of the sections.

The Callovian is most completely represented in sections at Wadi al Karn, Wadi Fawuar (Anti-Lebanon, Jebel Shekif), Bab Janneh, Braj and Maareen (Coastal Mountains). Foraminiferal associations in the Callovian of the two areas differ substantially in their species composition.

In the Wadi al Karn section (Anti-Lebanon) the Callovian rests conformably on the underlying Bathonian rocks (dolomitized limestone and dolomite); it is represented by a succession of microcrystalline, bioclastic and oolitic limestones with very thin and rare clay partings, yielding the following foraminifera: *Lituotuba nodus* Kosyr., *Ammobaculites suprajurassicus* (Schwag.), *Kurnubia palastiniensis* Henson, *Nautiloculina oolithica* Mohler, *Redmondoides lugeoni* (Sept.), *Lenticulina polonica* (Wisn.), *Citharina entypomatus* Loebl. et Tapp., *Sigmoilina nodosa* Danitch, *Quinqueloculina compressa* Terq. et Berth., *Spirillina polygyrata* Gümbel and *Globnuligerina calloviensis* K. Kuzn. This part of the section is recognized as the foraminiferal *Kurnubia palastiniensis–Globuligerina calloviensis* Zone.

The thickness of the Callovian in the Jebel Shekif reaches 700 m. North and north-east of the above-described section, the Callovian was explored in the Wadi Fawuar and Rowda sections, where it is composed of microcrystalline, commonly dolomitized, limestones and dolomite and, less commonly, oolitic limestone with occasional clay and clay marl partings, containing a sparse foraminiferal assemblage of: *Ammobaculites fontinensis* (Terq.), *Kurnubia palastiniensis* Henson, *Turrispirillina amoena* Dain, *Globuligerina calloviensis* K. Kuzn. To the north-east, clastic terrigenous rocks disappear; the oolitic and the argillaceous limestones are replaced by the microcrystalline variety and the proportion of the dolomite and dolomitized limestone increases. In the sections, the Callovian attains a thickness of 680–700 m.

In the Coastal Mountains, the Callovian is most complete in sections near Jdaida, Bab Janneh, Qadmous, the eastern Maareen, Shuekha, Wadi Shkeir, Bekraka, Sindianeh and at Nicola Quarry near the village of Marmarita. These rocks are characterized by reduction of ferric oxide and, in many sections, an almost complete absence of terrigenous layers in cryptocrystalline, bioclastic and oolitic limestones, comprising the Callovian in the area. As well as this, the Callovian of the Coastal Mountains is characterized by the presence of laterally extensive beds, with siliceous concretions, cavernous porosity and karst-weathering of carbonate rocks. In this stratigraphic interval, all the studied sections yielded foraminifera whose taxonomic composition differs from that of the Callovian of the Anti-Lebanon because of the presence of numerous and diverse tropical forms from the family Pfenderinidae, the genera *Praekurnubia*, *Palaeopfenderina*, *Pfenderella*, *Sanderella* and *Steinekella*. The data allow the *Kurnubia palastiniensis–Palaeopfenderina salernitana* Zone (Ecozone) to be distinguished.

In sections near the villages of Bab Janneh and Braj, the strata of this Callovian zone, resting with erosional unconformity on Bathonian rocks, are represented by

microcrystalline, argillaceous and bioclastic limestones, in the lower part crammed full of shell detritus, fragments, casts and intact lamellibranch and brachiopod shells, solitary and colonial corals, fragments of echinoids, crinoids and algae. The foraminiferal assemblage includes the following species: *Ammodiscoides magharaensis* Said et Bar., *Kurnubia palastiniensis* Henson, *K. bramkampi* Redm., *Sanderella laynei* Redm., *Steinekella crusei* Redm., *Palaeopfenderina salernitana* (Sart. et Cresc.). *P. gracilis* (Redm.), *Pfenderella arabica* Redm., *Redmondoides lugeoni* (Sept.), *Ammobaculites fontinensis* Terq., *Astacolus pellucida* Said et Bar., *Palaeogaudryina magharaensis* Said et Barakat and *Reinholdella dreheri* (Bart.).

In the Bab Jannah section, the Callovian is 35 m thick. In the section, like in most other sections in the northern Coastal Mountains, the Callovian deposits are overlain with a sharp erosional unconformity by Lower Cretaceous sediments. A more complete Callovian section was examined in the Qadmous area, where the upper Bathonian limestone is overlain with erosional unconformity by a succession of microcrystalline and argillaceous limestones with partings of marl and clay, yielding a poor foraminiferal assemblage. The composite thickness is 57 m.

A much richer and characteristic fossil assemblage was found in the Callovian of the Bchili section, yielding *Palaeogaudryina magharaensis* Said et Bar., *Dorothia terquemi* Said et Bar., *Verneuilinoides minuta* Said et Bar., *Ortomorphina terquemi* Said et Bar., *Ammobaculites magharaensis* Said et Bar., *Rectoglandulina vulgata* (Born.), *Globuligerina calloviensis* K. Kuzn., *Reinholdella crebra* Pazdro, and others. In composition, this particular association is similar to that known in the upper Callovian of the Jebel Maghara (Sinai). Although one index species of the zone, *Kurnubia palastiniensis*, has not been encountered there, nevertheless, an accompanying species assemblage allows assignment of this part of the section to the *Kurnubia palastiniensis–Globuligerina calloviensis* Zone. The thickness of the Callovian in the Bchili section is 60 m.

In sections near the villages of Sindianeh, Dahr al Killin and Bekraka, the Oxfordian, represented by terrigenous and terrigenous–carbonate rocks, rests on Callovian limstones. In a section at Jdaida village, the Callovian, here about 50 m thick, is characterized by a poor foraminiferal assemblage, containing no characteristic Callovian forms. The age was determined from the abundant bivalve fragments, found in clay and marl layers within the limestone. The assemblage includes *Pholadomya subexaltata* (Kasan.), *Protocardia* cf. *coneinna* (Buch), *Ceratomya concentrica* (Sow.) *C. wimmisensis* (Cill.) and *Homomya* sp. The faunal composition suggests a middle Callovian age for the enclosing rocks. The thickness of the Callovian in the Coastal Mountains varies from 10 m (Shuekha section) to 60 m (near the villages of Bekraka and Sindianeh).

Towards the north and north-west in the Kurd-Dag, the thickness of the Callovian sediments is reduced, they are cut by Lower Cretaceous sediments. The Rajo section contains no Callovian rocks; the Lower Cretaceous iron-stained sandstone rests with a sharp erosional unconformity on the Bathonian limestone. In the section at Smalek village, a few kilometres east of Rajo, the Jurassic is overlain

by Callovian, microcrystalline limestone showing extensive karst weathering containing siliceous concretions and rare foraminifera such as *Labyrinthina recoarensis* (Cati), *Redmondoides* sp., *Protopeneroplis* sp. and *Sigmoilina* sp. The apparent thickness of the Callovian in the section is 3 m.

In the Palmyrides, the Callovian is known to occur in the As-Satteh and Al Safra sections, where it is composed of argillaceous and microcrystalline limestones with occasional partings of clay and marl. The apparent thickness of the unit is 10 m. Foraminifera are absent and a Callovian age was assumed from the bivalves *Ceromya calloviensis* Kasan., *Pholadomya murchisoni* Sow., *Pholadomya subexaltata* (Kasan.) and *Anosocardia laudei* Roll. and other forms.

3.3.5 The Oxfordian

The Oxfordian is known to be developed in the Anti-Lebanon, in the central and southern Coastal Mountains and in the Palmyrides (as isolated outcrops).

The Oxfordian deposits contain a ubiquitous and rich fauna of lamellibranchs brachiopods, corals, ostracods and foraminifera. The latter are represented by characteristic species associations, whose variations over the section allow subdivision into the lower and the upper Oxfordian using foraminiferal zonation. The Oxfordian deposits are characterized by facies changes and variations in thickness; however, the species composition of the foraminiferal associations remains the same throughout the area in question.

In the Anti-Lebanon, the Oxfordian is most completely represented in the sections of Hadar, Rowda, Wadi al Karn and Wadi Fawuar. The sections of Wadi Shkeir, Bekraka and Sindianeh are the most representative in the Coastal Mountains.

In the south-western Anti-Lebanon, the Oxfordian is composed of microcrystalline, oolitic and bioclastic limestones and clay, over 100 m in composite thickness. In the Hadar section, the rocks conformably overlie the Callovian limestone and contain rare, unidentifiable remains of ammonites, *Gryphaea* sp. and the following foraminiferal assemblage: *Ammobaculites coprolithiformis* Schwag., *Pseudocyclammina maynci* Hott., *Mesoendothyra* sp., *Lenticulina quenstedti* (Gümb.), *L. russiensis* Mjatl., *Astacolus vacillantes* Esp. et Sigal, *Planularia beierana* (Gümb.), *Citharina entypomatus* Loebl. et Tapp., *C. paralella* Biel. et Poz., *Marginulinopsis suprajurassicus* (Schwag.), *Conorboides paravalendisensis* Reiss, *Spirillina kuebleri* Mjatl., *Epistomina nemunensis* Grig., *E. porcellanea* Brückm. and *Globuligerina oxfordiana* (Grig.).

The composition of the foraminiferal assemblage suggests a lower Oxfordian age for the enclosing deposits, which can be recognized as the *Lenticulina brueckmanni–Globuligerina oxfordiana* Zone. In the case of the tripartite division of the Oxfordian, the zone is equivalent to the lower and the middle Oxfordian. The thickness of the lower Oxfordian is 45–47 m.

In the Hadar section, the upper Oxfordian is made up of a succession of various limestones, such as bioclastic, coral, and algal types with oncolites and *Lithothamnion* and subordinate partings of clay and marl, containing the following foraminifera: *Reophai sterkii* Haeusl., *Ammobaculites suprajurassicus* (Schw.), *A. sequanus* Mohl., *Choffatella tingitana* Hott., *Alveosepta jaccardi* (Schrödt), *Palaeogaudryina varsoviensis* (Biel. et Poż.), *Trocholina tranversarii* Paalz., *Lenticulina quenstedti* (Gümb.), *Astacolus vacillantes* Esp. et Sig., *Citharina entypomatus* Loebl. et Tap., *C. lepida* (Schw.) and *C. paralella* (Biel. et Poż). This part of section corresponds with the foraminiferal *Alveosepta jaccardi–Lenticulina quenstedti* Zone; it is 76–82 m thick. The upper boundary of the Oxfordian in the section shows evidence of erosional unconformity: Lower Cretaceous sandstone rests disconformably on the Oxfordian. No uppermost Oxfordian, Kimmeridgian and Tithonian have been found in the section.

South- and south-westward, the Oxfordian section becomes more complete; near the village of Majdal Shams, the Oxfordian reaches a thickness of 280–285 m. Here the Oxfordian is characterized by ammonites and belemnites, allowing subdivision into three substages and the recognition of four ammonite zones (Ponikarov *et al.*, 1969).

The lower Oxfordian is represented by dark-grey marl with thin seams of bioclastic limestone, yielding large ammonites and belemnites; it is 69 m thick. This part of the section is equivalent to the ammonite *Creniceras renggeri* Zone.

The middle Oxfordian, composed of intercalated bioclastic limestone and light-grey hard marl, containing ammonites, is divided into two ammonite zones, namely, *Aspidoceras perarmatum* and *Gregoriceras transversarium*. In the Majdal Shams section, the middle Oxfordian reaches a thickness of 138 m.

The upper Oxfordian, (*Peltoceras bimammatum* Zone) comprises intercalated grey and dark-grey marl and limestones, detrital in the upper part; ammonites are abundant. The upper Oxfordian is 75 m thick (Ponikarov *et al.*, 1969). According to Golberg (in Picard and Hirsch, 1987), in the Majdal Shams section, the equivalents of the lower and middle Oxfordian are the Kidod Formation and, from the foraminifera, the "*Brotzenia parastelligera* Acme Zone". In the section, the upper Oxfordian corresponds with the Beersheba Formation and Haluza Formation, and one foraminiferal zone, namely *Alveosepta jaccardi*.

To the north, in the Rowda and Wadi al Karn sections, the lower part of the Oxfordian consists of bioclastic and oolitic limestones, locally replaced by argillaceous limestone and clay, containing a characteristic foraminiferal association, similar in composition to that given for the lower Oxfordian of the Hadar section.

In this area, the upper Oxfordian is represented by a unit of limestone (Rowda section) and clay, intercalated with bioclastic and microcrystalline limestones, yielding, in addition to abundant lamellibranch, brachiopod and gastropod shells, echinoderm fragments, the foraminifera *Reophax horridus* (Schwager), *R. sterkii* Haeusl., *Alveosepta jaccardi* (Schrödt.), *Ammobaculites braunsteini*

Cushm. et Appl., *Haplophragmium lutzei* Hanzl., *Trocholina transversarii* Paalz., *Vaginulina pasquetae* Bizon, *Dentalina brueckmanni* Mjatl., *Mesoendothyra croatica* Gusic, *Quinqueloculina tersa* Danitch, *Citharina sokolovi* (Mjatl.), *C. implicata* (Schwag.), *Lenticulina quenstedti* (Gümb.), *L. audax* Loebl. et Tapp., *Ophthalmidium inflatus* (Anton.) and *Steinekella steineki* Redm. The upper Oxfordian is 45–50 m thick. This part of the Oxfordian corresponds with the foraminiferal *Alveosepta jaccardi–Lenticulina quenstedti* Zone.

Farther north, in the area of Zabadani and Serghaya in the Jebel Shekif, the Oxfordian terrigenous rocks are completely replaced by carbonate deposits. In the Wadi Fawuar section, the Oxfordian is composed of hard cryptocrystalline, bioclastic and coral limestones, forming cliffs in the topography. The clay partings disappear. Thickness of the Oxfordian is about 150–160 m. In the Wadi Fawuar section, the lower Oxfordian and the upper Oxfordian are 70–72 m and 80–83 m thick, respectively. The foraminifera *Globuligerina oxfordiana* (Grig.) *Trocholina* cf. *transversarii* Paalz., *Citharina lepida* (Schwag.) are the most characteristic specties encountered there.

In the Coastal Mountains, the Oxfordian occurs in a number of sections south of the latitude of Slenfeh village, namely in Nicola Quarry and in sections at Ain Khlakem, Sindianeh, Bekraka and Wadi Shkeir. The lower Oxfordian, made up of limestone, intercalated with clay and marl, locally poorly consolidated and chalky (the Bekraka section) contains, along with brachiopods, corals and echinoderms, the foraminifera *Alveosepta jaccardi* (Schrödt), *Kurnubia palastiniensis* Hens., *K. wellingsi* Hens., *Lenticulina brueckmanni* (Mjatl.) and *Globuligerina oxfordiana* (Grig.). According to their composition, this part of the section is assigned to the lower Oxfordian foraminiferal *Lenticulina brueckmanni–Globuligerina oxfordiana* Zone. The thickness of the lower Oxfordian varies between 10 and 70 m.

The upper Oxfordian has not been preserved in all the above-mentioned sections; in places it has been eroded and the lower Oxfordian or the Callovian rocks are overlain, with an obvious erosional unconformity, by Lower Cretaceous sandstone, clay and marl (sections at Al Bustan, Ain Khlakem and Wadi Shkeir). In the Wadi Shkeir section, the thickness of the Oxfordian, overlain with a sharp erosional unconformity by lower Aptian clay, is about 32 m.

In the Kurd-Dag, the Oxfordian is absent and the Jurassic sections are completed by Middle Jurassic (Bathonian and Callovian) rocks.

In the Palmyrides, the Oxfordian is known to occur as small outcrops in the As-Satteh and the Dmer sections. In the Dmer section, the Oxfordian is composed of dolomite, bioclastic, oolitic, and stromatoporoid limestones, yielding lamellibranchs, the brachiopods *Somalirhynchia* cf. *africana* Weir., *Somalirhynchia* sp., corals and the foraminifera *Globuligerina oxfordiana* (Grig.), *Pseudocyclammina maynci* Hott., *Alveosepta jaccardi* (Schrödt), *Everticyclammina virguliana* (Koech.) and *Planularia beierana* (Gümb.). The presence of the species indicates an Oxfordian age for the rocks and allows the recognition of

the *Globuligerina oxfordiana–Alveosepta jaccardi* Beds. The thickness of the Oxfordian in the As-Satteh section is 55 m.

3.3.6 The Kimmeridgian

The Kimmeridgian is known to occur in the Anti-Lebanon, the Jebel Shekif and the southern Coastal Mountains (Nicola Quarry section near the village of Marmarita). In the Anti-Lebanon, the Kimmeridgian is most completely represented in the Wadi al Karn and Wadi Fawuar sections, where it rests conformably on the Oxfordian limestone and is overlain by Tithonian rocks. In the Wadi al Karn section, the Kimmeridgian is composed of bioclastic and oolitic–bioclastic limestones with abundant shells of lamellibranchs and brachiopods, solitary and colonial corals and stromatoporoids. In places, the lower section is made up of reef limestones, which weather differentially to form cliffs. The limestones contain partings of clay and clay marl, yielding the foraminifera *Reophax hounstoutensis* Lloyd, *Triplasia jurassica* Mjatl., *Marssonella doneziana* Dain, *M. hechti* Dieni et Mass, *Citharina lepida* (Schwag.) and *Alveosepta personata* (Tobler). The presence of *Alveosepta personata* in the assemblage indicates that this part of the section belongs to the *Alveosepta personata* Zone. The thickness of the Kimmeridgian in the Wadi al Karn section is 80–82 m.

In the Wadi Fawuar section (Jebel Shekif), the Kimmeridgian is made up of bioclastic and stromatoporoid limestone, passing up-section into light-grey cryptocrystalline and argillaceous limestones whose individual layers are rich in abundant algal remains and the shells of bivalves, brachiopods and gastropods, forming mounds and banks. This part of the section yielded *Somalirhynchia africana* Weir, *Septapiphoria inconstans* (Sow.), *Pholadomya moravica* Uhlig., *P. acuminata* Zieten. and *Ceratomya* sp.

A foraminiferal assemblage encountered in the argillaceous limestone of the middle part of the section includes *Alveosepta personata* (Tobl.), *Verneuilinoides* cf. *kirillae* Dain, *Marssonella* cf. *hechti* Dieni et Massari, *Mesoendothyra croatica* Gusic, *Torinosuella* sp., and *Quinqueloculina jurassica* Biel. et Styk. The presence of the zonal species *Alveosepta personata* (Tobler) and the associated assemblage allows the recognition of the foraminiferal zone of the same name, as defined in the Kimmeridgian of the Transcaucasian area (Kuznetsova, 1985) (the zone is equivalent to the lower Kimmeridgian in the type area). However, such forms as *Verneuilinoides kirillae* Dain and *Mesoendothyra croatica* Gusic, known from the upper Kimmeridgian of the Transcaucasian area, also suggest the presence of the upper Kimmeridgian or, possibly, a wider stratigraphic range for the above-mentioned foraminiferal assemblage. The thickness of the Kimmeridgian in the Wadi Fawuar section is 65–72 m.

To the north, the Kimmeridgian is almost totally absent from the Coastal Mountains. It is known only in the extreme south of the area, and was investigated

in the Nicola Quarry section near Marmarita village, where the *Alveosepta personata* Beds were recognized. There the Kimmeridgian is made up of tawny to chocolate-coloured "plastic" clay $\leq$2.5 m thick, showing conchoidal fracture; the clay contains the following foraminiferal assemblage: *Proteonina difflugiformis* (Brady), *Ammobaculites pellucida* Said et Barakat, *A. magharaensis* Said et Barakat, *Haplophragmoides* sp., *Pseudocyclammina* sp., *Alveosepta personata* (Tobl.), *Nautiloculina oolithica* Mohler and *Lenticulina subtilis* (Wisn.). Upsection, along a distinct boundary, the clay grades into pale-grey, medium-bedded microcrystalline limestone, 2.2 m thick, yielding the foraminifera *Pseudocyclammina* sp., *Ammobaculites magharaensis* Said et Barakat and *Nautiloculina oolithica* Mohler. The thickness of the Kimmeridgian in the section is under 5 m. The Kimmeridgian is overlain by Lower Cretaceous clay along a distinct erosional boundary.

Over the rest of Syria, no Kimmeridgian rocks are known from natural exposure: they may have been removed by almost universal pre-Cretaceous erosion. It is believed that originally they covered most of the area, since, in some sections of the Coastal Mountains (Wadi Jahannam, Braj), the lower part of the Aptian, overlying Middle Jurassic rocks along an erosional unconformity boundary, yielded a characteristic Kimmeridgian ostracod asemblage: *Palaeocytheridea monstrata* (Lubimova), *Galliaecytheridea* sp., *Dolocytheridea* sp., *Paracypris projecta* Peterson, *Paracypris* sp. Oertli, 1957 *Paracypris* sp., *Pontocypris* sp., *Bythocypris* sp., *Schuleridea* sp., *Praeschuleridea* sp. and *Argilloecia* sp. The forms were found together with brachiopods and lamellibranchs typical of the Lower Cretaceous; they were clearly redeposited, suggesting that Kimmeridgian marine sediments occurred there prior to pre-Cretaceous uplift.

3.3.7 The Tithonian

Outcrops of Tithonian rocks are known mainly from the central Anti-Lebanon. They were examined in the sections at the Wadi al Karn, the Wadi Fawuar and Rowda, near Zabadani, in the Jebel Shekif. No fossiliferous Tithonian sediments have been encountered in the north-west of Syria; however, according to Dubertret (1936), *Mytilus crassissimus* Bohm., typical of the Tithonian, is present in the upper limestone (assigned to the Jurassic) in the Jebel Akra.

The most complete section of the Tithonian, conformably overlying the Kimmeridgian limestone, was examined along the Wadi al Karn, where it can be divided into three parts and composed of bioclastic and oolitic limestones, hard and microcrystalline limestones and poorly consolidated, light-yellow carbonate clay. Rare tests of the foraminifera *Quinqueloculina* cf. *egmontensis* Lloyd, *Q.* cf. *mitchurini* Dain and *Kurnubia* sp., and the tintitinnids *Calpionella alpina* Lorenz., *C. elliptica* Cadisch. and *Tintinnopsella carpatica* (Murg. et Filip.) are present in the microcrystalline limestone unit. Higher up, the loose carbonate clay

yielded a rich foraminifera assemblage, including *Anchispirocyclina lusitanica* (Egger), *Alveosepta powersi* (Redm.), *Gaudryina vadazi* Cushm. et Glaz., *G. neocomica* Chalilov, *Textularia crimica* Gorb., *Pseudocyclammina parvula* Hottinger, *Melathrokerion eospirialis* Gorb., *Stomatostoecha compressa* Gorb., *Verneuilina angularis* Gorb., *Trochammina neocomiana* Mjatl., *Ophthalmidium inflatus* (Anton.), *Nautiloculina ex gr. oolithica* Mohler, *Globospirillina caucasica* (Hoffm.), *G. neocomiana* (Moullade) and *Spirillina* sp. The characteristic foraminiferal assemblage, including *Anchispirocyclina lusitanica* (Egger), allows this part of section to be assigned to the zone of the same name, i.e. the *Anchispirocyclina lusitanica* Zone, found in the Crimea and traced in the Caucasus, south-western Europe and North Africa.

At the same time, the species association of foraminifera, given above, contains forms, characteristic of the early Cretaceous, which began to develop in Berriasian times. They are *Verneuilina angularis* Gorb., *Globospirillina caucasica* (Hoffm.) and *G. neocomiana* (Moullade), suggesting the presence, in the upper section, of sediments transitional between the Jurassic and the Lower Cretaceous and possibly belonging to the lower Berriasian, whose deposits were previously considered to be absent throughout Syria. In the Anti-Lebanon, the thickness of the Tithonian is 30–35 m in the Wadi al Karn and Sad al Karn sections. In the Wadi Fawuar section, at Jebel Shekif, the Tithonian is represented by bioclastic, oolitic, stromatoporoid limestones, and no terrigenous sediments are present the strata are 25–30 m thick.

Separate, isolated outcrops of Tithonian sediments are known from localities near the village of Rowda, south of Zabadani. They comprise carbonate clay and yellowish grey friable clay marl with bands of argillaceous limestone that are impersistent along strike. The sediments contain a foraminiferal assemblage characteristic of the Tithonian, including *Gaudryina vadazi* Cushm. et Glaz., *G. neocomica* Chalilov, *Textularia crimica* Gorb., *Melathrokerion eospirialis* Gorb., *Pseudocyclammina parvula* Hott., *Pseudocyclammina* sp., *Stomatostoecha compressa* Gorb., *Nautiloculina oolithica* Mohler, *Globospirillina caucasica* (Hoffm.) and *G. neocomiana* (Moullade). The apparent thickness is 8–9 m.

3.3.8 The Undifferentiated Tithonian–Berriasian

Sediments with fossils identified as of Tithonian–Berriasian age occur in the Anti-Lebanon (Rowda section) and in the Coastal Mountains (Qadmous section) only. In the Qadmous section, the Callovian is overlain with sharp erosional unconformity by strata of interlayered argillaceous nodular limestone, microcrystalline silicified very hard, pink limestone and poorly consolidated, yellowish green clay, which is locally slightly arenraceous. The clay contains a very rich foraminiferal assemblage, in places as large mounds of tests. The following foraminiferal were found: *Ammobaculites* sp. 1, *Phenacophragma* sp., *Stomatostoecha compressa*

Gorb., *Charantia evoluta* Gorb., *Melathrokerion eospirialis* Gorb., *Pseudocyclammina sulaiyana* Redm., *Feurtillia frequens* Maync and *Bramkampella arabica* Redm. The species making up the association, are divided into three groups:

1) species characteristic of the Tithonian;

2) species characteristic of the Neocomian (Berriasian–Barremian);

3) species described from the Sulaiya Formation (undifferentiated deposits of the uppermost Jurassic–lowermost Cretaceous of Saudi Arabia (Redmond, 1964)). These sediments are distingusihed as the *Bramkampella arabica* Beds.

Thus, the taxonomic composition of the foraminiferal assemblage described above indicates that these sediments straddle the boundary between the Jurassic and the Cretaceous. Their thickness is 29 m in the Qadmous section. Disconformably above these sediments there is a sage-green clay containing large fragments of charred wood. The clay is dated as Neocomian from its position in the section between the Tithonian–Berriasian rocks (described above) and the clay of the overlying Aptian Bab Janneh Formation.

3.4 THE LOWER CRETACEOUS

3.4.1 The Neocomian

Until recently, the Neocomian was believed to be absent in many areas of Syria. Detailed study of the Jurassic rocks, and the Cretaceous strata directly overlying them, has aimed to obtain a more complete understanding of the completenes of the upper Jurassic section; the position of the Jurassic/Cretaceous boundary in Syria; and the duration and scale of the pre-Cretaceous uplift and break in deposition.

The Neocomian is most completely represented in the sections of Ain Khlakem, Al Bustan, Sindianeh, Teir Jamleh and the Wadi Shkeir in the Coastal Mountains; in the Rowda and the Wadi Fawuar sections of the Anti-Lebanon; and in the Jebel Abd Al Asis section in north-east Syria. In all the sections, the Neocomian sediments onlap the Jurassic (Callovian–Tithonian) rocks; however, most commonly, they lie disconformably on Oxfordian shallow-water deposits.

In the Al Bustan section, the Oxfordian limestone, containing abundant fragments and casts of lamellibranch and brachiopod shells, algae and worm burrows, is overlain with a sharp erosional unconformity by intercalated loose, locally sandy, yellow, russet and green clay, interbedded with subordinate limestone and marl. The upper part of the unit contains a rich brachiopod, fauna, including *Loriolithyris valdensis* (Loriol), characteristic of the Berriasian of North Africa and Switzerland and the Valanginian of Sardinia, and also

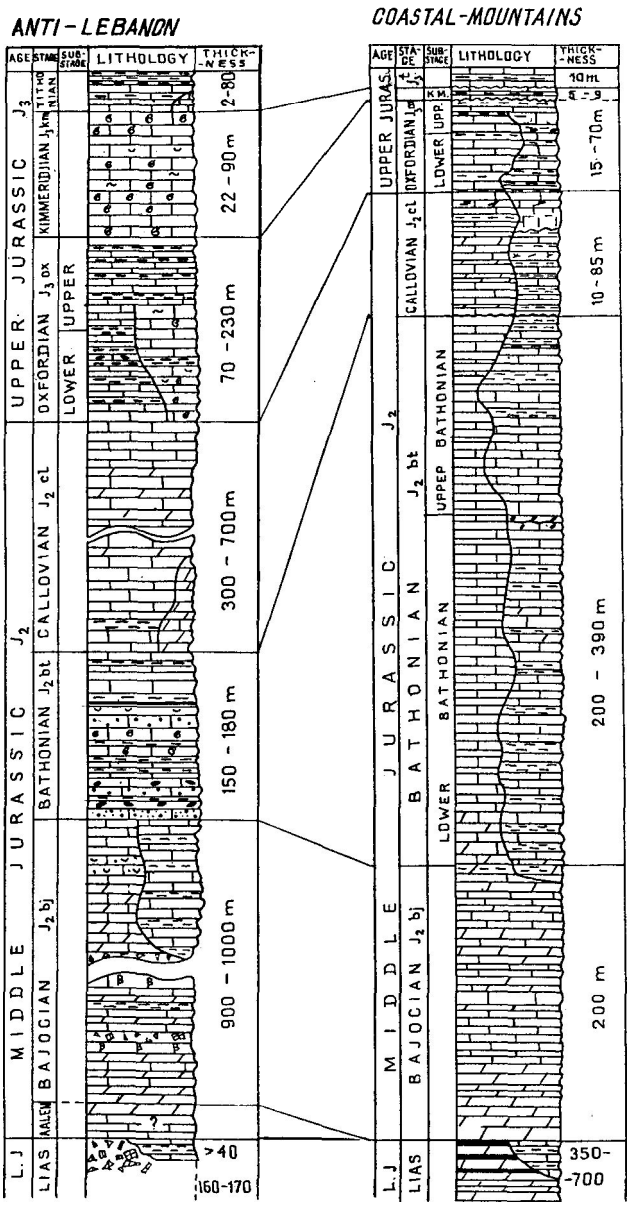

FIGURE 3.2 Composite sections of the Jurassic sediments of the Anti-Lebanon and the Coastal Mountains, Syria.

known from the Hauterivian of Spain and the northern Caucasus. The rocks also contain a foraminiferal assemblage, including *Kutsevella albustanenesis* sp. nov, *K. infravolgensis* (Mjatl.), *Pseudocyclammina* sp., *Choffatella decipiens* Schlumb., *Melathrokerion spirialis* Gorb., *Charentia evoluta* Gorb., and *Bullopora rostrata* (Quenst.). The species composition of the assemblage suggests a Berriasian–Hauterivian age. The thickness does not exceed 15 m in the Al Bustan section.

In the Teir Jamleh section near Misyaf, the Oxfordian limestones, similar to those described above, are overlain by a unit of marl and loose chalky clay with abundant subrounded lenses of microcrystalline, well-cemented, in places dolomitized, limestone and piles of lamellibranchs, brachiopods, corals, ostracods and foraminifera of mixed species composition, including both typical Oxfordian (*Kurnubia palastiniensis* Hens., *Alveosepta jaccardi* (Schrödt) and Neocomian *Choffatella decipiens* Schlumb., *Feurtillia frequens* Maync, *Stomatostoecha compressa* Gorb. and others) forms. The unit yielding the mixed Oxfordian and Neocomian fauna is over 20 m thick.

The following conclusions can be drawn from the above review of the Jurassic stratigraphy.

Along-strike variations in completeness of sections and in thickness of deposits occur from south-west to north-east, i.e. from the Anti-Lebanon to the Kurd-Dag. The Anti-Lebanon sections, containing all the Jurassic sediments from Liassic to Tithonian inclusive, display the most complete stratigraphic succession (Fig. 3.2). The duration of the pre-Cretaceous break in deposition in this part of the basin was much shorter than in the Coastal Mountains and the Kurd-Dag, hence, the Berriasian rocks and, in places, younger Cretaceous sediments, including the Barremian, have been preserved in some sections of the Anti-Lebanon. The Jurassic strata, especially the Bajocian, Callovian, and Oxfordian sediments, decrease in thickness from south to north (see Fig. 3.2). The Kimmeridgian and Tithonian sediments, which are fairly widespread — although not ubiquitous — in the Anti-Lebanon, are either missing from the section or occur sporadically and are of reduced thickness in the Coastal Mountains. In some sections, traces of Kimmeridgian sediments, removed by early Cretaceous erosion, were determined from the presence of redeposited fauna, found together with characteristic Cretaceous species in Aptian deposits. Jurassic sediments younger than the Callovian have not been discovered in the Kurd-Dag, i.e. Oxfordian, Kimmeridgian and Tithonian deposits are absent. The wide variations in the thickness of the Jurassic strata in the Anti-Lebanon, the Kurd-Dag and the Palmyrides is related to the type of sedimentation, which was more stable and continuous in the south-west of Syria, in the Anti-Lebanon and in parts of the Coastal Mountains, and less stable in the marginal parts of the basin. In Jurassic times, the Anti-Lebanon and the Coastal Mountains were an area of compensated subsidence where mainly carbonate- or, in some places, terrigenous–carbonate, sediments accumulated in an open, shallow-marine basin.

In early and middle Jurassic times, the central part of Syria (the Palmyrides) represented a marginal area of a Jurassic marine basin where offshore-lagoonal sediments were formed. Normal marine environments, with their distinctive faunas, in the Palmyrides, were developed only sometimes during extensive episodes of transgression.

CHAPTER 4
THE EVOLUTION OF JURASSIC TETHYAN FORAMINIFERA AND ANALYSIS OF SPECIES ASSEMBLAGES

4.1 INTRODUCTION

The evolution of foraminifera, like that of any group of organisms, is a multicomponent process with a pace and trend influenced by both biotic and abiotic factors and the ways in which these factors interact, for example during migration. Most biotic and abiotic factors are variable even over the relatively short time scales represented by a biozone. The more intensive the study of assemblage and the longer the time scale under consideration, the more complex the pattern obtained; however it is statistically more reliable.

The rich and diverse faunas of the vast Tethyan basins, including foraminifera, are of prime interest in this type of study.

The wealth of available data on Jurassic foraminifera from Syria, parts of Israel, the Crimea, the Caucasus and, to a lesser extent Western Europe, and the review of published information on other Tethyan regions, namely, the French–Spanish Pyrenees, Algeria, Morocco, Sinai, Saudi Arabia, Iran and Iraq, are used here to attempt to gain some insight into the evolution of foraminifera within the Tethyan region.

The analysis of the foraminiferal communities included research on their taxonomic composition, the influence of environmental conditions, the palaeobiogeographical ranges of both the communities and their component genera and the morphology of the dominant groups.

With regard to the dominant groups, the Jurassic foraminifera of the study area belong to the *Cyclammina–Pfenderina* type of fauna (Gordon, 1970; Basov *et al.*, 1972; Basov, 1974; Kuznetsova and Gorbachik, 1985), which inhabited the tropical and subtropical basins of the Tethys.

Benthonic foraminifera are subject to rigid facies control. Planktonic foraminifera, which first appeared in the Jurassic, rare in terms of numbers of both individuals and species however, they occur in sediments of three out of seven of the stages studied.

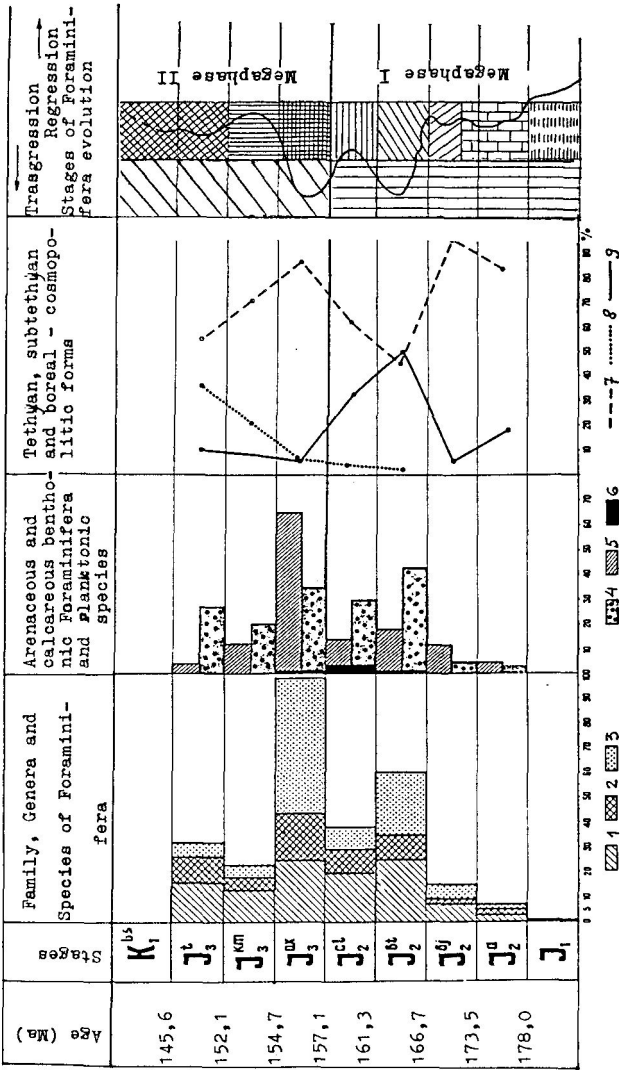

FIGURE 4.1 Relationships between the taxonomic, ecological and palaeobiographical components of Jurassic foraminiferal thanatocoenoses and the phases of their evolution. 1 families; 2 genera; 3 species; 4 agglutinated benthonic foraminifera; 5 calcareous benthonic foraminifera; 6 planktonic foraminifera; 7 boreal-cosmopolitan genera; 8 sub-Tethyan genera; 9 Tethyan genera.

4.2 PHASES IN THE EVOLUTION OF THE JURASSIC FORAMINIFERA

From a palaeobiogeographical standpoint, the communities in question contain tropical forms endemic to the Tethys subtropical, fairly widespread, forms and cosmopolitan species, widely known beyond the boundaries of the Tethys, in the Boreal realm (boreal–cosmopolitan elements).

Taking into consideration the foregoing information, we have endeavoured to outline the main phases of development of the Syrian faunas during the Jurassic, and to trace these phases in the adjacent Mediterranean (Fig. 4.1).

The first phase — equivalent to the Lower Jurassic — which is undifferentiated in Syria — is recognized in Morocco and south-western France. It is characterized by the family Orbitopsellidae, whose range was confined to the tropical region of the Tethys. *Pseudocyclammina, Lituosepta, Haurania* and *Palaeopfenderina*, living at the same time and also endemic, had a wider stratigraphic range: in the eastern Mediterranean, they are known in the Middle Jurassic and part of the Upper Jurassic. In Syria, Lower Jurassic sediments were deposited in a shallow-water basin where there was lowered salinity, as indicated by the sparse foraminiferal faunas and the presence of freshwater ostracods. In the Crimea, this time period is characterized by deposition of sediments of the Taurida Series, which contain no foraminifera.

The second phase of development embraces a stratigraphic range corresponding with the Aalenian–lower Bajocian; it is characterized by the predominance of boreal–cosmopolitan elements such as the genera *Epistomina*, *Lenticulina* and *Citharina*, with Tethyan-endemic species playing a minor role. This association occurred in southern-western Syria under middle-neritic conditions. Similar communities developed at the same time in south-western Europe, under similar ecological conditions (Pelissie *et al.*, 1984).

The third phase corresponds with the upper Bajocian. The fauna evolved gradually from the Aalenian–lower Bajocian fauna, as is shown by the continued dominance of the calcareous benthonic foraminifera, and the subordinate numbers of Tethyan species. The wide distribution of these assemblages in the Mediterranean enables a good correlation of the Bajocian sediments of Algeria, Sinai and south-western Syria, and the recognition of a single phase of development for their fauna.

The following (Bathonian) phase corresponds with an extensive transgression. In the Mediterranean it is characterized by the development of several different types of foraminiferal assemblage, occurring in various parts of the rapidly widening basin. Boreal–cosmopolitan elements continued to dominate in the south and south-west of Syria, in Sinai and in the north-east of Africa; in central and north-western Syria, south-western France and Algeria they played a minor role, with the quantitative and taxonomic diversity of the Tethyan endemics increasing drastically. The planktonic foraminifera (the genera *Conoglobigerina* and *Globuligerina*) first appear here. A marked change in the composition of the

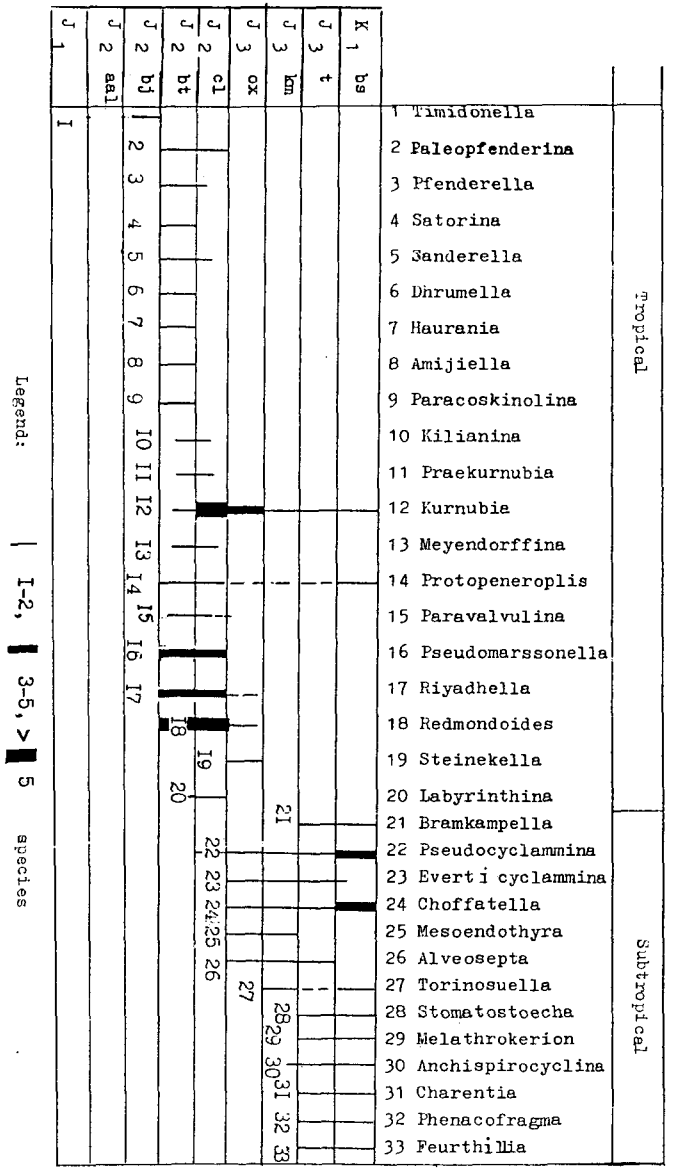

FIGURE 4.2 Stratigraphic ranges of some genera (tropical and subtropical types of Tethyan fauna) of foraminifera in Jurassic sediments of the eastern Mediterranean area.

communities is noted at the generic level: 18 foraminiferal genera appear at the beginning or in the middle of the Bathonian phase of faunal development (Fig. 4.2).

A new phase in the development of Jurassic foraminifera occurred throughout the Callovian, marked in the eastern Mediterranean by a reduction in marine transgression and an increase in the spatial variability of environmental conditions in the basins. There were two distinct types of communities whose compositions were inherited, as a whole, from the older Bathonian fauna. South-western Syria and Sinai were sites for accumulation of terrigenous–carbonate sediments and the development of communities dominated by boreal–cosmopolitan elements. A sparser Tethyan fauna inhabited shallow waters (middle-neritic and carbonate platform) at this time. In Callovian times, north-western Syria, the French–Spanish Pyrenees and Morocco were inhabited by a thermophilic endemic Tethyan fauna. The Crimea and the Caucasius were characterized by the development of transitional communities dominated by boreal–cosmopolitan elements. Planktonic foraminifera continued their evolution and increased their species diversity.

The next phase in the evolution of foraminiferal communities was related to a widespread marine transgression in Oxfordian times. The taxonomic diversity reached a maximum; the proportion of calcareous benthonic forms increased; and the planktonic foraminifera continued their development. The ratio of boreal–cosmopolitan to Tethyan elements is 9:1, although it varies slightly in different parts of the basin. The species cosmopolitan of the communities remained stable over a wide area. This can be attributed to widespread stable environmental conditions created by an extensive transgression, which reached as far as the Palmyrides of central Syria. The Crimea and the Caucasus, as well as Syria and Israel, are the sites of the appearance and wide dispersal of some new taxa (*Everticyclammina*, *Choffatella*, *Mesoendothyra* and *Alveosepta*), which lasted up to the end of the Jurassic and in some cases continued into the Cretaceous.

The beginning of the following, Kimmeridgian, phase is related to a regressive phase in the eastern Mediterranean basins and a change in the tectonic trend of the region. This is reflected in a reduction in the taxonomic diversity of the fauna, and the rather patchy distribution of Kimmeridgian outcrops in Syria. Kimmeridgian sediments are confined mainly to the south-western part of the country and their faunas are closely related to coeval communities in Israel, in both their composition and environment of deposition. They are characterized by a marked predominance of boreal–cosmopolitan elements over Tethyan forms. In north-western Syria, where Kimmeridgian rocks occur as isolated outcrops, foraminiferal assemblages are rich in sub-Tethyan elements (such as the genus *Torinosuella*). Agglutinated foraminifera predominate over calcareous (secreted) forms. No planktonic foraminifera were encountered in sediments representing the offshore shallow-water facies.

The final phase of faunal development covers the end of Jurassic and the beginning of Cretaceous, integrating the Tithonian and Berriasian communities

into a single developmental stage. Deposits of this age are of limited extent in the Middle East. The foraminiferal communities are noted for their high taxonomic diversity. The ratio between the above-mentioned groups, i.e. Tethyan, sub-Tethyan and boreal–cosmopolitan forms, remains the same: the sub-Tethyan and cosmopolitan elements dominate and the Tethyan endemics are subordinate in numbers. The beginning of the phase is marked by the appearance of six new genera in the Tethyan fauna, basic development and dispersal took place in Cretaceous times. All the genera are subtropical: they are common in the Middle East, the Crimea, Caucasus, south-western Europe and northern Africa. It is noteworthy that, in the Tethys, the variation in foraminiferal species composition at the Jurassic/Cretaceous boundary is as gradual as in the boreal basins. The appearance of new taxa at the boundary is confined to the species level. New Cretaceous taxa evolved mainly at the beginning and in the middle of the late Tithonian.

In considering the variations in foraminiferal faunas in close connection with, and against the background of, the depositional history of the Jurassic Tethyan basins, some important factors such as the biology of the group, the rate of evolution and spatial distribution have not been touched on yet.

The pace of evolution of a taxon, i.e. a genus in this case (since we will use mainly generic categories when discussing evolution), is inversely proportional to the length of time that it exists, and so we have attempted to understand which moments were crucial to the rate of evolution, what factors were common to and what factors were unique to the Tethyan foraminifera at different times in Jurassic history, and whether or not some morphological patterns were displayed in their development.

4.3 DISCUSSION

The development of Tethyan Jurassic foraminifera can be divided into two major stages, or megaphases, differing in the following ways: the morphotype of the dominant taxa; the rate of evolution; the degree of endemism; the palaeobiogeographical range and the degree of environmental tolerance; and the rate of evolution of new coiling modes (Fig. 4.1).

The first megaphase covered a lengthy period of time from the early Jurassic (Pliensbachian–Toarcian) to the end of middle Jurassic (Callovian) times. The distinguishing features of the foraminifera communities were:

1. The development of highly specialized forms, with a complex internal and external test architecture, i.e. unusual morphotypes.
2. A high degree of faunal endemism at the family level.
3. A reduced environmental tolerance as a result of extreme specialization.
4. Restricted palaeobiogeographical ranges of both genera and families.

5. High rates of evolution at the generic level. The time span is between 5.5 and 11 m.y. for genera and between 1 and 3 m.y. for species, i.e. equivalent to one or two ammonite zones.

6. High activity of form generation.

The second megaphase covers the whole of the late Jurassic and the beginning of the early Cretaceous. It is characterized by:

1. The development of — along with highly specialized forms — more adaptable, competitive groups, mainly from the family Lituolidae, which begin to dominate.

2. New morphotypes of the dominant taxa.

3. A decrease in the endemism (at the generic level).

4. Moderate tolerance to environmental changes.

5. Wider palaeobiogeographical ranges, covering both the tropical and subtropical belts of the Tethys (eastern Mediterranean, Crimea, the Caucasus, North Africa and Central Europe).

6. Moderate rates of evolution. The time span for genera is between 17 and 21 m.y. It is significant that the pace of *species* evolution does not decrease as compared with the first megaphase: the duration of species existence remains the same, i.e. between 1 and 3 m.y.

Thus, the foregoing discussion outlines the development of foraminiferal faunas inhabiting the Mediterranean in Jurassic times.

The stable evolutionary features of this group are based on the thorough analysis of foraminiferal species assemblages from Syria.

The analysis of the development and distribution of the foraminiferal communities and their taxonomic composition, structure and stratigraphic range, suggests the following pattern.

Bathonian, Callovian, Oxfordian and Tithonian sediments contain the richest and most diverse foraminiferal assemblages. Liassic, Aalenian, Bajocian and Kimmeridgian deposits, which are less extensive in Syria, are characterized by less-abundant communities, although in separate sections they are also fairly rich and varied in their taxonomic composition. The abundance ratios of benthonic foraminifera i.e. calcareous to agglutinated tests, vary considerably over a wide range, with the predominance of agglutinated over calcareous forms being characteristic of most of the stages. However, in the Bajocian and the Oxfordian calcareous foraminifera predominated in benthonic thanatocoenoses. This can be explained by the fact that in certain periods of geological history boreal–cosmopolitan (forms belonging mainly to the families Lenticulinidae and Vaginulinidae, which are dominant in the communities of the Boreal realm, Madagascar, Western Hindustan and the Canadian Atlantic shelf) penetrated into the eastern Mediterranean.

Planktonic foraminifera are rare and represented only by single specimens of *Globuligerina bathoniana* (Pazdro), *G. calloviensis* K. Kuznetsova, *G. meganomica* K. Kuznetsova and *G. oxfordiana* (Grigelis). However, despite their scarcity, these species are of prime importance in stratigraphy and correlation, because all of them:

1. are index species of the Bathonian, Callovian and Oxfordian foraminiferal zones;
2. have a nearly global distribution;
3. can be used in correlation sections of various palaeobiochores: provinces, regions and belts.

Liassic rocks, yielding a foraminiferal assemblage that is extremely poor in terms of species composition, are the oldest Jurassic sediments studied in Syria. They were encountered in two sections: near the village of Arneh in the Anti-Lebanon, and near the village of Jdaida in the Coastal Mountains. The first section contains rare specimens of *Trochammina nana* Brady, known from the Lias of Western Europe, and an ostrocod assemblage, including *Procytheridea magnicoutensis* Apostolescu, *P. sermoisensis* Apostolescu, *P. vermiculata* Apostolescu, *Progonocythere stilla* Sylvester-Bradley, *Aphelocythere kuhni* Triebel et Klinger, *Limnocythere alata* Dobrova, *Limnocythere lobata* Dobrova, *Limnocythere improcera* Dobrova and *Limnocythere cribellata* Dobrova. The section at Jdaida yielded tests of *Involutina liassica* (Jones), a species typical of the Lias of Europe and North America.

Middle Jurassic sediments are made up of Aalenian, Bajocian, Bathonian and Callovian rocks; they contain rich and diverse thanatocoenoses of foraminifera.

The oldest Middle Jurassic assemblages are those — including *Ammobaculites cobbani* Loeblich et Tappan, *Lenticulina protracta* (Bornemann), *Citharina clathrata* (Terquem), *C. pauperata* (Terquem) and *Praelamarckina humilis* Kaptarenko — that characterize the Aalenian and the Aalenian–Bajocian. The above list suggests that these foraminiferal assemblages include both typical Tethyan and boreal–cosmopolitan elements. The latter are represented by the genera *Lenticulina*, *Citharina* and *Praelamarckina*, which are common in Western Europe, Madagascar, Sinai and Morocco. This particular community was first found in Syria and was reported only from the Jurassic of the south-western Anti-Lebanon (the section at Arneh village, Hermon Mountains, the foot of Jebel Sheikh). Apart from a high species diversity, the above assemblage contains a large number of specimens, represented in some cases by tens of tests of both the micro- and macrospheric generations. The same applies to the lituolids: *Ammobaculites* tests are very abundant there. As for the species *Praelamarckina humilis* Kapt., reported from the Aalenian of the south of the European part of Russia, these beds yield only sporadic tiny specimens. Bajocian foraminiferal assemblages show a distinct continuation from older associations, they also contain abundant lenticulinids and vaginulinids. However,

no Tethyan endemics have been reported in the lower part of the Bajocian. The taxonamic diversity of the community is fairly high: it consists of about 30 species and eight families (Fig. 4.3). The appearance in Bajocian times of the ceratobuliminids (genera *Praelamarckina*, *Lamarckella* and *Reinholdella*) and the epistominids (genus *Epistomina*) is of particular note. These forms were cosmopolitan, although, because they were benthonic, they were influenced by particular environmental conditions and occur, as a rule, in offshore shallow-water sediments of the middle neritic zone. A quite different community was found in the Bajocian of the Coastal Mountains: compared with communities from the Anti-Lebanon, it is much lower in diversity and mainly consists of rare lenticulinids (*Lenticulina polymorpha* (Terq.), *L. veta* Hoffman), marginulinids (*Marginulina solida* Terq.) and nodosariids. However, in the upper part of Bajocians, Tethyan endemics appear, represented by the genus *Timidonella*.

In the Kurd-Dag and the Palmyrides, the Bajocian is unfossiliferous.

In the eastern Mediterranean, like elsewhere there was a widespread marine transgression in the Bathonian. Sediments of this age are very common in Syria, in fact they are ubiquitous in the Jurassic terrains, and yield rich and diverse foraminiferal assemblages. They differ greatly in composition from the Bajocian assemblages, owing to an increase in diversity, partly due to the appearance of about 65 new species, assigned to 38 genera of 27 families (Fig. 4.3).

These foraminiferal assemblages were dominated by agglutinated forms, with calcareous forms being of secondary importance. The first planktonic foraminifera appeared, which were represented by a few specimens of the only species, *Globuligerina bathoniana* (Pazdro). In Bathonian times, there were several different types of foraminiferal community in Syria: these are mainly represented by two types. The first type occurs in the Anti-Lebanon and consists primarily of common forms such as lituolidsd, lenticulinids and polymorphinids. Ophthalmidiidae, Trocholinidae, Ceratobuliminidae and planktonic Globuligerinidae are also present there. The taxonomic composition of this assemblage is similar to that of the Bathonian assemblage described from the Jebel Maghara, Sinai (Said et Barakat, 1958). The most typical species are *Reophax metensis* Franke, *Recurvoides bartouxi* Said et Barakat, *Ammobaculites fontinensis* Terq., *A. agglutinans* d'Orb., *Lenticulina polymorpha* (Terq.), *Citharina proxima* (Terq.), *Lamarckella antiqua* Kapt. and *Globuligerina bathoniana* (Pazdro). A community known from the Bathonian of the Coastal Mountains, the Kurd-Dag and the Palmyrides has quite a different composition. The Tethyan endemics of the families: Cyclamminidae (*Dhrumella*), Hauraniidae (genera *Amijiella* and *Haurania*), Dorothiidae (*Eomarssonella*), Chrysalidinidae (*Pseudomarssonella*, *Riyadhella*) and Dictyoconidae (*Kilianina*, *Meyendorffina* and *Paracoskinolina*) dominate the community. The most important is the family Pfenderinidae, represented by numerous species of the genera *Palaeopfenderina*, *Pfenderella*, *Praekurnubia* and *Kurnubia*.

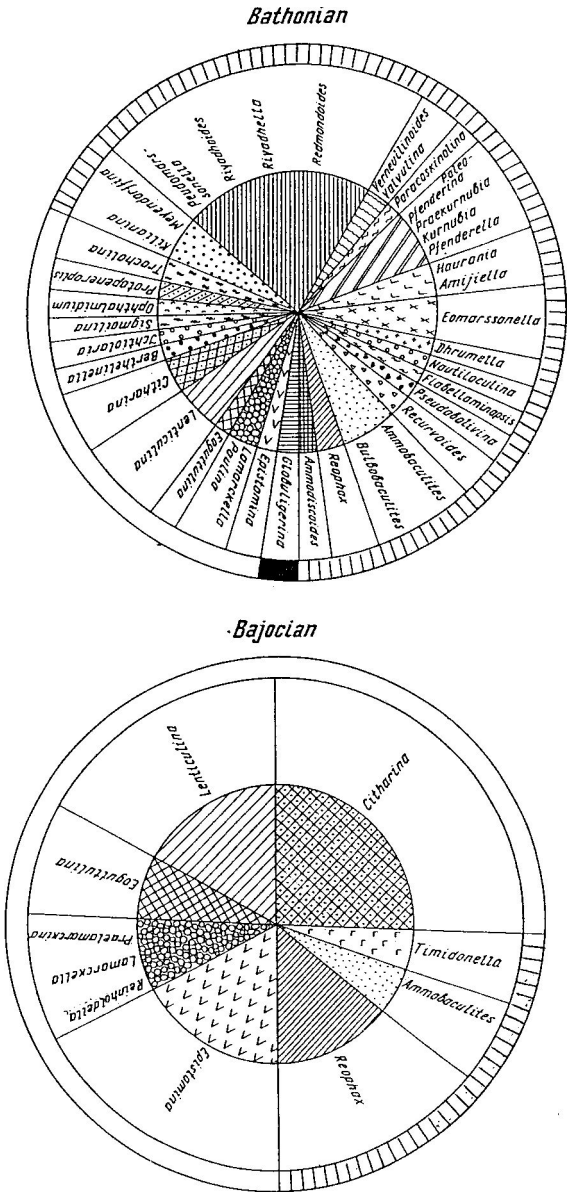

FIGURE 4.3 Taxonomic composition of foraminifera in the Bajocian and Bathonian deposits of Syria.

From the compositional variations of diverse and representative foraminiferal communities, the Bathonian of the Coastal Mountains can be subdivided into the lower and the upper Bathonian using foraminiferal zones and marker beds. There is a change in the assemblages, and the taxonomic composition is uniform over the entire area where this type of fauna is common. The lower Bathonian is characterized by the following species: *Haurania deserta* Henson, *Amijiella amiji* (Henson), *Redmondoides lugeoni* (Septfont.), *Pseudomarssonella primitiva* Redmond, *Riyadhella arabica* Redmond *Protopeneroplis striata* Weynschenk, *Palaeopfenderina trochoidea* (Smout et Sugden), *Dhrumella evoluta* Redmond and *Globuligerina bathoniana* (Pazdro). It is noteworthy that boreal–cosmopolitan elements are almost completely absent, this is a characteristic of the 'southern' Hermon assemblage.

Thus, early Bathonian times were marked by important variations in the composition of foraminiferal assemblages: the appearance of new genera of Tethyan endemics and a decrease in the proportion of boreal–cosmopolitan elements.

In late Bathonian times the trend became more obvious: the beginning of the late Bathonian witnessed the appearance of four new genera and the evolution continued of the genera which had appeared in early Bathonian times, such as *Palaeopfenderina, Pfenderella, Satorina, Sanderella, Dhrumella, Haurania, Amijiella, Protopeneroplis, Pseudomarssonella, Riyadhella* and *Redmondoides*. The lower/upper Bathonian boundary is drawn on the basis of the appearance of new species, a reduction in the proportion of the genera *Haurania* and *Amijiella* and the appearance of species of the above-listed new Tethyan genera. The most characteristic upper Bathonian species are: *Kilianina blancheti* Pfen., *Meyendorffina bathonica* Auroze and Bizon (index species of a standard zone), *Paracoskinolina occitanica* Peyb., *Praekurnubia crusei* Redm., *Kurnubia bramkampi* Redm., *Berthelinella paradoxa* (Berth.), *Limognella dufaurei* Pell. and Peyb., *Palaeopfenderina salernitana* (Sart. and Cresc.), *Mesoendothyra croatica* Gusic., *Pseudomarssonella bipartita* Redm. and *Globuligerina bathoniana* (Pazdro).

Early Callovian times were marked by a less extensive transgression, impoverishment of foraminiferal communities and continued evolution of Bathonian species and genera. There was a fairly obvious succession from the Bathonian to the Callovian communities. Most of the late Bathonian species survived into the Callovian. New genera do not appear. The Tethyan endemics were still important, along with newcomers such as the cosmopolitan Polymorphinidae (e.g. *Eoguttulina* and *Globulina*), Ammodiscidae (*Ammodiscoides*), Verneuilinidae (*Palaeogaudryina*) and Haplophragmoididae (*Haplophragmoides*). The evolution of planktonic foraminifera continued: *Globuligerina bathoniana* (Pazdro) gave way to the Callovian species *Globuligerina meganomica* K. Kuznetsova and *G. calloviensis* K. Kuznetsova. They were still uncommon but occurred in both pure carbonate and terrigenous–carbonate deposits. The taxonomic composition,

although still dominated by agglutinated foraminifera, was less diverse than that of the Bathonian: the Callovian displayed 18 families, 29 genera and about 60 species of foraminifera (Fig. 4.4).

As in the Bathonian, two types of community can be distinguished in the Callovian: cosmopolitan forms continue to dominate in the Anti-Lebanon, whereas Tethyan endemics are common in the Coastal Mountains. As is the case in the Crimea, the taxonomic composition does not allow the division of the Callovian into two parts. The composition varies in space between tectonic/facies zones. However, in complete and continuous sections, the main species composition does not vary greatly from the top of Bathonian to the base of Oxfordian. The most typical species in the Anti-Lebanon are: *Lituotuba nodus* Kos., *Kurnubia palastiniensis* Henson, *Palaeogaudryina varsoviensis* (Biel. et Poż.), *Nautiloculina oolithica* Mohler, *Ammobaculites fontinensis* (Terq.).

In the Coastal Mountains, the composition of the assemblage was as follows: *Ammodiscoides magharaensis* Said et Barakat, *Sanderella laynei* Redm., *Steinekella crusei* Redm., *Kurnubia palastiniensis* Henson, *Palaeopfenderina salernitana* (Sart. et Cresc.), *Astacolus pellucida* Said et Barakat, *Frondicularia spissa* (Terq.) and *Reinholdella dreheri* Bart.

Oxfordian times were marked by the extension of the marine transgression; making Oxfordian sediments very common in the eastern Mediterranean, particularly in Syria. These sediments are richly fossiliferous, and foraminifera play an important role. The foraminiferal faunas are very diverse (Fig. 4.4), and the composition of faunal communities is uniform over vast areas, because of extensive faunal migration. The high population density for most species, created by: the fairly stable environments in the palaeobasins; the presence of planktonic foraminifera: the dominance of calcareous benthonic forms over agglutinated forms; and the dominance of boreal–cosmopolitan species over Tethyan endemics, are all features peculiar to these assemblages. These features are also characteristic of all Oxfordian foraminiferal assemblages in Syria. A high taxonomic diversity (26 families, 43 genera and more than 100 species) allows us to trace changes in the communities and enables us to subdivide the Oxfordian into zones. The early Oxfordian foraminiferal assemblages, studied in the sections in the Anti-Lebanon (Hadar, Rowda and the Wadi al Karn), contain the following species: *Alveosepta jaccardi* (Schrödt), *Haplophragmium coprolithiformis* (Schwag.), *Pseudocyclammina maynci* Hott, *Mesoendothyra* sp., *Lenticulina brueckmanni* (Mjatl.), *L. quenstedti* (Gümb.), *L. russiensis* (Mjatl.), *Astacolus vacillantes* Esp. et Sigal, *Planularia beierana* (Gümb.), *Citharina entypomatus* Esp. et Sigal, *C. paralella* Biel. et Poż., *Marginulinopsis suprajurasssicus* (Schwager), *Conorboides paravalendisensis* Reiss, *Spirillina kuebleri* Mjatl., *Epistomina nemunensis* Grig., *E. porcellanea* Brückm. and *Globuligerina oxfordiana* (Grig).

Thus the above assemblage consists mainly of very common forms of calcareous benthonic, foraminifera recorded in the Boreal realm, Madagascar, Sinai, Canada

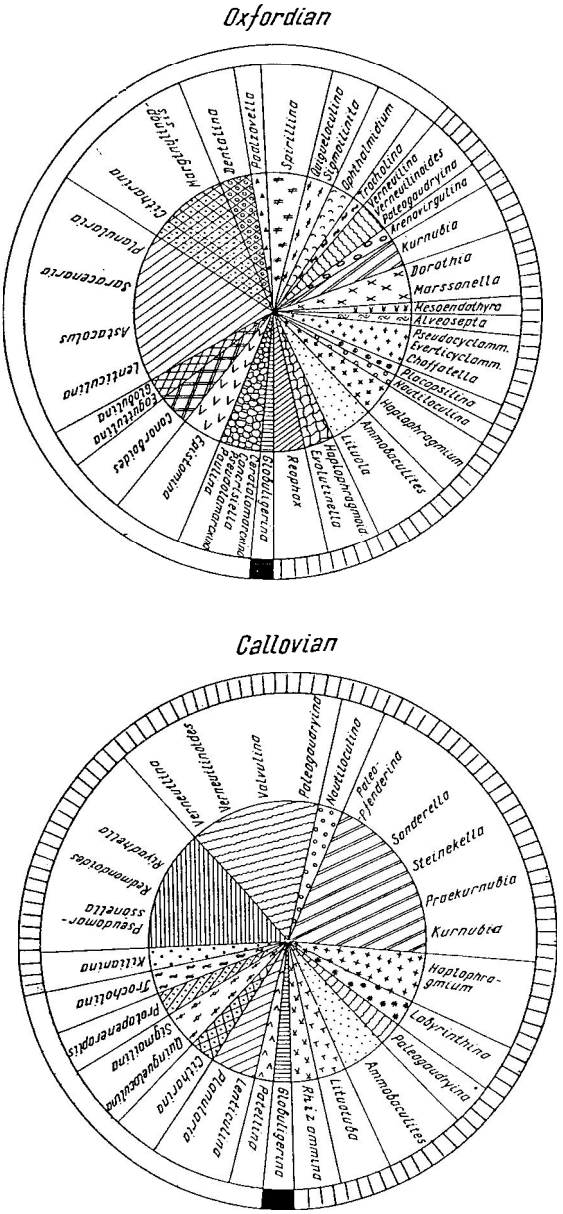

FIGURE 4.4 Taxonomic composition of foraminifera in the Callovian and Oxfordian deposits of Syria.

and the Crimea. This allows us to use the fauna for correlation of sediments of the *Lenticulina brueckmanni–Globuligerina oxfordiana* Zone which is known to have a similar extent and faunal composition in the lower Oxfordian of the European part of Russia, the Crimea and the Caucasus (Kuznetsova, 1985).

As a rule, there is a gradual transition between the upper Oxfordian and the underlying lower Oxfordian deposits. The evolution of foraminiferal communities shows a distinct evolutionary change. The change in composition is due mainly to the appearance of new typical upper Oxfordian species, such as *Reophax horridus* (Schwag.), *Haplophragmium lutzei* Hanzl., *Ammobaculites braunsteini* Cushm., *Trocholina transversarii* Paalz., *Lenticulina quenstedti* (Gümb.), *L. audax* Loebl. et Tapp and *Steinekella steineki* Redm. The latter species belongs to the family Pfenderinidae, which is typical of the Tethys and confined to it. In the Oxfordian, Tethyan and sub-Tethyan endemics are mainly represented by such genera as *Steinekella*, *Pseudocyclammina*, and *Everticyclammina*, which although low in species diversity, are extremely abundant in terms of individual tests.

The uniform taxonomic composition of the late Oxfordian foraminifera in all known Syrian localities allowed the recognition of a wide range of zones; they can be assigned to the standard stratigraphic time scale. Similar, although less abundant communities, have been found in the Oxfordian of the Palmyrides; the Oxfordian has not been recorded hitherto in this part of Syria (Jarmakani *et al.*, 1989).

The Kimmeridgian in Syria was marked by the beginning of a change in the regional tectonic trend, extensive uplift and a reduction in the size of the marine basin. All of these factors affected the composition, structure and palaeobiogeographical range of foraminiferal assemblages.

Kimmeridgian sediments occur mainly in the Anti-Lebanon (the Wadi al Karn and the Wadi Fawuar sections). Shallow-water sediments, mainly represented by bioclastic, oolitic and stromatoporoid limestones, yield a foraminiferal assemblage, consisting of only a few species, namely, *Reophax hounstoutensis* Lloyd, *Triplasia jurassica* Mjatl., *Marssonella doneziana* Dain, *M. hechti* Dieni et Massari, *Citharina lepida* (Schwag.) and *Alveosepta personata* (Tobler). The latter is the index species of the zone of the same name, which is widespread in the carbonate facies of the Mediterranean. At the same time, it is the only Tethyan species in the assemblage. The rest of the species represent very common, environmentally tolerant forms. A community that is similar in composition but rich in Tethyan elements, was reported from the Coastal Mountains (Nicola Quarry), from sediments that we have assigned to the Kimmeridgian. *Ammobaculites pellucida* Said et Barakat, *Pseudocyclammina* sp., *Alveosepta personata* (Tobler), *Nautiloculina oolithica* Mohler and *Lenticulina subtilis* (Wisn.) were recorded there. The community consists of 16 families, 20 genera and 21 species, most of them agglutinated forms. Planktonic species have not been found. Despite a high species diversity, the assemblage contains a low number of tests (Figs. 4.5 and 4.6).

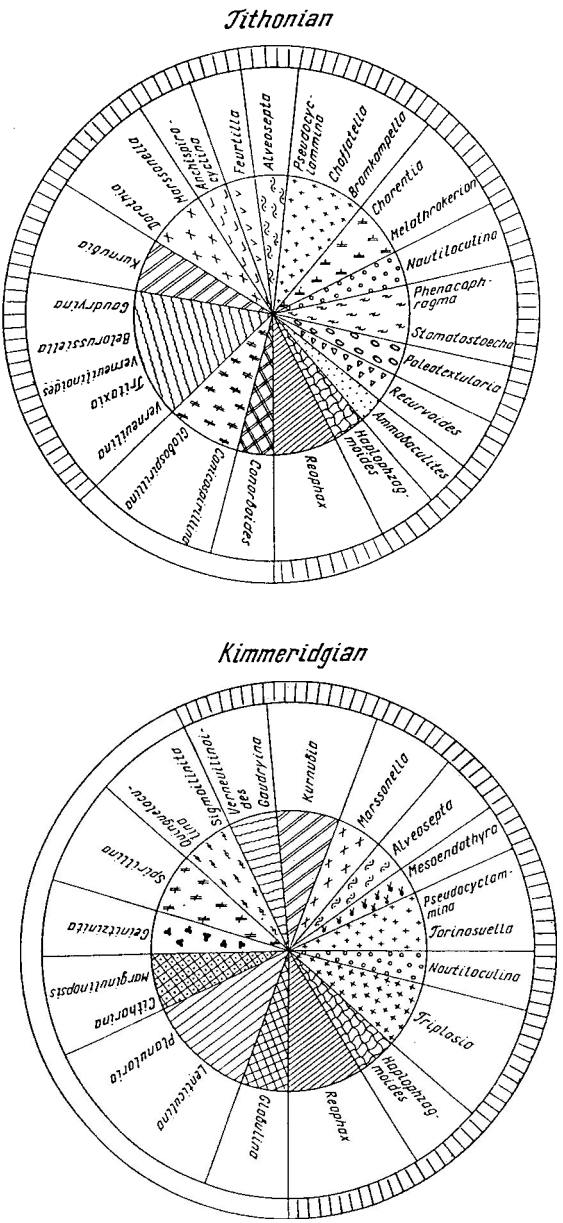

FIGURE 4.5 Taxonomic composition of foraminifera in the Kimmeridgian and Tithonian deposits of Syria.

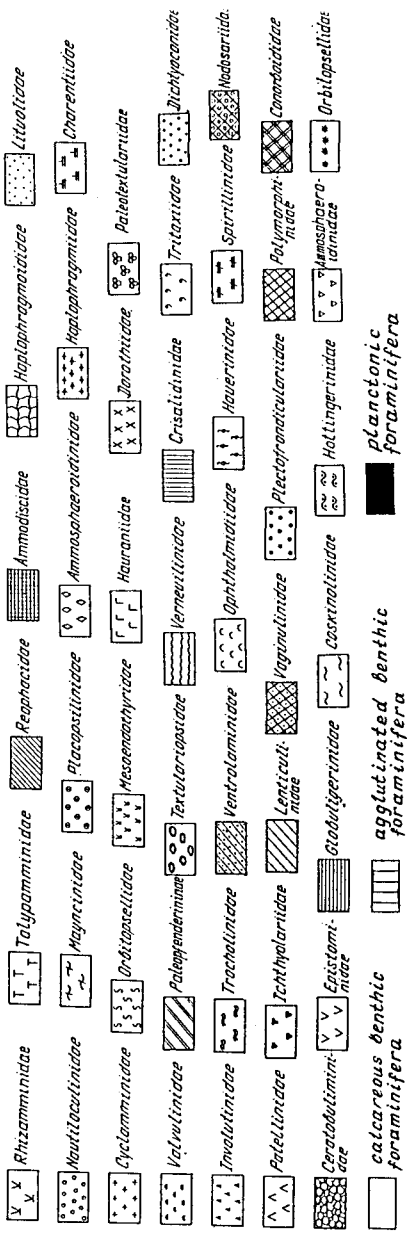

FIGURE 4.6 Key to Figures 4.3–4.5.

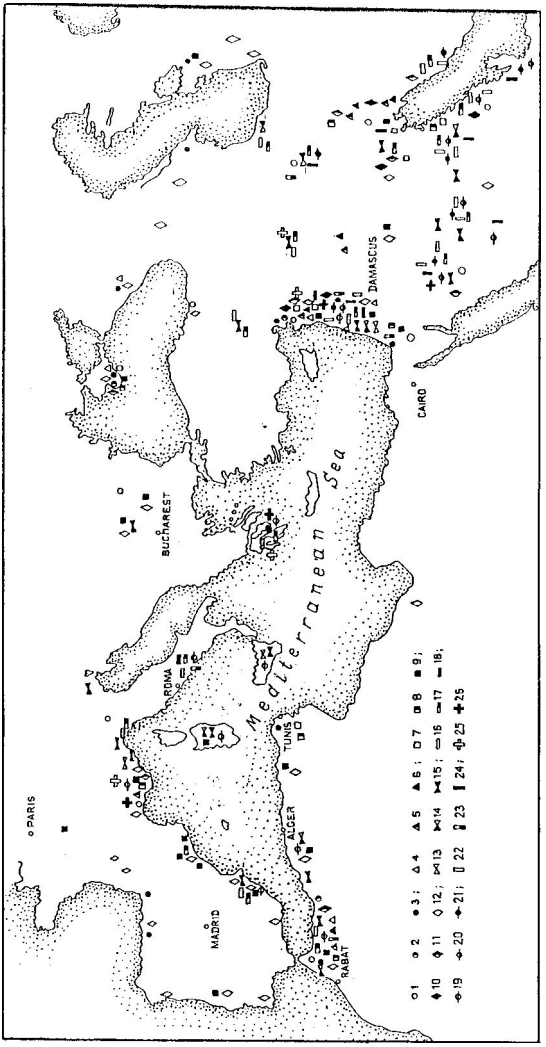

FIGURE 4.7 Range of foraminifera (Tethyan and sub-Tethyan genera) in the Middle to the Upper Jurassic, Mediterranean realm. 1 *Nautiloculina*; 2 *Stomatostoecha*; 3 *Charentia*; 4 *Melathrokerion*; 5 *Haurania*; 6 *Amijiella*; 7 *Bramkampella*; 8 *Pseudocyclammina*; 9 *Choffatella*; 10 *Dhrumella*; 11 *Everticyclammina*; 12 *Anchispirocyclina*; 13 *Timidonella*; 14 *Alveosepta*; 15 *Palaeopfenderina*; 16 *Praekurnubia*; 17 *Kurnubia*; 18 *Kilianina*; 19 *Meyendorffina*; 20 *Pseudomarssonella*; 21 *Redmondoides*; 22 *Riyadhella*; 23 *Labyrinthina*; 24 *Sandarella*; 25 *Protopeneroplis*; 26 *Mesoendothyra*.

In other areas of Syria, Kimmeridgian rocks were not deposited (Kurd-Dag) or were eroded during pre-Cretaceous uplift. At some localities there is evidence of ostracods and foraminifera that were redeposited in Cretaceous deposits (in the Wadi Jahannam section of the Coastal Mountains).

The Tithonian marks the final phase in the Jurassic geological history of Syria. Pre-Cretaceous uplift took place over most of the country, and Tithonian sediments only occur in some of the sections. These sediments were explored in the Anti-Lebanon (the Wadi al Karn, Sad al Karn and the Wadi Fawuar sections) and in the Coastal Mountains (a section near the town of Qadmous). Foraminiferal assemblages from these rocks are very diverse, very abundant, and contain common species, such as *Anchispirocyclina lusitanica* (Egger) and *Melathrokerion eospiralis* Gorb. (Fig. 4.5 and 4.7). The zone of the same name was recognized in the Tithonian of Syria, the Crimea, the Caucasus, and apparently can be found in Morocco. It is impossible to subdivide the Tithonian in more detail because of its incompleteness in Syria. A mixed composition, containing both Tethyan and sub-Tethyan ecdemics and cosmopolitan elements is an unusual feature of the Tithonian foraminiferal assemblages of the Anti-Lebanon. A community with the following composition was found there: *Gaudryina vadazi* Cushm. et Glaz., *Stomatostoecha compressa* Gorb., *Melathrokerion eospirialis* Gorb., *Alveosepta powersi* (Redm.), *Verneuilina angularis* Gorb., *Marssonella hechti* Dieni et Mass., *Anchispirocyclina lusitanica* (Egger), *Pseudocyclammina* sp. and *Kurnubia jurassica* Redmond. An assemblage that is quite different in species composition was found in the Tithonian of the Coastal Mountains (Qadmous section), yielding mainly the Tethyan endemics *Bramkampella arabica* Redm. and the sub-Tethyan species *Choffatella decipiens* Schlum., *Anchispirocyclina lusitanica* (Egger), *Pseudocyclammina parvula* Hott., *Feurtillia frequens* Maync, *Torinosuella* sp. and others. Large numbers of tests are present not only of Tithonian species, but also those whose evolution continued into the Cretaceous. It appears that overlying succession is composed of uppermost Jurassic sediments, i.e. upper Tithonian beds and those transitional to the Berriasian. It follows from the above discussion that analysis of the variations in and the evolution of the foraminiferal communities throughout the Jurassic leads to the following conclusions.

4.4 CONCLUSIONS

Variations in the foraminiferal, assemblages caused by changes in the dynamics of the Mediterranean Jurassic marine basins suggest that there were several phases in the evolution of foraminiferal communities, marked by different compositions, structures and distribution of communities. The duration of most phases is equivalent to a geological age (stage). Based on the biological features of the

foraminifera discussed, two major stages (megaphases) can be recognized in their evolution: early to middle Jurassic and late Jurassic to early Cretaceous. The following criteria were used to recognize the megaphases: the dominant morphotype, the degree of endemism, the environmental tolerance, the rate of evolution, the number of different morphologies appearing in a given time and the extent of geographical ranges. A comparison of the phases shows that biological changes in the fauna were much slower than changes related directly to abiotic factors in the basins that they inhabited.

The most obvious markers, reflecting the appearance of many new species of foraminifera, occur at the base of the Bathonian, in the upper Bathonian, at the beginning of the Oxfordian and at the base of Tithonian. All of these boundaries are marked by the appearance of new genera.

In the middle Jurassic (Aalenian–Callovian), all the new genera were tropical endemics. Starting from the late Jurassic (Oxfordian–Tithonian) to early Cretaceous (Berriasian–Barremian), the new elements of the communities were represented exclusively by sub-Tethyan genera whose geographical ranges were much wider and extended beyond the limits of the tropical part of the Tethys.

The variations in foraminiferal faunal composition at the Jurassic/Cretaceous boundary in the Mediterranean can be compared with those in the Boreal realm: the appearance of new taxa took place only at the species level, with the Jurassic faunas being succeeded, to a large extent, by the Cretaceous fauna. New genera appeared mainly in the Tithonian; their evolution continued in the early Cretaceous.

CHAPTER 5
THE CORRELATION OF THE JURASSIC OF SYRIA, NORTH AFRICA AND SOUTH-WESTERN EUROPE

5.1 INTRODUCTION

The Syrian Jurassic can be subdivided using biostratigraphic and lithostratigraphic methods. Correlation of the recognized stratigraphic units between the main regions of Syria, namely, the Anti-Lebanon, the Coastal Mountains, the Kurd-Dag and the Palmyrides, has been discussed in previous chapters. The next step is to correlate the Syrian Jurassic with its equivalents elsewhere. Correlation is based on published data for Saudi Arabia (Banner and Whittaker, 1991), Morocco (Hottinger, 1967), Israel (Picard and Hirsch, 1987; Hirsch, 1990) and the French–Spanish Pyrenees (Peybernes, 1976), as well as our own data on the Crimea and the Caucasus (Kuznetsova and Gorbachik, 1985; Kuznetsova, 1985). Figure 5.1 presents stratigraphic charts for the above-mentioned areas.

The Jurassic sediments were deposited in a single basin, encompassing Sinai, the Anti-Lebanon and the Coastal Mountains of Syria. Therefore, we will begin with the correlation of these deposits, even though the lithostratigraphic units were recognized for the Jurassic of Sinai and the biostratigraphic units were identified in the Anti-Lebanon and the Coastal Mountains.

The Lower Jurassic, which has been subdivided into Pliensbachian and Toarcian using molluscs, was identified in northern Sinai. It comprises the Mashabba (lower) Formation, with a thickness of < 80 m, and the Rajabian (upper) Formation, which is ≤ 262 m thick. The lower formation consists of various types of sandstone composition, and the upper formation is composed of bioclastic and oolitic–oncolitic limestones, yielding corals, molluscs and foraminifera. In Syria, Lower Jurassic sediments, reported from the southern Anti-Lebanon, do not exceed 160 m in thickness in the Arneh section. Here they are represented by intercalated limestone, clay and marl, generally dolomitized. They contain rare foraminifera and ostracods.

All the Middle Jurassic stages, from Aalenian to Callovian inclusive, are present in Sinai. Based on the composition of sandstone, dolomite and sandy limestone, the Aalenian to lower Bajocian deposits are grouped into the Shusha Formation, which is 277 m thick. The age was determined from the contained plant remains. Some localities yield brachiopods, lamellibranchs and foraminifera

STAGES	SUBSTAGES	AMMONITE ZONES / FORAMINIFERAL ZONES	CRIMEA Kuznetsova Gorbachik, 1985	CAUCASUS Kuznetsova, ed., 1985
TITHONIAN	*u*	Durangites	Anchispirocyclina lusitanica-Melathrokerion spirialis	Beds with Quingueloculina verbizhiensis Trocholina elongata
		Paraulacosphinites transitorius		
	m	Microcanthoceras ponti		Beds with Quingueloculina mitchurini-Pseudocyciammina parvula
		Semitormiceras fallauxi		
		Semiformiceras semiforme	Epistormina omninoreticulata	
	l	Danubisphinctes palatinus	Beds with Epistomina ventriosa-Textulatia densa	Verneuilinoides kirillae-Mesoendothyra sp
		Franconites vimineus		
		Usseliceras parvinodosum		
		Dorsoplanitoides triplicatus		
		Usseliceras tagmersheimense		
		Hybonoticeras hybonotum		
KIMMERIDGIAN	*u*	Aulacostephanus autissiodorensis		
		Aulacostephanus eudoxus		
		Aulacostephanus mutabilis		
	l	Rasenia cymodoce	Beds with Epistomina praetatariensis-Globuligerina parva	Alveosepta personata-Torinosuella peneroplliformis
		Pictonia baylei		
OXFORDIAN	*u*	Ringsteadia pseudocordata	Lenticulina russiensis-Epistomina uhligi	Alveosepta jaccardi-Epistomina nemunensis
		Decipia decipiens		
		Perisphintes cautisnigrae		Ceratolamarckina subspeciosa-Trocholina transversarll
	m	Gregoriceras transversarium		Beds Geratolamarckina speciosa-Marssonella jurassica
		Perisphinctes plicatilis		
	l	Cardioceras cordatum	Lenticulina guenstedti-Globuligerina oxfordiana	E. elschancaensis-L tumida
		Quenstedtoceras mariae	Lenticulina ovatoacuminata-LmoLesta	Sigmoilina costata-Epistomina mosquensis
CALLOVIAN	*u*	Quenstedtoceras lamberti	Lenticulina cultratiformis-L. pseudocrassa	Lenticulina sculpta-L. praerussiensis
		Peltoceras athleta		
	m	Erymnoceras coronatum		
		Kosmoceras jason		
	l	Sigaloceras calloviense	Lenticulina parmula-Globuligerina calloviensis	
		Macrocephalites macrocephalus		
BATHONIAN	*u*	Clidoniceras discus Oxycerites aspidoides		QuingerueLoculina micra-Epistomina peregzina
	m	Tulites subcontractus Gracillsphinctes progracilis		Kaptarenkoella minima -Epistomlma arcana
	l	Zigzagiceras zigzag		Sublamarckella terqueml-Garantella caucaslca
BAJOCIAN	*u*	Parkinsonia parkinsoni		Ophthalmidium caucasicum-Garantella floscula
		Garantiana garantiana		
		Strenoceras subfurcatum		Veneuilinoides tchegemensis-O.balcaricum
	l	Stephanoceras humphriesianum		Sublamarckella kaptarenkoaL. tchegemica-Nubeculinella infraoolithica
		Otoites sauzei		
		"Sonninia" sowerbyi		Ophthalmidium infraoolithicum-Reinholdella Lidljae
	u	Graphoceras concavum		Sublamarckella kaptarahkoae
		Ludwigia murchisonae		
	l	Lioceras opalinum		

FIGURE 5.1 Correlation and zonation of the Jurassic.

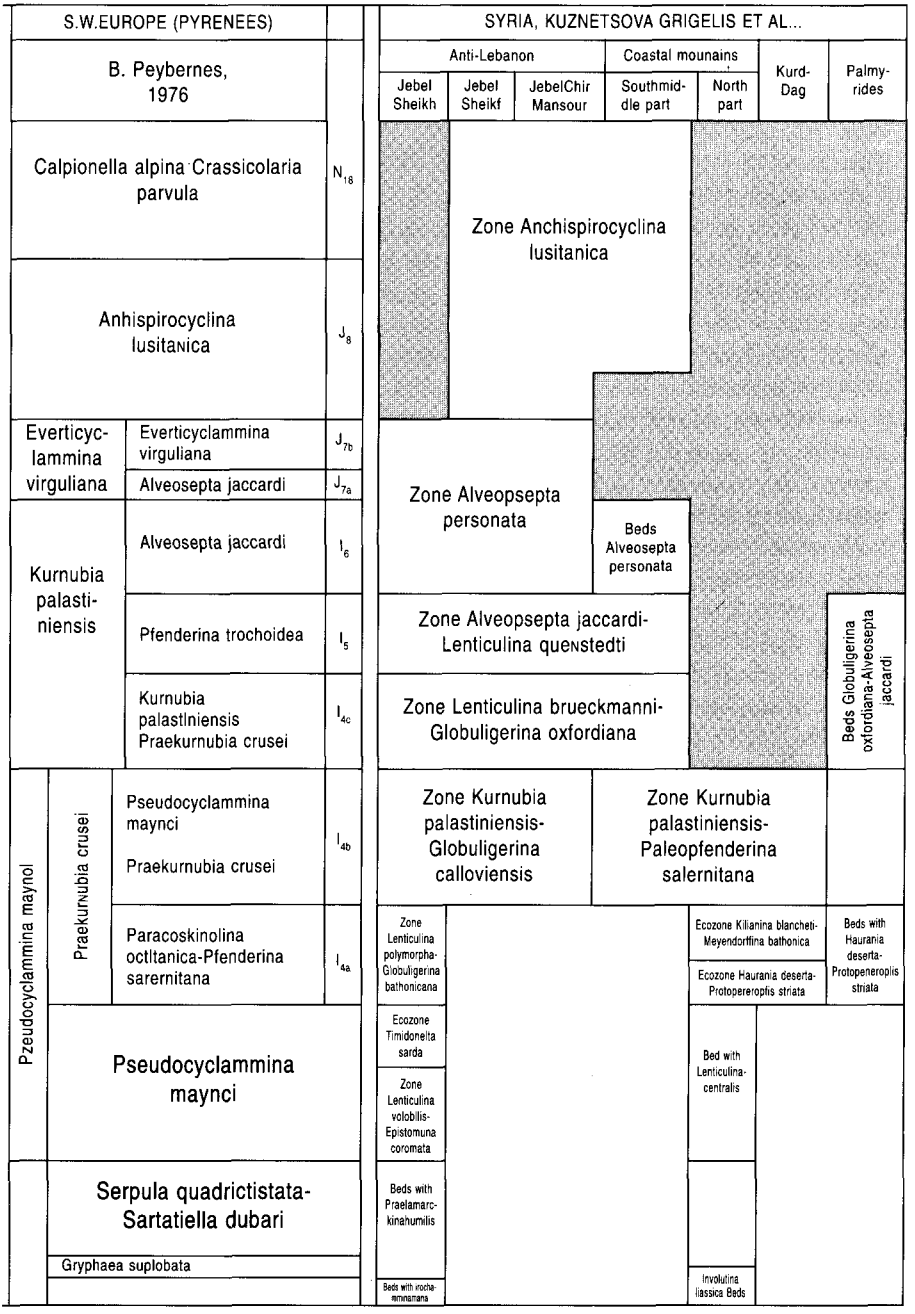

FIGURE 5.1 *Continued.*

(Said and Barakat, 1958), suggesting deposition in a normal-marine and locally brackish shallow-water basin. In Syria, deposits of this age, studied in the Anti-Lebanon, contain abundant foraminifera. Their species composition also suggests deposition in a normal-marine basin. There are some species in common with Israel and south-western Europe (Bassoullet *et al.*, 1976; Peybernes, 1976; Hirsch, 1990).

The middle to upper Bajocian of Sinai is represented by the Mahl and the Bir Maghara formations, which reach about 600 m in thickness. The age was determined by the ammonites, lamellibranchs, brachiopods and echinoderms. The Bajocian of Syria is represented by normal-marine sediments in the Anti-Lebanon, and shallow-water and lagoonal (dolomite) deposits in the Coastal Mountains, with the thickness decreasing northward from 950 to 200 m.

As in Syria, the Bathonian of Sinai can be subdivided into upper and lower parts. The lower Bathonian Safa Formation, (about 160 m thick), contains rare brachiopods, plant remains and coal seams. It is made up of limonite sand and sandy shale, containing abundant plant remains; the lack of foraminifera suggests deposition under terrestrial or brackish shallow-water conditions.

In Syria, lower Bathonian deposits are very common and contain abundant foraminifera, including planktonic forms, brachiopods, and lamellibranchs, indicating that deposition took place in an open marine basin with normal salinity.

The upper Bathonian of Sinai: the Kehailia Formation, essentially differs from the lower Bathonian. It attains a thickness of about 300 m, and consists mainly of carbonate-oolitic–oncolitic limestones, rare sandstone bands and shale (Karmon Shale). Foraminifera are less abundant than in the upper Bathonian of Syria. Calcareous nannoplankton are present; macrofossils are represented by ammonites, brachiopods and lamellibranchs.

The Zohar Formation, which is well known in the Jurassic of the Middle East, is equivalent to the Callovian in age; it is made up of limestones of varying compostition, which show extensive karstic weathering, and calcarenites. Common secondary silicification, siliceous nodules and concretions are characteristic of the Callovian of both Syria and Sinai; the foraminiferal faunas are also similar in composition.

As in Syria, the Oxfordian of Sinai divided into lower and upper parts, which correspond with two formations, the lower Kidod Formation (67 m thick) and the upper, Beersheba Formation (124 m thick). They comprise carbonate and terrigenous-carbonate sediments, namely limestone, clay and marl with a rich fauna of ammonites, belemnites, brachiopods, corals, foraminifera and nannoplankton. The Oxfordian of Syria has similar lithology, thickness and fossil assemblages and its sediments are very common. The Oxfordian here can be subdivided into substages and foraminiferal zones.

The Kimmeridgian of Sinai is of limited extent. The Haifa Bay Formation consists of limestone, argillaceous limestone and marl, containing foraminifera. The foraminiferal fauna is similar in composition to that of the Kimmeridgian of

Syria, and has some boreal–cosmopolitan forms in common with Europe.

The Tithonian has not been recorded in Sinai.

In Saudi Arabia, the Jurassic deposits have been studied mainly from drilling logs. Oil exploration began there in the 1930s and required the study of fossils, particularly foraminifera, in order to devise a detailed Jurassic and Cretaceous stratigraphy. The study, initiated by Redmond (1964, 1965) was followed up by the British micropalaeontologists, Banner and Whittaker in 1991, who, based on new palaeontological evidence, gave more precise ages for the Jubeila, Haifa and Sulaiya formations. They assigned the Sulaiya Formation to the Neocomian: previously it had been considered as a Jurassic Cretaceous boundary formation. These three formations are very common in the Middle East and are used in the Jurassic and early Cretaceous stratigraphy of Iraq, the United Arab Emirates and Saudi Arabia. The older Jurassic sediments (Bathonian to Callovian) were assigned to the Dhruma Formation, yielding foraminifera similar in composition to those from the Bathonian and Callovian of Syria.

In North Africa, the Jurassic sediments of eastern Morocco (Hottinger, 1967) are divided into stages which can be correlated directly using foraminifera, with those in Syria. The presence of complex lituolids, pfenderinids and cyclamminids, typical of the tropical Tethys, suggests that the areas correlated belonged to a single palaeobiogeographical province affected by similar environmental conditions.

In south-western Europe (Pyrenees), Jurassic sediments, mainly carbonates are subdivided into stages and foraminiferal zones (Peybernes, 1976). No formations have been recognized there. The foraminifera that are used for Jurassic zonation are common to the entire eastern Mediterranean and Syria, though the zones recognized differ somewhat in extent (see Fig. 5.1).

In the Crimea, the Jurassic foraminiferal zonation is based on species assemblages occurring in terrigenous facies (Kuznetsova, 1983; Kuznetsova and Gorbachik, 1985). This zonation covers the upper Middle Jurassic from the Callovian onwards, and the entire Upper Jurassic up to and including the Tithonian. Some of these zones also occur in Syria where they are of similar extent and their zonal assemblages have a similar compositon (*Anchispirocyclina lusitanica* Zone in the Tithonian, *Lenticulina quenstedti–Globuligerina oxfordiana* Zone in the Oxfordian). However, the Jurassic of Syria differs greatly from that of the Crimea in its lithology, thickness and foraminiferal assemblages. For example, the thickness of the Tithonian in Syria does not exceed 80 m in the Anti-Lebanon, whereas in the eastern Crimea it is over 3500 m. The evolution of the Crimean benthonic fauna took place in basins on the northern margins of the Tethys, while the Syrian assemblages evolved in the tropical equatorial zone of this Mesozoic ocean. This could explain the occurrence in the Syrian Jurassic of some endemic genera and families that have not been found in the Crimea or the Caucasus.

CHAPTER 6
THE GEOGRAPHICAL RANGES OF JURASSIC FORAMINIFERA IN THE MEDITERRANEAN BASINS

6.1 INTRODUCTION

In Jurassic times, the bottom sediments of the Mediterranean basins contained abundant foraminifera that can be classified within the cyclamminid–pfenderinid type of fauna. The features peculiar to these foraminiferal assemblages, their composition and evolution have been discussed in preceding chapters. It is interesting to establish the characteristics of this type of fauna, and whether its taxonomic composition is uniform throughout the Tethys, in other words, whether it is homogeneous and whether it is connected with the Jurassic biogeographical provinces.

6.2 DISCUSSION

Firstly, it is important to emphasize the emdemism of the Tethyan faunas. This is fully evident in the Jurassic and fairly distinct in the Cretaceous. The geographical range of the faunas, their composition and the degree of endemism are clearly controlled by climatic factors. For this purpose, the appearance of individual sub-Tethyan genera such as *Pseudocyclammina*, *Everticyclammina*, *Choffatella*, *Melanthrokerion*, *Charentia*, *Stomatostoecha*, *Anchispirocyclina* and *Feurtillia* was recorded for the Crimea, the Lesser Caucasus and, to a lesser extent, for the Greater Caucasus (Georgian Block) and the Pamirs. The Cretaceous is marked there by the presence of *Palorbitolina* and *Orbitolina*. No specimens of the family Pfenderinidae have been found there, either in pelagic or neritic facies. In other words, the assemblages are classified as sub-Tethyan and, strictly speaking, cannot be grouped with the cyclamminid–pfenderinid type of fauna. They occurred around the northern margin of Tethys. This part of the northern Tethys was characterized by a mixed fauna of boundary (adjoining) provinces and types, namely abundant nodosariids, epistominids, lituolids (with a simple agglutinated wall), ataxophragmiids, and others. These forms coexisted with the lituolids with

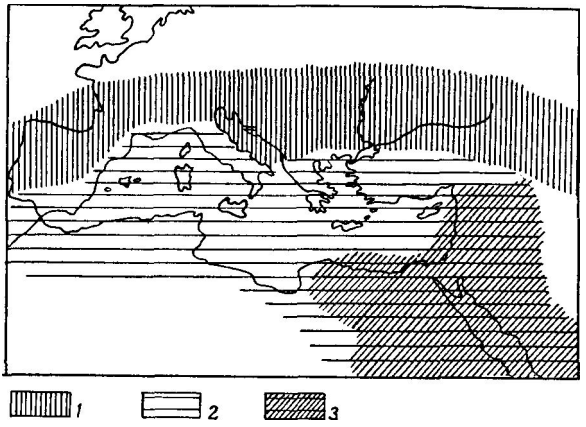

FIGURE 6.1 Sketch paleobiogeographical map of the Mediterranean realm for the Middle to the Upper Jurassic as determined using foraminifera. 1 Europen-Caucasian province; 2 Africa-Mediterranean province; 3 Arabian subprovince.

a structurally complex test architecture (alveolar wall), typical of species from the tropical Tethys.

Nikolov (1987) has reported the presence of so-called "boreal immigrants", not just among foraminifera but also among molluscs. The Tethyan basins also contained calpionellids, which were very abundant and diverse in Western and south-western Europe and less common in the basins of the Crimea and the Caucasus.

The above-mentioned part of the Mediterranean realm covered the European–Caucasian province (Nikolov, 1987), including south-western Europe and the Crimea–Caucasian region (Fig. 6.1).

The Africa–Mediterranean province extended roughly east–west, to the south of the European–Caucasian province (Gorbachik and Kuznetsova, 1991). The palaeobiochore is recognized from a very high level of foraminiferal endemism, mainly made up by tropical forms. The subdivision of the Mediterranean realm into provinces began in the mid-Jurassic and can be traced throughout the late Jurassic and early Cretaceous. Obviously, the boundaries between the palaeobiochores were not fixed, but their general position and feature remained relatively stable.

Some parts of the basins were isolated during parts of the Jurassic and the Cretaceous. For example, in the middle and late Jurassic, the eastern Mediterranean basins, encompassing Syria, Saudi Arabia, Iraq and Iran, contained abundant tropical endemic foraminifera, including the genera *Praekurnubia*, *Kurnubia*, *Palaeopfenderina*, *Kilianina*, *Meyendorffina*, *Timidonella*, *Haurania*, *Amijiella*, *Limognella*, *Redmondoides*, *Riyadhella*, *Riyadhoides*, *Pseudo-*

marssonella, *Paravalvulina*, *Paracoskinolina*, *Steinekella*, *Sanderella*, *Bramkampella* and *Dhrumella*. Along with the above-listed tropical forms, subtropical genera were very common, for example *Labyrinthina*, *Nautiloculina*, *Pseudocylammina*, *Everticyclammina*, *Mesoendothyra* and *Protopeneroplis*, accompanied by rare planktonic foraminifera of the genera *Globuligerina* and *Conoglobigerina*. The assemblages also contain abundant nodosariids and epistominids of the boreal–cosmopolitan type.

Figure 4.2 shows the stratigraphic ranges of foraminiferal genera from the tropical and subtropical faunas. Thirty-three out of 104 genera in the Jurassic of the eastern Mediterranean are of the above type. It is noteworthy that almost all the tropical endemics appeared in middle Jurassic times and that most of them ceased to evolve by the onset of the late Jurassic. They comprise the following genera: *Timidonella*, *Palaeopfenderina*, *Sanderalla*, *Dhrumella*, *Haurania*, *Amijiella*, *Praekurnubia*, *Meyendorffina*, *Redmondoids*, *Riyadhella* and *Pseudomarssonella*. Some of the genera that appeared in the middle Jurassic continued into the late Jurassic and their numbers of species and the density of particular populations increased in the late Jurassic. This holds true for most members of the family Cyclamminidae: e.g. the genera *Pseudocyclammina*, *Everticyclammina* and *Rectocyclammina*.

The early late Jurassic (Oxfordian) marked the appearance of some new genera (see Fig. 4.2) that evolved during the Jurassic and the early Cretaceous. From their palaeobiogeographical ranges, they can be classified with the subtropical fauna, since their ranges are wider than those of the above-listed genera and embrace not only the central part of Tethys, but also its northern margin (the Crimea and Caucasia).

6.3 CONCLUSIONS

Analysis of the geographical ranges of foraminifera inhabiting the Jurassic Mediterranean basins of Tethys implies the following: the group studied consists of 26 genera, of which 15 and 11 genera can be classified as tropical and subtropical benthonic foraminiferal fauna, respectively. The geographical ranges of tropical types are confined to the African–Mediterranean province, but the ranges of subtropical genera extend beyond its confines, also encompassing the European–Caucasian province (Fig. 4.7). In the Jurassic, the ranges of 20 foraminiferal genera, 16 of which are of the tropical type, were confined to North Africa (Morocco and Algeria). In south-western Europe (southern France, Spain, Italy and Greece), 19 genera were reported from the Jurassic. The ratio of tropical to subtropical genera is 10:9. The highest concentration of tropical genera was recorded in the eastern Mediterranean (Syria, Saudi Arabia, Iraq and Iran), where

we can see a complete overlap of the geographical ranges of all the 26 genera whose ranges were studied.

The endemism of the Jurassic communities, their taxonomic diversity, and the high density of populations enable us to recognize the eastern Mediterranean as a separate Arabian subprovince of the Africa–Mediterranean province, which existed throughout the middle and late Jurassic (Gorbachik and Kuznetsova, 1991). The foregoing suggests that in Jurassic times the basins were centres for the generation and dispersal of benthonic Tethyan foraminifera, migrating in a roughly west–east direction within south-western Europe, the Crimea–Caucasian region and towards the north and north-west of the African continent.

The recognition of the above-mentioned palaeobiochores containing tropical and subtropical faunas, supports the position of the equator, inferred from palaeomagnetic data, as passing along the northern coast of the African continent in Jurassic and early Cretaceous times (Monin and Zonenshain, 1987).

CHAPTER 7
SYSTEMATIC PALAEONTOLOGY OF THE FORAMINIFERA

7.1 INTRODUCTION

Several different classification schemes are currently used by micropalaeontologists, the most popular being that of the American researchers, Loeblich and Tappan (1964, 1988) who believe that foraminifera constitute an order of their own. This concept was first proposed in 1964, and has not been altered since. However, as mentioned recently by Jenkins (1990), it is not universally agreed upon, and neither is it indisputable.

Other micropalaeontologists have assigned forminifera to the higher taxonomic rank of subclass (Fursenko, 1958), or subphylum (Mikhalevich, 1980). In 1990, Maslakova proposed the rank of class for the Foraminiferida within the phylum Sarcodina based on new and pre-existing data. We support her classification, which is borne out by ontogenetic and phylogenetic studies as well as geochronological and ecological criteria. It is also important that this classification provides a fairly wide "taxonomic space", incorporating the taxonomic categories of subclasses, orders and superfamilies. Loeblich and Tappan's classification, which assigns the rank of order to the Foraminiferida, has led to very large and, in some cases, cumbersome suborders and superfamilies.

Following on from the above, we have used Maslakova's (1990) system for the higher taxa, supplemented in some cases by our own conclusions and information taken from other publications.

Our classification at the family and generic level, and type designation, mainly follows that of Loeblich and Tappan (1988). The classification of the Jurassic and early Cretaceous superfamilies Lituolacea and Textularicacea was refined, using new evidence from Septfontaine (1988) and Banner *et al. (1991).*

7.2 DESCRIPTION OF GENERA AND SPECIES OF FORAMINIFERA

The description of genera and species is based only on their reference to taxa of a family group.

Foraminiferal taxonomy uses a generally accepted nomenclature. The morphological terminology is taken from several different monographs and from the glossary of *Introduction to the Study of Foraminifera*, (Subbotina *et al.*, 1981). The nomenclature for wall structure and texture was devised by Rauzer-Chernoussova and Gerke (1971), and that for large foraminifera with complex test structure was described by Hottinger (1967), and several other authors.

All illustrated specimens and additional unfigured ones are deposited at the Geological Institute of the Russian Academy of Sciences, Moscow, Russia.

The following abbreviations for measurements of figured specimens are used for:

elongate tests: L, length; B, breadth; B_a, breadth of coiled portion; B_u, breadth of uncoiled portion; H, height; H_s, height of coiled portion; H_u, height of uncoiled portion;

planispiral tests: D, greatest diameter; d, smallest diameter; H, height; a height of notch at the base of the apertural surface is characterized by lateral side (h_{al}) and median height (h_{am}) of the apertural surface;

conispiral tests: L, length; B, breadth of greatest (D) and smallest (d) diameters;

trochospiral tests: D_1 and D_2, diameters; H, height; height of ventral (h_v) and dorsal (h_d) sides.

As regards measurements that can characterize the proportions of the test they are as follows: $D : d$, index of elongation; $d : H$ and $H : d$, index of flatness for planispiral and trochospiral test, and $L : B$ and $B : H$ for elongate and uncoiled tests. The symbol $\angle$ denotes angle of slope in Citharina chambers.

Subfamily **Rhizamminiae** Rhumbler, 1895

Genus *Rhizammina* Brady, 1879

Type species. *Rhizammina algaeformis* Brady, 1879. Recent; Pacific Ocean. Silurian to Recent; cosmopolitan.

Rhizammina rudis Kaptarenko

Plate I, fig. 1

Rhizammina rudis: Kaptarenko-Chernousova, 1959, p.22, pl.I, fig. 1.

Specimen GIN RAN 4656/18 from the Middle Jurassic (Callovian), Coastal Mountains, Dahr al Killin village, near the town of Misyaf, Syria.

Material. Six tests.
Dimensions (mm). *L* 2.5, *D* 0.5
Distribution and age. Toarcian of the Dnieper–Donets Basin; Callovian of Syria.

Family **Tolypamminidae** Cushman, 1928
Subfamily **Lituotubinae** Loeblich et Tappan, 1984
Genus *Lituotuba* Rhumbler, 1895

Type species. *Trochammina lituiformis* Brady, 1879. Recent; Gulf of Mexico.
Carboniferous to Recent; cosmopolitan.

Lituotuba nodus Kosyreva
Plate I, fig. 2

Lituotuba nodus: Kosyreva, in Khabarova, 1959, p.474, pl. I, fig. 3.
Specimen GIN RAN 4656/19 from the Middle Jurassic (Callovian), Jebel Shekif, Anti-Lebanon, Damascus-Beirut Highway, 46km from Damascus Wadi al Karn, Syria.
Material. Three tests.
Dimensions (mm). *D* 0.6–0.7, *H* 0.4.
Distribution and age. Lower Callovian of the Saratov Volga area, Central Russia; Callovian of Syria.

Family **Reophacidae** Cushman, 1927
Subfamily **Reophacidae** Cushman, 1910
Genus *Reophax* de Montfort, 1808

Type species. *Reophax scorpiurus* de Montfort, 1808. Recent; Gulf of Mexico.
Carboniferous to Recent; cosmopolitan.

Reophax barnardi Said et Barakat
Plate I, fig. 3 a, b

Reophax barnardi: Said et Barakat, 1958, p. 238, pl. 4, fig. 7; Dieni et Massari, 1966, p. 86, pl. I figs. 3, 4.
Specimen GIN RAN 4656/20 from the Lower Cretaceous (Barremian to lower Aptian), Al Ghab rift zone, Coastal Mountains, Al Bustan village, Syria.
Material. Over 20 tests.
Dimensions (mm). *L* 1.0–1.1, $B \geqslant 0.6$, *H* 0.5.
Distribution and age. Kimmeridgian of Sinai, Egypt; upper Valanginian of Sardinia, Italy; Barremian to lower Aptian of Syria.

Reophax horridus (Schwager)

Plate I, fig. 5 a, b

Haplostiche horrida: Schwager, 1865, p. 92, pl. 2, fig. 2.
Reophax horridus: Seibold et Seibold, 1956, p. 104, fig. 3, pl. 7, fig. 12; Lutze, 1960, p. 436, pl. 26, figs. 13, 14; Gordon, 1967, p. 448, pl. I, figs. 6–8; Oesterle, 1968, p. 718; Groiss, 1970, p. 48.
non Reophax horridus: Dieni et Massari, 1966, p. 86, pl. I, figs. 5–7.
Specimen GIN RAN 4656/22 from the Upper Jurassic (Oxfordian), Jebel Shekif, Anti-Lebanon, Damascus-Beirut Highway, 46km from Damascus, Wadi al Karn, Syria.
Material. About 50 tests.
Dimensions (mm). *L* 1.56, *B* 0.5, *H* 0.56.
Distribution and age. Callovian and Oxfordian of western Germany; Callovian of Scotland; Oxfordian of Syria.

Reophax hounstoutensis Lloyd

Plate I, figs. 4 a, b

Reophax hounstoutensis: Lloyd, 1959, p. 308, pl. 54, fig. 7, text fig. 5.
Specimen GIN RAN 4656/23 from the Upper Jurassic (Kimmeridgian), Jebel Shekif, Anti-Lebanon, Damascus-Beirut Highway, 46 km from Damascus, Wadi al Karn, Syria.
Material. Six tests.
Dimensions (mm). *L* 1.40, *B* 0.76, *H* 0.80.
Distribution and age. Lower Tithonian of the Dorset coast, England; Kimmeridgian of Syria.

Reophax folkestoniensis Chapman

Plate I, fig. 6 a, b

Reophax folkestoniensis: Chapman, 1892, p. 321, pl. 5, fig. 6 (*fide Catalogue of Foraminifera*, 1940).
Specimen GIN RAN 4656/21 from the Lower Cretaceous (Barremian to lower Aptian), Al Ghab rift zone, Coastal Mountains, near Al Bustan village, Syria.
Material. About 50 tests.
Dimensions (mm). *L* 0.94, *B* $\leqslant$ 0.36, *H* 0.32.
Distribution and age. Lower Cretaceous (Gault) of Folkestone, England; Barremian to lower Aptian of Syria.

Reophax sterkii Haeusler

Plate I, fig. 7

Reophax sterkii: Haeusler, 1890, pl. 3, fig. 23; Lloyd, 1959, p. 307, pl. 54, fig. 6; Gordon, 1967, p. 449, pl. I, figs. 16–17; Oesterle, 1968, p. 720, text figs. 14, 15 f–i; Groiss, 1970, p. 47; Dain, 1972, pl. VI, fig. 2.

Specimen GIN RAN 4656/24 from the Upper Jurassic (Oxfordian), Jebel Shekif, Anti-Lebanon, Rowda village, near the town of Zabadani, Syria.

Material. About 20 tests.

Dimensions (mm). *L* 0.86, *B* 0.32, *H* 0.3.

Distribution and age. Callovian of Scotland, Oxfordian of Switzerland, Syria; lower Kimmeridgian of England and near-polar Urals.

Reophax ex gr. toarcensis Makarjeva

Plate I, fig. 8

Reophax toarcensis: Makarieva, 1971, p. 33, pl. I, fig. 7, pl. IX, fig. 1.

Specimen GIN RAN 4656/26 from the Upper Jurassic (Oxfordian), Jebel Shekif, Anti-Lebanon, Damascus-Beirut Highway 46 km from Damascus, Wadi al Karn, Syria.

Material. Twelve tests.

Dimensions (mm). *L* 1.72, *B* 0.82, *H* 0.78.

Differs from *Reophax toarciensis* Makarjeva from Lower Jurrasic (Toarcian) deposits of the Northern Caucasus in the greater test size and the smaller size of the agglutinated grains in the test wall.

Distribution and age. Oxfordian of Syria.

Reophax metensis Franke

Plate I, fig. 9

Reophax metensis: Franke, 1936, p. 19, pl. I, fig. 17 (*fide Catalogue of Foraminifera*, 1940); Bartenstein et Brand, 1937, p. 133, pl. 10, fig. 8, pl. 13, figs. 1–4; Kaptarenko-Chernousova, 1959, p. 28, pl. 5, figs. 3 and 4.

Specimen GIN RAN 4656/25 from the Middle Jurassic (upper Bathonian), Coastal Mountains, Wadi Jahannam, near the town of Querdaha, Syria.

Material. Ten tests.

Dimensions (mm). *L* 1.32, breadth at the site of the final chamber $\leqslant$ 0.56.

Distribution and age. Lower to Middle Jurassic of western Germany; Callovian of the Ukraine; Bathonian of Syria.

Family **Haplophragmoididae** Maync, 1952

Subfamily **Haplophragmoidinae** Maync, 1952

Genus *Haplophragmoides* Cushman, 1910

Type species. *Nonionina canariensis* d'Orbigny, 1839. Recent; Canary Islands. Cretaceous to Holocene; cosmopolitan.

Haplophragmoides* cf. *rotundatus Barnard

Plate I, fig. 11 a, b

Haplophragmoides cf. *rotundatus*: Barnard, 1953, p. 185, fig. A, 1a, 1b; Oesterle, 1968, p. 733.

Specimen GIN RAN 4656/27 from the Upper Jurassic (Oxfordian), Jebel Shekif, Anti-Lebanon, Rowda, near the town of Zabadani, Syria.

Material. Four tests.

Dimensions (mm). *D* 0.32, *d* 0.30, *H* 0.22.

Distribution and age. Oxfordian of Syria.

Haplophragmoides sp. 1

Plate III, fig. 3 a, b

Specimen GIN RAN 4656/40 from the Upper Jurassic (Oxfordian), Al Ghab rift zone, Coastal Mountains, Ain Khlakem village, Syria.

Material. Six tests.

Description. Test large, close-coiled, involute, smooth periphery sandal-shaped in end view, with the greatest thickness at the terminal chamber; seven to eight chambers in the final whorl, septal sutures invisible externally; umbilicus deep; apertural surface high, broadly triangular; aperture basal, slit-like; wall agglutinated, fine-to medium grained.

Dimensions (mm). *D* 0.96, *d* 0.86, *H* 0.40.

In their structure, the tests of *Haplophragmoides* sp. 1 are somewhat similar in structure to those of *Haplophragmoides latidorsatus* (Brönnimann) from the lower Tithonian of England (Lloyd, 1959, pl. 54, fig. 23); however, our specimens are three times larger and have a greater height of coil. *Haplophragmoides nonioninoides* (Reuss) from the Barremian of the central Volga area (Myatlyuk, 1939, pl. I, figs. 1–3) differs in the greater number of chambers (up to 11) in the final whorl and the depressed septal sutures.

Distribution and age. Oxfordian of Syria.

Genus *Evolutinella* Mjatliuk, 1971

Type species. *Evolutinella subevoluta* Nikitina et Mjatliuk, *in* Myatlyuk, 1971. Upper Aptian; southern Emba, Kazakhstan.

Jurassic to Cretaceous; cosmopolitan.

Evolutinella sp. 1

Plate II, fig. 1 a, b

Specimen GIN RAN 4656/28 from the Upper Jurassic (Oxfordian), Coastal Mountains, Bekraka village near the town of Misyaf, Syria.

Material. Five tests.

Description. Test large, rounded, planispiral, semi-evolute, slightly wavy in outline; 10–11 narrow triangular chambers in the final whorl; septal sutures slightly depressed, indistinct; periphery rounded; aperture rounded-triangular; wall agglutinated, medium grained.

Dimensions (mm). *D* 1.24, *d* 1.06.

Distribution and age. Oxfordian of Syria.

Evolutinella evoluta (Alekseeva)

Plate I, fig. 10 a

Haplophragmoides evolutus: Alekseeva, 1963, p. 19, pl. I, fig. 8.

Evolutinella evoluta: Myatlyuk, 1988, p. 42, pl. 5, fig. 7.

Specimen GIN RAN 4656/29 from the Lower Cretaceous (Barremian to lower Aptian), Al Ghab rift zone, Coastal Mountains, Al Bustan village, Syria.

Material. Nine tests.

Dimensions (mm). *D* 0.52, *d* 0.48, *H* 0.20.

Distribution and age. Aptian of western Turkmenistan, Mangyshlak, Ustyurt, Caspian lowlands; Barremian to lower Aptian of Syria.

Family **Lituolidae** de Blainville, 1925

Subfamily **Ammomarginulininae** Podobina, 1978

Genus *Ammobaculites* Cushman, 1910

Type species. *Spirolina agglutinans* d'Orbigny, 1846. Miocene; Austria.

Carboniferous to Holocene; cosmopolitan.

Ammobaculites coprolithiformis (Schwager)

Plate II, fig. 3 a, b

Haplophragmium coprolithiforme: Schwager, *in* Waagen, 1867, p. 654, pl. 34, fig. 3 (*fide Catalogue of Foraminifera*, 1940).

Ammobaculites ex gr. coprolithiformis: Pyatkova and Permyakova, 1978, p. 20, pl. 4, fig. 1.

Ammobaculites coprolithiformis: Bielecka et Pozaryski, 1954, p. 27, pl. III, 6; Gordon, 1967, p. 449, pl. I, fig. 18.

Specimen GIN RAN 4656/31 from the Upper Jurassic (Oxfordian), Jebel Shekif, Anti-Lebanon, Rowda village near the town of Zabadani, Syria.

Material. Over 30 tests.
Dimensions (mm). *L* 0.80–1.04, B_s 0.30–0.50, B_u 0.34–0.38, *H* 0.28–0.40.
Distribution and age. Bajocian to Kimmeridgian of Europe; Oxfordian of Syria.

Ammobaculites hagni Bhalla et Abbas

Plate II, figs. 5 a, b, 6 a, b

Ammobaculites hagni: Bhalla et Abbas, 1978, p. 171, pl. 3, figs. 1–3; Kuznetsova et Gorbachik, 1985, p. 78, pl. I, fig. 9.
Specimens GIN RAN 4656/32 and 4656/223 from the Upper Jurassic (Oxfordian), Al Ghab rift zone, Coastal Mountains, Ain Khlakem village, Syria.
Material. 40 tests.
Dimensions (mm). *L* 0.9–1.56, B_s 0.52–0.64, *H* 0.3–0.54.
The species is distinguished in assemblages by its characteristically large test with a small coiled portion and large chambers in the uncoiled portion.
Distribution and age. Oxfordian of Syria, Egypt; Tithonian of the Crimea.

Ammobaculites sequanus Mohler

Plate III, fig. 1 a, b

Ammobaculites coprolithiformis var. *sequana*: Mohler, 1938, p. 11, pl. 3, figs. 1, 2; Bielecka et Pozaryski, 1954, p. 28, pl. III, 7.
Specimen GIN RAN 4656/33 from the Upper Jurassic (Oxfordian), Jebel Shekif, Anti-Lebanon, Rowda village near the town of Zabadani, Syria.
Material. About 20 tests.
Dimensions (mm). *L* 0.78, B_s 0.38, B_u (of final chamber) 0.28.
Distribution and age. Uppermost Oxfordian and Kimmeridgian of Switzerland and Poland; Oxfordian of Syria.

Ammobaculites suprajurassicus (Schwager)

Plate III, fig. 2 a, b

Haplophragmium suprajurassicum: Schwager, 1865, p. 92, pl. 2, fig. 1 (*fide Catalogue of Foraminifera*, 1940).
Ammobaculites suprajurassicus: Seibold et Seibold, 1956, p. 105, fig. 3, pl. 7, fig. 16; Lutze, 1960, p. 442, pl. 26, fig. 10, pl. 27, fig. 4; Winter, 1970, p. 8, pl. 2, fig. 5 and figs. 36, 37.
Specimen GIN RAN 4656/34 from the Upper Jurassic (Oxfordian), Jebel Shekif, Anti-Lebanon village Rowda, near the town of Zabadani, Syria.
Material. About 30 tests.
Dimensions (mm). *L* 0.44, *B* 0.30, *H* 0.14.
Distribution and age. Oxfordian and lower Kimmeridgian of Germany; Oxfordian of Syria.

Ammobaculites tobolskensis Levina

Plate III, figs. 4 a, b, 5

Ammobaculites tobolskensis Levina in Dain, 1972, p. 61, pl. XV, figs. 3–7.
Specimens GIN RAN 4656/35 and 4656/224 from the Upper Jurassic (Oxfordian), Jebel Shekif, Anti-Lebanon, Damascus-Beirut Highway 46km from Damascus, Wadi al Karn, Syria.
Material. 18 tests.
Dimensions (mm). *L* 1.84, B_s 0.96, B_u 0.76.
Considerable intraspecific variation, namely, the absence of the uniserial part and a variation in the number of chambers is noted.
Distribution and age. Lower Oxfordian of western Siberia; Oxfordian of Syria.

Ammobaculites sp. 5

Plate III, fig. 7 a, b

Specimen GIN RAN 4656/36 from the Upper Jurassic (Tithonian), Jebel Shekif, Anti-Lebanon, Rowda village near the town of Zabadani, Syria.
Material. 16 tests.
Description. Test large, elongate, oval in section, lobulate in outline; early coiled part, formed by 6–7 subtriangular chambers, comprises half the length of the test; the later uncoiled part consists of two high chambers, irregularly rectangular in shape: it tapers somewhat at the base. Tests with no uniserial part have been encountered. Septal sutures slightly depressed; periphery rounded; apertural surface obtusely truncated at the tapering end of the final chamber; aperture terminal, rounded; wall agglutinated, medium grained.
Dimensions (mm). *L* 1.26, B_s 0.68, B_u 0.44, H_s (greatest in the coiled part) 0.36.

Differs from the similar *Ammobaculites haplophragmioides* Furssenko et Poljenova (Fursenko et Polenova, 1950, pl. I, figs. 2, 3) from the lower Volgian deposits of the Inder Lake area, in the lenticular, biconvex rather than compressed, cross-section of the coiled portion and, correspondingly, in lacking a depressed umbilicus.
Distribution and age. Tithonian of Syria.

Genus *Ammomarginulina* Wiesner, 1931

Type species. *Ammomarginulina ensis* Wiesner, 1931. Recent; Antarctica.
Jurassic to Recent; cosmopolitan.

Ammomarginulina subcretacea (Cushman et Alexander)

Plate II, fig. 4a, b

Ammobaculites subcretacea: Cushman et Alexander, 1930, p. 6, pl. 2, figs. 9–10.
Ammobaculites suprajurassicus (Schwager); Dieni et Massari, 1966, p. 88, pl. I, figs. 10–11.

Specimen GIN RAN 4656/38 from the Lower Cretaceous (Barremian to lower Aptian), Al Ghab rift zone, Coastal Mountains, Al Bustan, Syria.
Material. Seven tests.
Dimensions (mm). L 0.8, B_s 0.40, B_u upto 0.28, H_u (greatest in the final chamber) 0.24.
Distribution and age. Lower Cretaceous (Valanginian to Albian) of Europe and North America: Barremian to lower Aptian of Syria.

Genus *Kutsevella* Dain, 1978

Type species. *Ammobaculites labythnangensis* Dain, 1972. Upper Jurassic; Polar Urals.
Upper Jurasssic to Eocene of Central Russia, western Siberia, eastern Mediterranean.

Kutsevella albustanensis K. Kuznetsova et Grigelis, sp. nov.

Plate II, fig. 2

"Albustanensis" (Latin) from Al Bustan, the locality.
Holotype GIN RAN 4656/30 from the Lower Cretaceous (Barremian to lower Aptian), Al Ghab rift zone, Coastal Mountains, Al Bustan village, Syria.
Material. Ten tests.
Description. Test very large, elongate; early part coiled, later part uncoiled; section rounded, outline uneven, lobulate; in the coiled part: chambers triangular, septal sutures flush; in the uncoiled part: one or two trapeziform, broad chambers, sutures oblique, depressed; periphery rounded; aperture terminal, rounded on a small protuberance; wall agglutinated, with sand grains of different sizes, including large grains and intact tests.
Dimensions (mm). L 2.84, $B_s \leqslant 1.40$, B_u 1.20.
Distribution and age. Barremian to lower Aptian of Syria.

Kutsevella ex gr. infravolgensis (Mjatliuk)

Plate III, fig. 6a, b; Plate IV, fig. 1a, b

Ammobaculites infravolgensis: Myatlyuk, 1939, p. 45, pl. II, figs. 17, 18; Dain et Kuznetsova, 1976, p. 39, pl. I, figs. 8, 9; Pyatkova et Permyakova, 1978, p. 21, fig. 7.

Specimens GIN RAN 4656/39 and 4656/226 from the Lower Cretaceous (Barremian to lower Aptian), Al Ghab rift zone, Coastal Mountains, Al Bustan village, Syria.

Material. About 40 tests.

Dimensions (mm). L 2.04, B_s 1.18, B_u 1.06, $H_s \leqslant 0.70$, $H_u \leqslant 0.50$.

Distribution and age. Barremian to lower Aptian of Syria.

Subfamily **Flamillammininae** Podobina, 1978

Genus *Triplasia* Reuss, 1854

Type species. *Triplasia murchisoni* Reuss, 1854. Upper Cretaceous; Austria.

Jurassic to Holocene; cosmopolitan.

Triplasia elegans (Mjatliuk)

Plate VII, fig. 1a, b

Frankeina elegans: Myatlyuk, 1939, p. 48, pl. II, fig. 26.

Triplasia elegans: Hanzlikova, 1965, p. 61, pl. II, fig. 3, 5; Dain et Kuznetsova, 1976, p. 44, pl. III, fig. 1.

Specimen GIN RAN 4656/41 from the Upper Jurassic (Kimmeridgian), Jebel Shekif, Anti-Lebanon, Damascus-Beirut Highway 46km from Damascus, Wadi al Karn, Syria.

Material. Six tests.

Dimensions (mm). L 2.08, B 0.82.

The figured specimen is probably macrospheric, thus explaining the lack of a well-defined coiled part.

Distribution and age. Volgian (Dorsoplanites panderi Beds) of the lower and middle Volga area; Tithonian (Klentnice Beds) of Czechoslovakia; Kimmeridgian of Syria.

Subfamily **Lituolinae** de Blainville, 1825

Genus *Lituola* Lamarck, 1804

Type species. *Lituolites nautiloidea* Lamarck, 1804. Upper Cretaceous; France.

Triassic to Recent; cosmopolitan.

Lituola* aff. *compressa Cushman et Glažewski

Plate IV, figs. 2, 4, 5a, b

Lituola compressa: Cushman and Glažewski, 1949, p. 5, pl. I, figs. 8–10; Pyatkova et Permyakova, 1978, p. 23, pl. 5, figs. 5, 6.

Specimens GIN RAN 4656/42 and 4656/262 from the Lower Cretaceous (Barremian to lower Aptian), Al Ghab rift zone, Coastal Mountains, Al Bustan village, Syria.

Material. Nine tests.

Dimensions (mm). L 0.90–1.12, B_s upto 0.60, B_u upto 0.24, H_s 0.12 H_u upto 0.22.

Our specimens are similar to *Lituola compressa* from the Kimmeridgian-Portlandian of Podolia, Ukraine, but differ in the well-developed coiled part and in the tapering (rather than broadening) uniserial part in plan view.

Distribution and age. Kimmeridgian to Tithonian of Podolia, Ukraine; Barremian to lower Aptian of Syria.

Lituola podolica Cushman and Glažewski

Plate IV, fig. 3

Lituola podolica: Cushman et Glažewski, 1949, p. 4, pl. I, figs. 4, 5; Pyatkova et Permyakova, 1978, p. 24, pl. 5, figs. 7, 8.

Specimen GIN RAN 4656/43 from the Upper Jurassic (Oxfordian), Jebel Shekif, Anti-Lebanon, Rowda village, near the town of Zabadani, Syria.

Material. Seven tests.

Dimensions (mm). L 0.74. B_s 0.26, B_u 0.16–0.20, H_u 0.18, H_s 0.12–0.14.

Distribution and age. Kimmeridgian to Tithonian (Nizhnev Beds) of Podolia, Ukraine; Oxfordian of Syria.

Family **Nautiloculinidae** Loeblich et Tappan, 1985

Genus *Nautiloculina* Mohler, 1938

Type species. *Nautiloculina oolithica* Mohler, 1938. Upper Jurassic (Rauracian to Sequanian); Switzerland.

Jurassic to Lower Cretaceous of Europe, eastern Mediterranean.

Nautiloculina oolithica Mohler

Plate VII, figs. 2–6

Nautiloculina oolithica: Mohler, 1938, p. 14, pl. 4, figs. 1–3.

Specimens GIN RAN 4656/239 (fig. 2) from the Oxfordian, Sindianeh village, Syria; 4656/240 (fig. 3) from the Kimmeridgian, Anti-Lebanon, Wadi al Karn; 4656/241 (fig. 4) from the Callovian, Coastal Mountains, Dahr Al Killin village;

4656/242 (fig. 5) from the Oxfordian, Coastal Mountains, Ain Khlakem village; 4656/243 (fig. 6) from the Barremian to lower Aptian, Coastal Mountains, Al Bustan.

Material. Over 200 tests.

Dimensions (mm). *D* 0.4–0.5, *d* 0.3–0.39.

Distribution and age. Jurassic to Lower Cretaceous of Europe, eastern Mediterranean; Callovian to Tithonian, Barremian to lower Aptian of Syria.

Nautiloculina sp. 1

Plate VII, fig. 7; Plate XX, figs. 17, 19

Specimens GIN RAN 4656/224 (fig. 7), 4656/245, 4656/246, 4656/263 (figs. 17–19) from the Upper Jurassic (Tithonian), Anti-Lebanon, Wadi al Karn, Syria.

Material. Ten tests.

Description. Test small, planispiral, lenticular, consists of 5–6 whorls of a coil, with 12–15 low, almost square, chambers in the final whorl; sutures straight, distinct; wall of microgranular calcite, very finely agglutinated; aperture narrow interiomarginal.

Dimensions (mm). *D* 0.34–0.46, *d* 0.3–0.45.

Remarks and comparison. Differs from typical *N. oolithica* Mohler specimens in the more inflated test and the generally smaller size. Differs from *N. bronnimanni* Arnaud-Vanneau et Peybernes from the lower Aptian (Bedoulian) of the French–Spanish Pyrenees in its smaller test size, scalloped periphery and the character of the sutures, which are thinner and more distinct in the species described.

Distribution and age. Tithonian of Syria.

Family **Ammosphaeroidinidae** Cushman, 1927

Subfamily **Recurvoidinae** Alekseitchik, 1973

Genus *Recurvoides* Earland, 1934

Type species. *Recurvoides contortus* Earland, 1934. Recent; Antarctica.

Jurassic to Recent; cosmopolitan.

Recurvoides concavus (Bartenstein et Brand)

Plate IV, fig. 7

Haplophragmoides concavus: Bartenstein, et Brand, 1951, p. 268, pl. I, figs. 24, 25.

Specimen GIN RAN 4656/45 from the Lower Cretaecous (Barremian to lower Aptian), Al Ghab rift zone, Coastal Mountains, Al Bustan, Syria.

Material. About 20 tests.

Dimensions (mm). *D* 0.58, *d* 0.48, *H* 0.3.

Distribution and age. Barremian to lower Aptian of Syria.

Family **Haplophragmiidae** Eimer et Fickert, 1899

Subfamily **Haplophragmiinae** Cushman, 1927

Genus *Haplophragmium* Reuss, 1860

Type species. *Spirolina aequalis* Roemer, 1841. Lower Cretaceous; western Germany.

Middle Jurassic to Cretaceous; cosmopolitan.

Haplophragmium aequale (Roemer)

Plate V, figs. 2 a, b, 3 a, b

Spirolina aequalis: Roemer, 1841, p. 98, pl. 15, fig. 27 (*fide Catalogue of Foraminifera*, 1940).

Haplophragmium aequale: Lutze, 1960, p. 438, pl. 26, figs. 1, 2, 5, 6, pl. 27. figs. 1, 2; Hanzlikova, 1965, p. 58, pl. I, figs. 1, 2.

Ammobaculites aequalis: Kaptarenko-Chernousova, 1959, p. 19, pl. 3, fig. 7.

Specimens GIN RAN 4656/46 and 4656/225 from the Upper Jurassic (Oxfordian), Jebel Shekif, Anti-Lebanon, Rowda village, near the town of Zabadani area, Syria.

Material. Over 30 tests.

Dimensions (mm). *L* 0.96–1.40, *H* 0.44–0.58.

Distribution and age. Bajocian to Barremian of Europe; Oxfordian of Syria.

Haplophragmium* ex gr. *monstratus (Dain)

Plate V, fig. 4 a, b

Orbignynoides monstratus: Dain et Kuznetsova, 1971, p. 111, pl. I, figs. 2–4; Dain et Kuznetsova, 1976, p. 45, pl. IV, figs. 1–4; Kuznetsova et Gorbachik, 1985, p. 81, pl. III, fig. 1.

Specimen GIN RAN 4656/47 from the Upper Jurassic (Oxfordian), Al Ghab rift zone, Coastal Mountains, Ain Khlakem village, Syria.

Material. Eleven tests.

Dimensions (mm). *L* 2.48, *B* 1.30, $H \leqslant 0.80$.

Differs from *Haplophragmium monstratus* (Dain) from the Kimmeridgian of the middle Volga area and the Tithonian of Crimea in its larger size, relatively more compressed test and the smaller streptospiral portion.

Distribution and age. Oxfordian of Syria.

Haplophragmium subaequale (Mjatliuk)

Plate V, fig. 1 a, b

Ammobaculites subaequalis: Myatlyuk, 1939, p. 44, pl. II, figs. 19, 20; Pyatkova et Permyakova, 1978, p. 22, pl. 5, fig. 12.
Haplophragmium subaequale: Lutze, 1960, p. 439, pl. 26, figs. 3, 4, 7, 9, pl. 27, fig. 3; Hanzlikova, 1965, p. 60, pl. I, figs. 3, 4, 6.
Specimen GIN RAN 4656/48 from the Upper Jurassic (Oxfordian), Jebel Shekif, Anti-Lebanon, Rowda village, near the town of Zabadani, Syria.
Material. Seven tests.
Dimensions (mm). L 1.0–1.68, B_s 0.48–0.56, B_u 0.64–0.84, H_s 0.30–0.36, H_u 0.48–0.72.
Distribution and age. Bathonian to Hauterivian of Europe; Oxfordian of Syria.

Family **Charentiidae** Loeblich et Tappan, 1985

Genus *Charentia* Neumann, 1965

Type species. *Charentia cuvillieri* Neumann, 1965 (=*Hemicyclammina praesigali* Banner, 1966, p. 216). Upper Cretaceous; France. = *Tonasia* Gorbachik, 1968, p. 71.
Upper Jurassic (Tithonian) to Cretaceous (Berriasian to Cenomanian) of France, Spain, Algeria, Egypt, Crimea, Syria and Texas, USA.

Charentia **aff.** *evoluta* (Gorbatchik)

Plate VI, fig. 4 a, b

Specimen GIN RAN 4656/4 from the Lower Cretaceous (Neocomian), Coastal Mountains, Al Bustan, Syria.
Material. Ten well-preserved tests.
Description. Test large, dimorphic, laterally compressed asymmetric; the transverse section displays a twisting of the axis in the uncoiled portion of the test; 16–19 chambers in the final whorl of the coiled portion; the coiled part consists of four to six broad, low, curved chambers, irregularly quadrangular in shape; periphery subacute, rounded; aperture terminal, slit like.
Dimensions (mm) of. the type specimen L 2.1, B 1.4, H 0.84; other tests L 1.92–2.1, B 1.2–1.4, H 0.82–0.86.
Comparison. Differs from *Charentia evoluta* (Gorbatchik) in the much larger size of the test and the more-developed uncoiled portion.
Distriubiton and age. Neocomian of Syria.

Charentia arabica Tobolina, K. Kuznetsova et Grigelis sp. nov.

Plate VI, fig. 5 a, b

Holotype GIN RAN 4656/5 from the Upper Jurassic (Oxfordian), Coastal Mountains, Ain Khlakem, Syria.

Material. Twelve well-preserved tests.

Description. Test medium sized, strongly compressed, poorly assymmetrical, tending to uncoil; 15–17 broad, low chambers in the final whorl, very gradually increasing in size, periphery slightly crenulated in outline; aperture a narrow slit, terminal; wall of fine-grained agglutinated material.

Dimensions (mm) of. the holotype *L* 1.6, *B* 1.2, *H* 0.32; other tests *L* 1.5–1.8, *B* 1.1–1.3, *H* 0.3–0.34.

Comparison. Differs from *Charentia evoluta* (Grobatchik) in the less asymmetrical and more compressed test, and the smaller size of the chambers, which are also fewer in number in the coiled and uncoiled parts.

Distribution and age. Oxfordian of Syria.

Charentia evoluta (Gorbatchik)

Plate VI, fig. 6 a, b

Tonasia evoluta: Gorbachik, 1968, p. 8, pl. 2, figs. 1–5.

Charentia evoluta: Plotnikova, 1979, p. 17, pl. 3, fig. 6; Kuznetsova and Gorbachik, 1985, p. 82, pl. III, figs. 5, 6.

Specimen GIN RAN 4656/6 from the Upper Jurassic (Tithonian), Anti-Lebanon, Wadi al Karn, Syria.

Material. Twenty-five tests with fairly good preservation.

Dimensions (mm). *L* 1.2, *B* 0.9, *H* 0.38, *L*:*B* 1.3, *L*:*H* 3.1

Distribution and age. Tithonian to lower Neocomian of Syria; Berriasian to lower Valanginian of Crimea; Berriasian of Algeria.

Genus *Melathrokerion* Brönnimann et Conrad, 1967

Type species. *Melathrokerion valserinensis* Brönnimann et Conrad, 1967, upper Barremian; France.

Tithonian to Berriasian of the Crimea, Caucasus and France; Oxfordian to Neocomian of Syria.

***Melathrokerion* sp. 1**

Plate VI, fig. 1 a, b

Specimen GIN RAN 4656/1 from the Upper Jurassic (Oxfordian), Coastal-Mountains, Ain Khlakem village, Syria.

Material. About 20 well-preserved tests.

Description. Test medium-sized, biconvex, consisting of 2–2.5 whorls of a spiral; eight to ten chambers in the final whorl; chambers narrow, subtriangular, increasing rapidly in height in the final whorl; septal sutures slightly depressed, indistinct; periphery rounded; test outline oval; apertural surface triangular; areal aperture triangular as well.
Dimensions (mm). *D* 0.72, *d* 0.5, *H* 0.34, *D*:*d* 1.4, *D*:*H* 2.1.
Variability. Apertures of final chambers vary from triangular to half-moon shaped; the test dimensions and their ratios vary within the following limits: *D* 0.72–0.74, *d* 0.5–0.6, *H* 0.34–0.4; *D*:*d* 1.23–1.4; *D*:*H* 1.8–2.1.
Comparison. Differs from *Melathrokerion spirialis* Gorbatchik in the more elongate test outline, which is a result of a rapid increase in height of the final chambers.
Distribution and age. Oxfordian of Syria.

Melathrokerion eospirialis Gorbatchik

Plate VI, fig. 2 a, b

Melathrokerion eospirialis: Kuznetsova et Gorbachik, 1985, p. 82, pl. III, fig. 7.
Specimen GIN RAN 4656/2 from the Upper Jurassic (Tithonian), Anti-Lebanon, Wadi al Karn, Syria.
Material. About 40 tests.
Dimensions (mm). *D* 0.68, *d* 0.58, *H* 0.32; *D*:*d* 1.2; *D*:*H* 2.1.
Distribution and age. Tithonian to lower Neocomian of Syria; upper Tithonian of Crimea.

Melathrokerion spirialis Gorbatchik

Plate VI, fig. 3 a, b

Melathrokerion spirialis: Gorbachik, 1968, p. 6, pl. I, figs. 1–6; Voloshina, 1974, p. 22, pl. I, fig. 45, pl. 7–9; Plotnikova *et al.*, 1979, p. 17, pl. 3, fig. 5; Kuznetsova et Gorbachik, 1985, p. 81, pl. III, fig. 4.
Specimen GIN RAN 4656/3 from the Lower Cretaceous (Barremian to lower Aptian), Coastal Mountains, Al Bustan, Syria.
Material. Twelve tests with fairly good preservation.
Dimensions (mm). *D* 0.5, *d* 0.4, *H* 0.33; *D*:*d* 1.2, *D*:*H* 1.2.
Distribution. Tithonian to Neocomian of Syria; Berriasian of the Crimea, the Caucasus, Algeria.

Family **Hottingeritidae** Loeblich and Tappan, 1985

Genus *Alveosepta* Hottinger, 1967

Type species. *Cyclammina jaccardi* Schrödt, 1894, Upper Jurassic; Switzerland.
Upper Jurassic of Switzerland, France, Portugal, Morocco, Syria and Canada.

Alveosepta jaccardi (Schrödt)

Plate VII, fig. 11 a, b

Cyclammina jaccardi: Schrödt, 1894, p. 743, figs. 1, 2.

Pseudocyclammina jaccardi: Redmond, 1964 a, p. 406, pl. I, figs. 2–4, pl. 2, figs. 3–4.

Alveosepta jaccardi: Hottinger, 1967, pp. 79–84, pl. 15, figs. 9–13; pl. 16, fig. 1–9

Specimen GIN RAN 4656/10 from the Upper Jurassic (Oxfordian), Coastal Mountains, Ain Khlakem, Syria.

Material. About 80 well-preserved tests.

Dimensions (mm). *D* 1.3, *d* 0.98, *H* 0.35; *D*:*d* 1.3, *D*:*H* 3.1.

Distribution and age. Kimmeridgian of Saudi Arabia; Oxfordian of Syria.

Alveosepta powersi (Redmond)

Plate VIII, fig. 3 a–c, Plate XXI, figs. 6, 7

Pseudocyclammina powersi: Redmond, 1964a, p. 406, pl. I, figs. 5–8, pl. II, figs. 5–8.

Alveosepta powersi: Hottinger, 1967, p. 81, text fig. 41, 42, pl. I, fig. 15, pl. 16, fig. 20, pl. 17, figs. 1–16, pl. 18, figs. 1–12.

Alveosepta (Redmondellina) powersi: Banner et Whittaker, 1991, p. 43, pl. I, figs. 1–8.

Specimens GIN RAN 4656/13 (Plate VIII, fig. 3) from the Tithonian, Anti-Lebanon, near Rowda, Syria: 4656/49 (Plage XXI, fig. 6) from the Tithonian, Anti-Lebanon, Sad al Karn; 4656/50 (Plate XXI, fig. 7) from the Tithonian to Neocomian, Qadmous, Coastal Mountains.

Material. About 100 tests.

Dimensions (mm) of specimen 4656/13. *D* 1.0, *d* 0.8; *H* 0.3; *D*:*d* 1.2, *D*:*H* 3.1.

Distribution and age. Kimmeridgian of Saudi Arabia; Tithonian to Neocomian of Syria.

Family **Cyclamminidae** Marie, 1941

Subfamily **Choffatellinae** Maync, 1958

Genus *Pseudocyclammina* Yabe et Hanzawa, 1926

Type species. *Cyclammina lituus* Yokoyama, 1890. Upper Jurassic (Kimmeridgian); Japan.

Lower Jurassic to Upper Cretaceous of Japan, Morocco, France, Italy, Poland, the former Yugoslavia, the Crimea, and Syria.

Pseudocyclammanina maynci Hottinger

Plate VIII, fig. 1 a, b

Pseudocyclammina maynci: Hottinger, 1967, p. 59, text fig. 29.
Pseudocyclammina jaccardi: Maync, 1966, pl. II, fig. 1.
Specimen GIN RAN 4656/11 from the Upper Jurassic (Oxfordian), Coastal Mountains, Bekraka, Syria.
Material. Fifteen tests.
Dimensions (mm). *D* 2.4, *d* 1.8, *H* 0.5; *D*:*d* 1.3, *D*:*H* 4.8.
Distribution and age. Oxfordian of Syria and Israel; Middle Jurassic of Morocco.

Pseudocyclammina calloviensis Tobolina et K. Kuznetsova, sp. nov.

Plate XXI figs. 4, 5

Holotypes GIN RAN 4656/15, median section from the Middle Jurassic (Callovian), Anti-Lebanon, the Wadi al Karn, Syria: 4656/16, axial section from the Midddle Jurassic (Callovian).
Material. Eighteen tests.
Description. Test large, streptospiral in the earlier part, later planispiral, tending to uncoil, with two to two and a half whorls in the coiled portion; 15–17 curved-rectangular low chambers in the final whorl; sutures distinct, curved in the adult stage; test wall is composed of medium-grained material; sub-epidermal wall layer coarse; wall and septa similar in structure; septa are almost equal in thickness to the chamber cavity, with septal pits; aperture cribrate.
Dimensions (mm). *D* 1.6, *d* 1.2, *H* 0.4.
The degree of compression and symmetry of tests is variable.
Comparison. Differs from *Pseudocyclammina maynci* Hottinger in the number and shape of chambers.
Distribution and age. Callovian of Syria.

Genus *Choffatella* Schlumberger, 1905

Type species. *Choffatella decipiens* Schlumberger, 1905, Lower Cretaceous; Portugal.
Upper Jurassic (Kimmeridgian) to Upper Cretaceous (Cenomanian) of Western Europe, Central and South America, North Africa, central Asia, Mediterranean and Syria.

Choffatella alkarnensis Tobolina et K. Kuznetsova, sp. nov.

Plate VII, fig. 10

"alkarnensis" (Latin), from the Wadi al Karn locality where it was first found.
Holotype GIN RAN 4656/9, from the Upper Jurassic (Tithonian), Anti-Lebanon, Wadi al Karn, Syria.
Material. Over 100 tests.
Description. Test large, oval, tending to uncoil; consists of 2.5–3 whorls of coiling; total number of chambers varies from 24 to 30; chambers in lateral view, the chambers are shaped like long, narrow curved triangles, increasingly very gradually in size when added; sutures distinct, thin, curved; test outline almost even; periphery obtuse-angular; wall composed of microgranular calcite; septa simple, thick, massive, pierced with holes in median section; aperture multiple, a series of ordered round holes.
Dimensions (mm). *D* 1.4, *d* 1, *H* 0.34, *D*:*d* 1.4, *D*:*H* 3.6.
Variability. Test dimensions vary within the following limits: *D* 1.4–1.9, *d* 0.9–1.0, *H* 0.34–0.36, *D*:*H* 3.6–4.6, *D*:*d* 1.4–1.9.
Comparison. Differs from *C. decipiens* Schlumberger in the greater test size and the more curved half-moon-shaped sutures.
Distribution and age. Tithonian of Syria.

Choffatella decipiens Schlumberger

Plate IV, figs. 8, 9 a, b, 10 a, b; Plate VIII, fig. 2 a, b; Plate XXI, fig. 1

Choffatella decipiens: Schlumberger, 1905, p. 763, pl. 28, figs. 1–6; Hottinger, 1967, p. 65, text fig. 32 A–E.
Specimens GIN RAN 4656/51 (Plate IV, fig. 9) from the Barremian to lower Aptian, Coastal Mountains, Al Bustan, Syria; 4656/52 (Plate IV, fig. 10); 4656/12 (Plate VIII, fig. 2) from the Barremian to lower Aptian, Anti-Lebanon, Rowda village; 4656/57 (Plate XXI, fig. 7).
Material. About 100 tests.
Dimensions (mm) of specimen 4656/12. *D* 1.2, *d* 1, *H* 0.4, *D*:*d* 1.2, *D*:*H* 3.0.
Distribution and age. Barremian to lower Aptian of Syria and Morocco.

Subfamily **Psudochoffatellinae** Loeblich et Tappan, 1985

Genus *Dhrumella Redmond, 1965*

Type species. *Dhrumella evoluta* Redmond, 1965, upper Bajocian or Bathonian; Saudi Arabia.
Middle Jurassic of eastern Mediterranean and Near East.

Dhrumella evoluta Redmond

Plate VIII, fig. 4

Dhrumella evoluta: Redmond, 1965, p. 140, pl. 1, figs. 40–44.

Specimen GIN RAN 4656/15 from the Middle Jurassic (upper Bathonian), Coastal Mountains, Wadi Jahannam, Syria.

Material. Ten tests.

Dimensions (mm). *L* 0.6, *B* 0.4, *H* 0.2.

Distribution and age. Bathonian of Syria; upper Bajocian and Bathonian of Saudi Arabia.

Subfamily **Buccicrenatinae** Loeblich et Tappan, 1985

Genus *Everticyclammina* Redmond, 1964

Type species. *Everticyclammina hensoni*, Redmond, 1964a

= Cyclammina greigi Henson, 1948. Lower Cretaceous; Saudi Arabia.

= *Pseudobaculites,* Maync, 1965, p. 39; = *Mayncella* Banner, 1966, p. 206.

Upper Jurassic to Upper Cretaceous (Cenomanian) of Saudi Arabia, Syria, North Africa, France.

Everticyclammina virguliana (Koechlin)

Plate VII, figs. 8 a, b, 9 a, b; Plate XXI, fig. 2

Pseudocyclammina virguliana: Koechlin, 1942, pl. VI, figs. 1–7.

Everticyclammina virguliana: Hottinger, 1967, p. 84, pl. 9, figs. 10–16, text fig. 43.

Specimens GIN RAN 4656/7 (Plate VII, fig. 8), juvenile from the Oxfordian, Coastal Mountains, Ain Khlakem, Syria; 4656/8 (Plate VII, fig. 9), adult; 4656/58 (Plate XXI, fig. 2) from the Upper Jurassic (Oxfordian), Dahr Al Killin.

Material. Thirty well-preserved tests.

Dimensions (mm) of. specimen 4656/7, *L* 0.96, *B* 0.6, *H* 0.4; 4656/8 *L* 1.5, *B* 0.75, *H* 0.45.

Distribution and age. Oxfordian of Syria; Kimmeridgian, Portlandian (Tithonian) of Morocco.

Family **Hauraniidae** Septfontaine, 1988

Subfamily **Amijellinae** Septfontaine, 1988

Genus *Anchispirocyclina* Jordan et Applin, 1952.

Type species. *Anchispirocyclina henbesti* Jordan et Applin, 1952.

= *Dicyclina lusitanica* Egger, 1902. Upper Jurassic; Portugal, Upper Jurassic to Lower Cretaceous of Europe, North Africa, North America, Cuba, Crimea and Syria.

Anchispirocyclina lusitanica (Egger)

Plate IX, fig. 1 a–c; Plate XXI, fig. 3

Dicyclina lusitanica: Egger, 1902, p. 585, pl. 7, figs. 4, 11, 12, 14, pl. 8, figs. 1–4;

Anchispirocyclina lusitanica: Hottinger, 1967, p. 74, pl. 13, figs. 6–8, text fig. 37 a, b; Ascoli, 1976, pl. 6, fig. 12.

Specimens GIN RAN 4656/14 (Plate X, 1), 4656/64 (Plate XXI, fig. 3) from the Tithonian, Anti-Lebanon, Wadi al Karn, Syria.

Material. About 50 tests.

Dimensions (mm) of specimen 4656/14. *D* 2.1, *d* 2, *H* 0.6, *D*:*d* 1.05, *D*:*H* 3.5.

Distribution and age. Upper Kimmeridgian to lower Tithonian of Syria; Kimmeridgian to Portlandian of Morocco; Tithonian of Atlantic coast of Canada.

Subfamily **Hauraniinae** Septfontaine, 1988

Genus *Haurania* Henson, 1948

Type species. *Haurania deserta* Henson, 1948. Jurassic; Wadi Amiji, Iraq.

Lower to Middle Jurassic of Mediterranean, Near East, North Africa and China.

Haurania deserta Henson

Plate XII, figs. 13, 14, Plate XIX, fig. 13

Haurania deserta: Henson, 1948, pl. 11, pl. XV, figs. 1–4; 1967, p. 51, pl. 8, figs. 22–26.

Haurania amiji: Maync, 1959, p. 371, pl. XXIII, figs. 11–12.

Specimens GIN RAN 4656/82 and 4656/83 from the Upper Bathonian, Coastal Mountains, Wadi Jahannam, Syria; 4656/84 from the Middle Jurassic (upper Bathonian), Coastal Mountains, Maareen village near the town of Querdaha.

Material. About 200 tests.

Dimensions (mm) of specimen 4656/84, microspheric test (Pl. XII, 14). *L* 1.8, *H* 0.34.

Distribution and age. Bathonian of Iraq, France, Greece, Italy and Syria; Lower Jurassic of Morocco.

Genus *Timidonella* Bassoullet

Chabrier et Fourcade, 1974

Type species. *Timidonella sarda* Bassoullet, Chabrier et Fourcade, 1976. Middle Jurassic; Sardinia.

Middle Jurassic of southern Europe, eastern Mediterranean and Madagascar.

Timidonella sarda Bassoullet, Chabrier et Fourcade

Plate XXII, fig. 1 a, b, 2–4

Timidonella sarda: Bassoullet *et al.*, 1976, p. 3, pls 1–4.

Specimen GIN RAN 4656/248 from the Middle Jurassic (Bajocian), Anti-Lebanon, Arneh village, Syria.

Material. About 100 tests.

Dimensions (mm) of type specimen. *L* 0.84, *B* 0.83, *H* 0.1.

Distribution and age. Aalenian to Bajocian of Sardinia, Italy, France, Madagascar, Iran and Bajocian of Syria.

Family **Dorothiidae** Balakhmatova, 1972

Subfamily **Dorothiidae** Balakhmatova, 1972

Genus *Eomarssonella* Levina, 1972

Type species. *Eomarssonella paraconica* Levina, 1972. Lower Oxfordian; western Siberia.

Middle to Upper Jurassic of Europe, Siberia, Syria and India.

Eomarssonella querdahensis K. Kuznetsova et Grigelis *sp. nov.*

Plate X, fig. 5

"querdahensis" (Latin), from the town of Querdaha, the locality.

Holotype GIN RAN 4656/128 from the Middle Jurassic (upper Bathonian), Coastal Mountains, Wadi Jahannam, Querdaha area, Syria.

Material. About 20 tests.

Description. Test small, short, conical, increasing rapidly in width; rounded in cross-section, almost equilaterally triangular in plan view. Test consists of some trochospiral whorls; the amount of chambers per whorl in the earlier 1–2 whorls is obscure, probably four; each succeeding whorl, including the final one, has three triserially arranged low chambers; spiral and septal sutures indistinct; chambers rounded rhomboidal in shape; in the final whorl, they increase rapidly in size, forming a broadened test base, parallel or slightly skewed about the axis of coiling; aperture slit-like, at the centre of the internal margin of the final chamber; wall very finely agglutinated.

Dimensions (mm). *L* 0.22–0.48, *B* (at the base) 0.26–0.36; those of the holotype 0.34 and 0.34, respectively.

Remarks. No specimens fo the genus have been known previously from the Middle Jurassic. They differ from species of the genus *Marssonella* in lacking the biserial portion.

Distribution and age. Bathonian and Callovian of Syria.

Genus *Marssonella* Cushman, 1933

Type species. *Gaudryina oxycona* Reuss, 1860. Upper Cretaceous; western Germany.

Upper Jurassic to Upper Cretaceous; cosmopolitan.

Marssonella haeusleri (Groiss)

Plate X, fig. 6

Textularia haeusleri haeusleri: Groiss, 1963, p. 38, pl. 1, fig. 5.

Specimen GIN RAN 4656/53 from the Upper Jurassic (Kimmeridgian), Jebel Shekif, Anti-Lebanon, Damascus-Beirut Highway 46km from Damascus, Wadi al Karn, Syria.

Material. Eight test.

Dimensions (mm). *L* 0.30, *B* (at the base) 0.20–0.24.

Distribution and age. Middle Tithonian of western Germany; Kimmeridgian of Syria.

Marssonella jurassica Mitjanina

Plate X, fig. 1

Marssonella jurassica: Mityanina, 1957, p. 219, pl. 1, figs. 5–7.

Specimen GIN RAN 4656/54 from the Upper Jurassic (Oxfordian), Jebel Shekif, Anti-Lebanon, Rowda village, near the town of Zabadani, Syria.

Material. Sixteen tests.

Dimensions (mm). *L* 0.42, *B* (at the base) 0.22.

Distribution and age. Oxfordian of Belorussia, Syria.

Family **Chrysalidinidae** Neagu, 1968

Subfamily **Paravalvulininae** Banner, Simmons et Whittaker, 1991

Genus *Riyadhella* Redmond, 1965

Type species. *Riyadhella regularis* Redmond, 1965. Bathonian, Callovian; Saudi Arabia.

Middle Jurassic of eastern Mediterranean, Near East, India, Eastern Europe and Siberia.

Riyadhella regularis Redmond

Plate XIII, fig. 13–17, 19, 20 Plate XX, figs. 14, 15

Riyadhella regularis: Redmond, 1965, p. 138, pl. I, figs. 32–34; Banner *et al.*, 1991, p. 131, figs. 57–63.

Riyadhella hemeri: Redmond, 1965, p. 137, pl. I, figs. 23–24.

Riyadhella intermedia: Redmond, 1965, p. 137–138, pl. 1, fig. 25–27.

Specimen GIN RAN 4656/120 (Pl. XIII, fig. 13) from the Middle Jurassic (upper Bathonian), Coastal Mountains, Wadi Jahannam, near the town of Querdaha, Syria; specimens 4656/121–4656/126.

Material. More than 100 tests.

Dimensions (mm). *L* 0.58–0.92, *B* 0.24–0.30, *H* 0.22.

Distribution and age. Bathonian or Callovian (Dhruma Formation) of Saudi Arabia; Bathonian of Syria.

Genus *Redmondoides* Banner, Simmons et Whittaker, 1991

Type species. *Pseudomarssonella media* Redmond, 1965. Bathonian; Saudi Arabia.

Middle Jurassic of the eastern Mediterranean, southern Europe and Near East.

Redmondoides medius (Redmond)

Plate X, figs. 2–4

Pseudomarssonella media: Redmond, 1965, p. 135, pl. I, figs. 1–13.

Pseudomarssonella biangulata: Redmond, 1965, p. 134, pl. I, fig. 1.

Redmondoides medius: Banner *et al.*, 1991, p. 120, figs. 35–37.

Specimens GIN RAN 4656/117, 4656/118, 4656/119 from the Middle Jurassic (upper Bathonian), Coastal Mountains, Wadi Jahannam, near the town of Querdaha, Syria.

Material. Over 50 tests.

Dimensions (mm) of specimen 4656/118. *L* 0.5, *B* (greatest) 0.4, 4656/119: *L* 0.3, *B* (greatest) 0.8.

Distribution and age. Upper Bathonian to Callovian of Saudi Arabia, France and Syria.

Redmondoides primitivus (Redmond)

Plate XIII, fig. 18, Plate XX, fig. 13.

Pseudomarssonella primitiva: Redmond, 1965, p. 136, pl. I, figs. 16–18.

Redmondoides primitivus: Banner *et al*, 1991, p. 122, figs. 40–41.

Specimen GIN RAN 4656/111 from the Middle Jurassic (upper Bathonian), Coastal Mountains, Wadi Jahannam, near the town of Querdaha, Syria.

Material. About 20 tests.

Dimensions (mm) of specimen 4656/111. *L* 0.26, *B* 0.16 (Pl. XIII, fig. 18).

Distribution and age. Bajocian (lower Dhruma Formation) of Saudi Arabia; Bathonian of Syria.

Redmondoides lugeoni (Septfontaine)

Plate XII, fig. 15, Plate XX, figs. 9, 10

Valvulina lugeoni: Septfontaine, 1977, p. 612, 613, fig. 6, Plate 2 figs. 2–5; Pellisie, Peybernes et Rey, 1984, p. 481, pl. 2, fig. 13.
Redmondoides lugeoni: Banner *et al.*, 1991, p. 125, figs. 46–54.
Specimen GIN RAN 4656/102 and 4656/108 from the Middle Jurassic (Callovian), Anti-Lebanon, Rowda village, 4656/264 (Pl. XII, fig. 15), Coastal Mounatins, the eastern Maareen, upper Bathonian, Syria.
Material. Over 20 tests.
Dimensions (mm) of specimen 4656/102. *L* 0.89. *B* 0.53; 4656/108 *L* 0.43, *B* 0.42; 4656/264, *L* 0.8, *B* 0.61.
Distribution and age. Bathonian, Callovian of France, Italy, and Greece; Callovian to Oxfordian of Morocco; Kimmeridgian of Malaysia; Callovian and Bathonian of Syria.

Genus *Pseudormarssonella* Redmond, 1965

Type species. *Pseudomarssonella maxima* Redmond, 1965. Bathonian or Callovian; Saudi Arabia.
Middle Jurassic of eastern Mediterranean, Near East.

Pseudomarssonella plicata Redmond

Plate XX, fig. 12

Pseudomarssonella plicata: Redmond, 1965, p. 135, pl. 1, figs. 14–15; Banner *et al.*, 1991, p. 140, fig. 75–77.
Pseudomarssonella reflexa: Redmond, 1965, p. 136, pl. 1, fig. 19.
Specimen GIN RAN 4656/127 from the Middle Jurassic (upper Bathonian), Coastal Mountains, Wadi Jahannam, Syria.
Material. Over 50 tests.
Dimensions (mm) of specimen 4656/127. *L* 0.28, *B* 0.2.
Distribution and age. Callovian to Bathonian (upper Dhruma Formation) of Saudi Arabia; upper Bathonian of Syria.

Family **Pfenderinidae** Smout et Sugden, 1962

Subfamily **Palaeopfenderininae** Septfontaine, 1988

Genus *Palaeopfenderina* Septfontaine, 1988

Type species. *Pfenderina salernitana* Sarton et Crescenti, 1962. Bathonian, Italy.
Middle Jurassic of Europe, eastern Mediterranean.

Palaeopfenderina salernitana (Sartoni et Crescenti)

Plate XII, fig. 1, Plate XIX, figs. 1, 2, Plate XX, fig. 11

Pfenderina salernitana: Sartoni et Crescenti, 1962, p. 280, pl. L, figs. 1, 4, 7.
Specimens GIN RAN 4656/71 and 4656/72 from the upper Bathonian, Coastal Mountains, Wadi Jahannam, Syria; 4656/73 (Pl. XIX, fig. 1) from the Callovian, Anti-Lebanon, Rowda village.
Material. Over 100 tests from friable rocks and section in thin sections of limestone.
Dimensions (mm) of specimen 4656/71. *L* 1.32, *B* 0.51.
Distribution and age. Middle Jurrassic of southern Europe, eastern Mediterranean; Bathonian and Callovian of Syria.

Palaeopfenderina trochoidea (Smout et Sugden)

Plate XIX, figs. 11, 12

Pfenderina trochoidea: Smout et Sugden, 1962, p. 588, pl. 73, figs. 9–15, pl. 74, figs. 4–6, pl. 75, figs. 1–6, text fig. IE–H; Redmond, 1964a, p. 256, pl. I, figs. 19–27, text figs. 1–3.
Specimen GIN RAN 4656/74 from the Callovian, Anti-Lebanon, Jebel Shekif, Wadi Fawuar, near the town of Serghaya area, Syria; specimen 4656/75 from the Middle Jurassic (upper Bathonian), Shuekha village, near the town of Slenfeh, Coastal Mountains.
Material. Over 20 tests.
Dimensions (mm) of specimen 4656/74. *L* 0.9, *B* 0.4; specimen 4656/75, *L* 0.48, *B* 0.38.
Distribuxion and age. Bathonian, Callovian of southern Europe, eastern Mediterranean, Morocco; Bathonian and Callovian of Syria.

Genus **Pfenderella** Redmond, 1964

Type species. *Pfenderella arabica* Redmond, 1964a. Bathoniam to Callovian of Saudi Arabia.
Middle Jurassic of Near East, Mediterranean.

Pfenderella arabica Redmond

Plate XIX, fig. 3

Pfenderella arabica: Redmond, 1964, p. 258, pl. 2, figs. 1–3.

Specimen GIN RAN 4656/76 from the Middle Jurassic (Callovian), Anti-Lebanon, Jebel Shekif, Wadi Fawuar, near the town of Serghaya, Syria.

Material. Eight tests.

Dimensions (mm) of specimen 4656/76. *L* 1.15, *B* (diameter) 0.45.

Distribution and age. Bathonian to Callovian of Saudi Arabia, Greece, France, Italy and Syria.

Genus *Steinekella* Redmond, 1964

Type species. *Steinekella steinekei* Redmond, 1964 p. 259, pl. 2, figs. 8, 14. Oxfordian, Saudi Arabia.

Upper Jurassic (Oxfordian) of Near East, Mediterranean.

Steinekella steinekei Redmond

Plate X, figs. 8–11, Plate XII, fig. 3

Steinekella crusei: Redmond, 1964, p. 260, pl. 2, figs. 15–17.

Specimens GIN RAN 4656/77 from the Upper Jurassic (Oxfordian), Coastal Mountains, Sindianeh village, Syria; 4656/78–4656/81 from the Upper Jurassic (Oxfordian), Wadi Shkeir, near Jdaida village.

Material. Over 50 tests.

Dimensions (mm). *L* 1.52–1.86, *B* (diameter) 0.54–1.4.

Distribution and age. Oxfordian of Saudi Arabia, Greece, Italy and Syria.

Subfamily **Kurnubiinae** Redmond, 1964

Genus *Praekurnubia* Redmond, 1964

Type species. *Praekurnubia crusei* Redmond, 1964. Bathonian, Callovian; Saudi Arabia.

Middle Jurassic of Saudi Arabia, eastern Mediterranean.

Praekurnubia crusei Redmond

Plate XI, fig. 6 a, b

Praekurnubia crusei: Redmond, 1964a, p. 254, pl. I, figs. 5–8.

Specimen GIN RAN 4656/55 from the Middle Jurassic (Callovian), Anti-Lebanon Wadi al Karn, Syria.

Material. Eight tests.

Dimensions (mm). *L* 0.78, *B* 0.26.

Distribution and age. Callovian to Bathonian (Dhruma Formation) of Saudi Arabia; upper Bathonian to lower Callovian of Syria.

Genus *Kurnubia* Henson, 1948

Type species. *Kurnubia palastiniensis* Henson, 1948. Upper Jurassic; Palestine, eastern Mediterranean, Near East, Morocco, former Yugoslavia, southern; France.

Kurnubia palastiniensis Henson

Plate XI, fig. 9 a, b, Plate XII, fig. 4, Plate XIX, figs. 4, 5, 7–9

Kurnubia palastiniensis: Henson 1948, p. 608, pl. XVI, figs. 8, 11, pl. XVIII, figs. 10, 11; Sartoni et Crescenti, 1962, p. 283, pl. XIX, fig. 2, pl. L, figs. 2, 3, 5, 8; Smout et Sugden, 1962, pp. 589–590, pl. 73, fig. 16; Hottinger, 1967, pp. 90–93, pl. 19, figs. 30–34, 38–48, text figs. 45, 46.

Specimens GIN RAN 4656/56 (Pl. XI, fig. 9) from the Oxfordian, Coastal Mountains, Teir Jamleh village, Syria; 4656/232 (Pl. XII, fig. 4) from the Tithonian, Anti-Lebanon, Wadi al Karn; 4656/234 (Pl. XIX, fig. 4) from the Callovian, Anti-Lebanon, near Rowda; 4656/235–4656/237 (Pl. XIX, fig. 7–9) from the Kimmeridgian and Tithonian, Wadi al Karn.

Material. Over 200 tests.

Dimensions (mm) of specimen 4656/56. *L* 2.74, *B* 0.6.

Distribution and age. Callovian, Oxfordian of Palestine, France, Morocco, Iraq and former Yugoslavia. In Syria, it is very abundant in the Callovian, where it is the index species of a foraminiferal zone; a few specimens were encountered in the Oxfordian, Kimmeridgian and Tithonian.

Kurnubia bramkampi Redmond

Plate XI, figs. 7, 8, Plate XIX, fig. 10

Kurnubia bramkampi: Redmond, 1964a, p. 253, pl. I, figs. 1–3.

Specimens GIN RAN 4656/59 (Pl. XI, fig. 8) from the Callovian, Coastal Mountains, Dahr Al Killin village, Syria; specimen 4656/60 from the upper Bathonian, Coastal Mountains, Wadi Jahannam.

Material. Nineteen tests.

Dimensions (mm) of specimen 4656/59. *L* 0.96, *B* 0.26; 4656/60, *L* 1.4, *B* 0.4.

Distribution and age. Bathonian to Callovian of Saudi Arabia, North Africa, Syria.

Kurnubia variabilis Redmond

Plate XII, figs. 10–12

Kurnubia variabilis: Redmond, 1964a, p. 254, pl. I, figs. 9–10.
Specimens GIN RAN 4656/61, 4656/62, 4656/63 from the Middle Jurassic (Callovian), Anti-Lebanon, Wadi al Karn, Syria.
Material. Thirteen tests.
Dimensions (mm) of specimen 4656/61. *L* 0.72, *B* 0.3; 4656/63 *L* 1.2, *B* 0.3; 4656/63, *L* 0.84, *B* 0.26.
Distribution and age. Bathonian to Callovian of Saudi Arabia; Callovian of Syria.

Kurnubia wellingsi (Henson)

Plate XII, figs. 5, 6

Valvulinella wellingsi: Henson, 1948, p. 606, pl. XV, fig. 9, pl. XVI, fig. 5, pl. XVIII, fig. 1.
Kurnubia wellingsi: Smout et Sugden, 1962, p. 285, pl. XIX, figs. 17–18, pl. 76, figs. 1–8; Sartoni et Crescenti, 1962, p. 285, pl. XIX, figs. 1, 2, pl. 1, figs. 1, 2.
Specimens GIN RAN 4656/65, 4656/66 from the Upper Jurassic (lower Oxfordian), Coastal Mountains, Sindianeh village, Syria.
Material. About 20 tests.
Dimensions (mm) of specimen 4656/65. *L* 1.3 *B* 0.4; 4656/66 *L* 0.48 *B* 0.3.
Distribution and age. Oxfordian of eastern Mediterranean, Italy and France; lower Oxfordian of Syria.

Kurnubia jurassica (Henson)

Plate XII, figs. 7–9

Valvulinella jurassica: Henson, 1948, p. 60, pl. XVI, figs 1–4, pl. XVIII, figs. 8, 9.
Kurnubia jurassica: Smout et Sugden, 1962, pl. 73, fig. 19.
Specimens GIN RAN 4656/67, 4656/68 and 4656/69 from the Lower Cretaceous (Barremian to lower Aptian), Coastal Mountains, Al Bustan, Syria.
Material. About 20 tests.
Dimensions (mm) of specimen 4656/67. *L* 1.1, *B* 0.3; 4656/68; *L* 1.9, *B* 0.4, 4656/69 *L* 1.34, *B* 0.4.
Distribution and age. Neocomian of France, Italy, eastern Mediterranean; Barremian to lower Aptian of Syria.

Kurnubia morrisi Redmond

Plate XII, fig. 2

Kurnubia morrisi: Redmond, 1964a, p. 253, pl. I, fig. 4.
Specimen GIN RAN 4656/70 from the Upper Jurassic (Oxfordian), Coastal Mountains, Ain Khlakem, Syria.
Material. Twenty-five tests.
Dimensions (mm). *L* 2.0, *B* 0.64.
Distribution and age. Kimmeridgian of Saudi Arabia; upper Oxfordian of Syria.

Family **Textulariopspidae** Loeblich et Tappan, 1982

Subfamily **Arenovirgulininae** Grigelis et Kuznetsova, subfam. *nov.*

Description. Test elongate, triserial and trihedral in the short earlier stage, in the stage biserial; wall very finely agglutinated.
Type genus. *Arenovirgulina* Said et Barakat, 1958.
Distribution. Jurassic; eastern Mediterranean.

Genus *Arenovirgulina* Said et Barakat, 1958

Type species. *Arenovirgulina aegyptiaca* Said et Barakat, 1958.
Callovian, Egypt.
non Plectinella Marie, 1956, *in* Loeblich et Tappan, 1988, p. 115 I.
Middle to Upper Jurassic of eastern Mediterranean.

Arenovirgulina aegyptiaca Said et Barakat

Plate XIII, fig. 1a, b

Arenovirgulina aegyptiaca: Said et Barakat, 1958, p. 243, pl. 3, fig. 38.
Specimen GIN RAN 4656/131 from the Upper Jursssic (Oxfordian), Jebel Shekif, Anti-Lebanon, Damascus–Beirut Highway 46 km from Damascus, Wadi al Karn, Syria.
Material. Over 20 tests.
Dimensions (mm). *L* 0.56, *B* $\leqslant$ 0.22, *H* 0.14.
Distribution and age. Callovian of Egypt (Sinai); Oxfordian of Syria.

Family **Verneuilinidae** Cushman, 1911

Subfamily **Verneuilinoidinae** Suleymanov, 1973

Genus *Verneuilinoides* Loeblich et Tappan, 1949

Type species. *Verneuilina schizea* Cushman et Alexander, 1930.
Lower Cretaceous; North America.
Jurassic to Cretaceous; cosmopolitan.

Verneuilinoides minuta Said et Barakat

Plate XIII, figs. 3–5

Verneuilinoides minuta: Said et Barakat, 1958, p. 242, pl. 4, fig. 25; Maync, 1966, pl. IV, figs. 10, 11.

Specimens GIN RAN 4656/133, 4656/134, 4656/135 from the Upper Jurassic (Oxfordian), Coastal Mountains, Sindianeh village, near the town of Misyaf, Syria.

Material. Over 30 tests.

Dimensions (mm) of specimen 4656/133. *L* 0.3, *B* 0.24.

Distribution and age. Kimmeridgian of Sinai (Egypt); Oxfordian and Kimmeridgian of Syria.

Verneuilinoides osowiensis (Bielecka)

Plate XIII, fig. 2a, b

Dorothia osowiensis: Bielecka et Styk, 1981, p. 23, 47, pl. I, figs. 15–17. Specimen GIN RAN 4656/132 from the Upper Jurassic (Oxfordian), Jebel Shekif, Anti-Lebanon, Rowda village, near the town of Zabadani area, Syria.

Material. Eight tests.

Dimensions (mm). *L* 0.99, *B* 0.70.

Distribution and age. Upper Callovian of Poland; Oxfordian of Syria.

Verneuilinoides subminuta (Gorbatchik)

Plate XIII, fig. 6a, 6

Verneuilina subminuta: Gorbachik, 1971, p. 131, pl. II, fig. 7;

Plotnikova *et al.*, 1979, p. 19, pl. III, fig. II.

Specimen GIN RAN 4656/136 from the Lower Cretaceous (Barremian to lower Aptian), Anti-Lebanon, Rowda village, near the town of Zabadani, Syria.

Material. Seventeen well-preserved tests.

Dimensions (mm). *L* 0.34, *B* 0.29.

Distribution and age. Upper Tithonian to Berriasian of Crimea; Berriasian of Switzerland; Barremian to lower Aptian of Syria.

Verneuilinoides jannamensis Grigelis et K. Kuznetsova, *sp. nov.*

Plate X, fig. 7

"*jannamensis*" (Latin) from Wadi Jahannam, the locality.

Holotype GIN RAN 4656/143 from the Middle Jurassic (upper Bathonian), Coastal Mountains , Wadi Jahannam, near the town of Querdaha, Syria.

Material. About 20 well-preserved tests.

Description. Test small to medium sized, conical, elongate, with low chambers closely packed, triserially arranged; irregularly rounded in cross-section, with depressions where the chambers join; early chamber very small; septal sutures flush to slightly depressed, indistinct; apertural surface flattened or slightly concave, subparallel to the base of the test, with three final chambers; aperture slit-like in the middle of the apertural surface, interiomarginal in the final chamber; wall very finely agglutinated.

Dimensions (mm) of holotype. *L* 0.44, *B* 0.34; of other specimens, *L* 0.30–0.56, *B* 0.28–0.34.

Remarks Differs from *Verneuilinoides minuta* Said et Barakat in its shorter test which rapidly increases in width; from *V. subminuta* (Gorbatchik) in the rounded rather than subtriangular cross-section, in the flattened or depressed apertural surface and the character of the septal sutures; from *V. attenuata* Said and Barakat in the short, conical test, the flattened apertural surface, and the flush sutures.

Distribution and age. Upper Bathonian of Syria.

Subfamily **Belorussiellinae** Balakhmatova, 1973

Genus *Belorussiella* Akimets, 1958

Type species. *Belorussiella bolivinaeformis* Akimets, 1958. Upper Cretaceous; Belorussia.

Lower to Upper Cretaceous of Eastern Europe, the Caucasus, Syria.

Belorussiella textularioides (Reuss)

Plate XIII, fig. 8

Bolivina textularioides: Reuss, 1863, p. 81, pl. 10, fig. 1 (*fide Cataloge of Foraminifera*, 1940).

Palaeogaudryina textularioides: Dieni et Massari, 1966, p. 101, pl. II, figs. 8, 9.

Specimen GIN RAN 4656/138 from the Lower Cretaceous (Barremian to lower Aptian), Jebel Shekif, Anti-Lebanon, Rowda village, near the town of Zabadani, Syria.

Material. About 30 tests.

Dimensions (mm). *L* 0.66, *B* 0.24.

Distribution and age. Valanginian to Barremian of Europe; Barremian to lower Aptian of Syria.

Genus *Palaeograudryina* Said et Barakat, 1958

Type species. *Palaeogaudryina* magharaensis Said et Barakat, 1958.

Upper Jurassic; Egypt.

Middle to Upper Jurassic of the eastern Mediterranean.

Palaeogaudryina magharaensis: Said et Barakat

Plate XIII, figs. 9, 11

Palaeogaudryina magharaensis: Said et Barakat, 1958, p. 243, pl. 4, figs. 33–36; Bignot et Guyader, 1965, p. 54, pl. I, figs. 7–25.

Specimens GIN RAN 4656/141 and 4656/142 from the Upper Jurassic (Oxfordian), Anti-Lebanon, near Rowda, Syria.

Material. More than 40 well-preserved tests.

Dimensions (mm) of specimen 4656/141. *L* 0.6, *B* 0.22, *H* 0.12.

Distribution and age. Callovian of Sinai (Egypt); Oxfordian of Syria.

Palaeogaudryina varsoviensis (Bielecka et Pożaryski)

Plate XIII, figs. 10, 12

Neobulimina varsoviensis: Bielecka et Pożaryski, 1954, p. 65, pl. 10. 50; Hanzlikova, 1965, p. 92, pl. IX, figs. 9, 10.

Palaeogaudryina varsoviensis: Bielecka et Kuznetsova, 1969, p. 69, pl. I, fig. 2; Grigelis, 1985, p. 42, pl. 10, fig. 11.

Specimens GIN RAN 4656/139, 4656/140 from the Upper Jurassic (Oxfordian), Jebel Shekif, Anti Lebanon, Damascus–Beirut Highway 46km from Damascus, Wadi al Karn, Syria.

Dimensions (mm). *L* 0.34–0.56, *B* 0.16–0.26, $H \leqslant 0.16$.

Distribution and age. Kimmeridgian of Poland, Czechoslovakia and Lithuania; Oxfordian of Syria.

Family **Dictyoconidae** Moullade, 1965

Subfamily **Dictyoconinae** Moullade, 1965

Genus *Kilianina* Pfender, 1933

Type species. *Kilianina blancheti* Pfender, 1933. Middle Jurassic; France.

Middle Jurassic of Europe, eastern Mediterranean and SW Asia.

Kilianina blancheti Pfender

Plate XI, figs. 1–3, Plate XX, figs. 1–4, 6–8

Kilianina blancheti: Pfender, 1933, p. 245, pl. 1; fig. a–k; pl. 2, fig. 1–3.

Specimens GIN RAN 4656/90, 4656/91, 4656/92, 4656/99 (Pl. XX, figs. 1–3), (Pl. XX, figs. 1–4, 6–8) from the Middle Jurassic (upper Bathonian), Coastal Mountains, Wadi Jahannam, Syria.

Material. About 200 tests.

Dimensions (mm) of specimen 4656/90 (Pl. XI, I). *L* (greatest) 1.4, *B* 0.22; 4656/92 (Pl. XI, fig. 3): *H* 0.74, *L* (greatest) 1, *B* 0.54, *H* 0.3.

Distribution and age. Middle to Upper Jurassic of Morocco, France, Italy; Bathonian of Saudi Arabia; upper Bathonian of Syria.

Genus *Meyendorffina* Auroze et Bizon, 1958

Type species. *Meyendorffina bathonica* Auroze et Bizon, 1958. Middle Jurassic; France.
Middle Jurassic of Europe, eastern Mediterranean.

Meyendorffina bathonica Auroze et Bizon

Plate XI, figs. 4, 5, Plate XX, fig. 5

Meyendorffina bathonica: Auroze et Bizon, 1958, p. 72; pl. 2, fig. 1–7, 9, pl. 3, fig. 3.
Specimens GIN RAN 4656/85 and 4656/89 (Pl. XI, figs. 4, 5), 4656/253 (Pl. XX, fig. 5) from the Middle Jurassic (upper Bathonian), coastal Mountains, Wadi Jahannam, Syria.
Material. Over 30 tests.
Dimensions (mm) of specimen 4656/8 (Pl. XI, fig. 5, microspheric specimen): *L* 1.4, B_s 0.5, B_u 0.38; specimen 4656/85 (Pl. XI, fig. 4, megalospheric specimen): *L* 0.7, *B* 0.34.
Distribution and age. Bathonian of France, Morocco and Italy; upper Bathonian of Syria.

Family **Involutinidae** Bütschli, 1880

Subfamily **Involutininae** Bütschli, 1880

Genus *Globospirilina* Antonova, 1964

Type species. *Globospirillina condensa* Antonova *et al.*, 1964. Aptian; NW Caucasus.
Upper Jurassic to Lower Cretaceous of southern Europe and eastern Mediterranean.

Globospirillian neocomiana (Moullade)

Plate XV, fig. 7 a–c

Spirillina neocomiana: Moullade, 1961, p. 233, pl. I, figs. 6–8.
Globospirillina condensa: Antonova *et al.*, 1964, p. 68, pl. XIV, figs. 1–6.
Globospirillina neocomiana: Kuzentsova et Gorbachik, 1985, p. 115, pl. XI, figs. 11, 12.
Specimen GIN RAN 4656/153 from the Tithonian-Berriasian, Jebel Shekif, Anti-Lebanon, Rowda village, near the town of Zabadani, Syria.
Material. Over 50 tests.
Dimensions (mm). *D* 0.3, *H* 0.17.

Comparison. Differs from *Globospirillina caucasica* (Hoffman) in the more convex test and partly open umbilical lobe of two to three whorls.

Distribution and age. Berriasian to Valanginian of France; Tithonian to Valanginian of the Crimea; Berriasian to upper Valanginian of Rumania; Tithonian to Berriasian of Syria.

Family **Trocholinidae** Kristan-Tollman 1963

Subfamily **Trocholininae** Kristan-Tollman, 1963

Genus *Trocholina* Paalzow, 1922

Type species. *Involutina conica* Schlumberger, 1898. Middle Jurassic; Germany. Upper Triassic to Upper Cretaceous; cosmopolitan.

Trocholina conosimilis Subbotina, Dakka et Srivastava

Plate XIII, figs. 21, 22 and 24

Trocholina conosimilis: Subbotina, Dakka et Srivastava, 1960, p. 41, pl. IV, fig. 5.

Specimens GIN RAN 4656/137, 4656/245, 4656/246 from the Middle Jurassic (upper Bathonian), Coastal Mountains, Wadi Jahannam, Querdaha area, Syria.

Material. Fifteen well-preserved tests.

Dimensions (mm). *D* 0.34–0.4, *H* 0.16–0.2.

Distribution and age. Callovian and Oxfordian of India; Bathonian of Syria.

Trocholina transversarii Paalzow

Plate XIII, fig. 23 a–c

Trocholina transversarii: Paalzow, 1932, p. 141, pl. XI, figs. 8–10; Grigelis, 1985, p. 177, pl. XV, fig. 7.

Specimen GIN RAN 4656/144 from the Upper Jurassic (Oxfordian), Jebel Shekif, Anti-Lebabon, Rowda village, near the town of Zabadani, Syria.

Material. About 30 tests.

Dimensions (mm). D_1 0.86, D_2 0.78, *H* 0.40; juvenile D_1 0.34, D_2 0.28, *H* 0.13.

Distribution and age. Oxfordian of Europe; in addition, Kimmeridgian of Swabian Alb, Germany; Oxfordian of Syria.

Family **Ventrolaminidae** Weynschenck, 1950

Genus *Protopeneroplis* Weynschenck, 1950

Type species. *Protopeneroplis striata* Weynschenck, 1950. Middle Jurassic; Italy. Middle Jurassic to Lower Cretaceous of southern Europe, eastern Mediterranean and the Near East.

Protopeneroplis striata Weynschenk

Plate XXII, figs. 5, 6

Protopeneroplis striata: Weynschenck, 1950, p. 13, pl. 2, fig. 12–14; Barattolo et Pugliese, 1987, pl. II, figs. 6, 8–10.
Specimen GIN RAN 4656/249, 4656/265 from the Middle Jurassic (Bathonian), Kurd-Dag, Rajo village, Syria.
Material. About 20 tests.
Dimensions (mm). *D* 0.52, *H* 0.28 (Pl. XXII, fig. 5).
Distribution and age. Middle Jurassic of Italy, Austria, France, former Yugoslavia, Switzerland, Israel and Turkey; Bathonian of Syria.

Family **Ophthalmidiidae** Wiesner, 1920

Subfamily **Ophthalmidiinae** Wiesner, 1920

Genus *Ophthalmidium* Kübler et Zwingli, 1870

Type species. *Oculina liassica* Kübler et Zwingli, 1866. Upper Liassic; Switzerland.
Upper Triassic to Upper Jurassic; cosmopolitan.

Ophthalmidium sagittum (E. Bykova)

Plate XV, fig. 1 a, b

Spirophthalmidium sagittum: E. Bykova, 1948, p. 104, pl. III, figs. 1, 2.
Ophthalmidium sagittum; Azbel, 1973, p. 106, pl. I, figs. 1–3; Grigelis, 1985, pl. XI, fig. 8.
Specimen GIN RAN 4656/145 from the Upper Jurassic (lower Oxfordian), Jebel Shekif, Anti-Lebanon, Damascus–Beirut Highway 46 km from Damascus, Wadi al Karn, Syria.
Material. Nine tests.
Dimensions (mm). *L* 0.30, *B* 0.14, *H* 0.03–0.04.
Distribution and age. Lower Oxfordian of Moscow area, Volga area, Lithuania and Mangyshlak, Syria.

Family **Hauerinidae** Schwager, 1876

Subfamily **Quinqueloculininae** Cushman, 1917

Genus *Quinqueloculina* d'Orbigny, 1826

Type species. *Serpula seminulum* Linne, 1875. Recent; Adriatic Sea. Upper Jurassic to Recent; cosmopolitan.

Quinqueloculina jurassica Bielecka et Styk

Plate XV, figs. 9a–c, 10

Quinqueloculina jurassica: Bielecka et Styk, 1966, p. 382, pl. I, fig. 1; Grigelis, 1985, p. 50, pl. I, fig. 5, pl. I, fig. 5, pl. IX, fig. 17.

Specimens GIN RAN 4656/146 and 4656/227 from the Upper Jurassic (Oxfordian), Jebel Shekif, Anti-Lebanon, Rowda village, near the town of Zabadani, Syria.

Material. About 20 tests.

Dimensions (mm). *L* 0.38–0.42, *B* 0.26, *H* 0.11 (pl. XV, fig. 9).

Distribution and age. Upper Oxfordian, Kimmeridgian of Poland and Lithuania; Oxfordian of Syria.

Family **Spirillinidae** Reuss et Fritsch, 1861

Subfamily **Spirillininae** Reuss, 1862

Genus *Spirillina* Ehrenberg, 1843

Type species. *Spirillina vivipara* Ehrenberg, 1843. Recent; Gulf of Mexico.

Upper Triassic to Recent; cosmopolitan.

Spirillina kuebleri Mjatliuk

Plate XV, figs. 2 a, b, 4 a, b, 5 a, b, 8 a, b

Spirillina kuebleri: Myatlyuk, 1953, p. 27, pl. I, figs. 6, 7; Pyatkova and Permyakova, 1978, p. 117, pl. 42, fig. 5; Grigelis, 1985, p. 171, pl. XXXIX, fig. 6; Kuznetsova et Gorbachik, 1985, p. 115, pl. XI, figs. 7–9.

Specimens GIN RAN 4656/147-4656/150 from the Upper Jurassic (Oxfordian), Jebel Shekif, Anti-Lebanon, Hadar village, near the town of Majdal Shams area, Syria.

Material. Over 30 tests.

Dimensions (mm). *D* 0.22–0.36, *H* 0.04–0.05.

Distribution and age. Callovain and Oxfordian of eastern European platform, the Crimea, the Caucasus; Oxfordian of Switzerland, Syria.

Spirillina eichbergensis (Kübler et Zwingli)

Plate XV, fig. 3

Cornuspira eichbergensis: Kübler et Zwingli, 1870, p. 17, pl. II, fig. 2 (*non* pl. III, fig. 2).

Spirillina eichbergensis: Myatlyuk, 1953, p. 26, pl. I, fig.; Pyatkova and Permyakova, 1978, p. 117, pl. 42, fig. 4.

Specimen GIN RAN 4656/51 from the Middle Jurassic (Callovian), Jebel Sheikh, Anti-Lebanon, Arneh village, Syria.

Material. Over 20 tests.

Dimensions (mm). *D* 0.27, *H* 0.04.

Distribution and age. Bathonian (Parkinsonian Clay) of Switzerland; Callovian of eastern European platform and Syria.

Subfamily **Turrispirillininae** Cushman, 1927

Genus *Turrispirillina* Cushman, 1927

Type species. *Spirillina conoidea* Paalzow, 1917. Upper Jurassic; western Germany.

Middle Jurassic (Callovian) to Holocene; cosmopolitan.

Turrispirillina amoena Dain

Plate XV, fig. 6 a–c

Turrispirillina amoena Dain, *in* Mjatliuk: Myatlyuk, 1953, p. 28, pl. I, fig. 8; Kaptarenko-Chernousova, 1959, p. 75, pl. X, fig. 7.

Specimen GIN RAN 4656/152 from the Upper Jurassic (Oxfordian), Jebel Sheikh, Anti-Lebanon, Hadar, Majdal Shams area, Syria.

Material. Fifteen well-preserved tests.

Dimensions (mm). *D* 0.38, *H* 0.16.

Distribution and age. Upper Oxfordian to Kimmeridgian of Ukraine; Oxfordian of Syria.

Family **Patellinidae** Rhumbler, 1906

Subfamily **Patellininae** Rhumbler, 1906

Genus *Patellina corrugata* Williamson, 1858

Type Species. *Patellina corrugata* Williamson, 1858. Recent; Canary Islands.

Lower Cretaceous to Recent; cosmopolitan.

Patellina subcretacea Cushman et Alexander

Plate XV, fig. 11 a–c

Platellina subcretacea: Cushman et Alexander, 1930, p. 10, pl. 3, fig. 1; Dulub, 1972, p. 44, pl. VIII, fig. 5; Kaptarenko-Chernousova *et al.*, 1979, p. 84, pl. 23, fig. 8.

Specimen GIN RAN 4656/228 from the Barremian to lower Aptian, Jebel Shekif, Anti-Lebanon, Rowda village, near the town of Zabadani, Syria.

Material. Eight well-preserved tests.

Dimensions (mm). *D* 0.3, *H* 0.14.

Distribution and age. Lower Cretaceous of North America, Germany, Bulgaria, the Netherlands, Ukraine; Valanginian to Hauterivian of Poland; Barremian to lower Aptian of Syria.

Family **Ichthyolariidae** Loeblich et Tappan, 1986

Subfamily **Prodentalininae** Grigelis et K. Kuznetsova, *subfam. nov.*

Test rounded or oval in section; wall simple with radial fibres, prinarily foliated (lamellar) mesolamellar in some species, smooth or finely costate.
Type genus. *Prodentalina* Norling, 1968.
Remarks. Similar to Cretaceous to Recent Dentalininae Schwager, 1977 (family Nodosariidae Ehrenberg, 1838), showing the presence of multiple longitudinal costae and secondarily multilayer wall.
Distribution. Jurassic; cosmopolitan.

Genus *Prodentalina* Norling, 1968

Type species. *Dentalina terquemi* d'Orbigny, 1849. Lias; France; Jurassic, Europe, eastern Mediterranean and Asia.

Prodentalina brueckmanni (Mjatliuk)

Plate XV, fig. 12

Dentalina brueckmanni: Myatlyuk, 1959, p. 414, pl. II, figs. 8–10; Grigelis, 1985, p. 60, pl. XIII, fig. 6.
Specimen GIN RAN 4656/159 from the Upper Jurassic (Oxfordian), Jebel Shekif, Anti-Lebanon, Rowda village, near the town of Zabadani area, Syria.
Material. Eight tests.
Dimensions (mm). *L* 0.92, *B* 0.22.
Distribution and age. Callovian of eastern Europe; lower Oxfordian of Scotland; Oxfordian of Syria.

Subfamily **Ichthyolariinae** Loeblich et Tappan, 1986

Genus *Geinitzinita* Sellier de Givrieux et Dessauvagie, 1965

Type species. *Geinitzinita oberhauseri* Sellier et Civrieux et Dessauvagie, 1965. Triassic; Austria.
non Grillina Kristan-Tollmann, 1964.
Triassic to Lower Cretaceous; cosmopolitan.

Geinitzinita wolinensis Bielecka

Plate XV, fig. 13 a, b

Geinitzinita wolinensis: Bielecka, 1975, p. 334, pl. VI, figs. 11–13, Grigelis, 1985, p. 58, pl. XIII, fig. 2.

Specimen GIN RAN 4656/160 from the Upper Jurassic (Oxfordian), Jebel Shekif, Anti-Lebanon, Damascus-Beirut Highway 46km from Damascus, Wadi al Karn, Syria.

Material. Six tests.

Dimensions (mm). *L* 0.40, *B* 0.16, *H* 0.10.

Distribution and age. Middle Portlandian of Poland; upper Kimmeridgian of Lithuania and France; Oxfordian of Syria.

Family **Lenticulinidae** Chapman, Parr et Collins, 1934

Subfamily **Lenticulininae** Chapman, Parr et Collins, 1934

Genus *Lenticulina* Lamarck, 1804

Type species. *Lenticulites rotulatus* Lamrarck, 1804. Upper Cretaceous; France. Triassic to Holocene; cosmopolitan.

Lenticulina brueckmanni (Mjatliuk)

Plate XV, figs. 18–20 a, b

Cristellaria brueckmanni: Myatlyuk, 1939, p. 59, pl. IV, fig. 49.

Lenticulina brueckmanni: Kuznetsova, 1961, p. 104, pl. II, fig. 9; Grigelis, 1985, p. 79, pl. XVI, fig. 5.

Specimens GIN RAN 4656/161 (fig. 19) and 4656/162 (fig. 20) from the Oxfordian, Jebel Sheikh, Anti-Lebanon, near Hadar, Majdal Shams area, Syria; 4656/163 (fig. 18) from the upper Oxfordian, Wadi al Karn.

Material. Over 60 tests.

Dimensions (mm). *D* 0.56–0.78, *d* 0.40–0.62, *h* 0.24–0.28, h_{al} 0.28–0.36, *D*:*d* 1.26–1.40, *d*:*H* 1.66–2.22.

Distribution and age. Oxfordian (mainly lower), of Europe and Syria; also lower Kimmeridgian of Poland.

Lenticulina hebetata (Schwager)

Plate XV, fig. 21 a, b, Plate XVI, fig. 18 a, b

Cristellaria hebetata: Schwager 1865, p. 134, pl. VII, fig. 2.

Lenticulina hebetata: Grigelis, 1985, p. 70, pl. XIV, fig. 10.

Specimen GIN RAN 4656/164 from the Upper Jurassic (Oxfordian), Jebel Shekif, Anti-Lebanon, Rowda village, near the town of Zabadani, Syria.

Material. Twenty-five well-preserved tests.

Dimensions (mm). *D* 0.64–0.76, *d* 0.50–0.62, *H* 0.40, h_{al} 0.30, h_{am} 0.15, *D*:*d* 1.28, *D*:*h* 1.25, h_{am}:*D* 0.23.
Distribution and age. Oxfordian of Europe, Syria.

Lenticulina nostra Grigelis

Plate XV, figs. 15 a, b, 22

Lenticulina nostra: Grigelis, 1985, p. 74, pl. II, fig. 1, pl. XV, fig. 5.
Specimen GIN RAN 4656/165, 4656/266 from the Upper Jurassic (Oxfordian), Jebel Sheikh, Anti-Lebanon, Hadar village, near the town of Majdal Shams, Syria.
Material. Eight tests.
Dimensions (mm). *D* 0.48, *d* 0.40, *H* 0.32, h_{al} 0.30, h_{am} 0.18, h_{am}:*D* 0.38.
Distribution and age. Oxfordian of Lithuania and Syria.

Lenticulina nuda (Reuss)

Plate XV, fig. 17 a, b

Cristellaria nuda: Reuss, 1862, p. 328, pl. 6, figs. 1–3.
Lenticulina nuda: Kaptarenko-Chernousova, 1967, p. 81, pl. VIII, fig. 12.
Specimen GIN RAN 4656/166 from the Lower Cretaceous (Barremian to lower Aptian), Jebel Shekif, Anti-Lebanon, Rowda village, near the town of Zabadani, Syria.
Material. Thirty tests.
Dimensions (mm). *D* 0.52, *d* 0.4, *H* 0.24.
Distribution and age. Lower Cretaceous (Berriasian to Aptian) of Europe and eastern Mediterranean.

Lenticulina quenstedti (Gümbel)

Plate XV, fig. 23 a, b

Cristellaria quenstedti: Gümbel, 1862, p. 266, pl. IV, fig. 2.
Lenticulina quenstedti: Grigelis, 1985, p. 81, pl. XVI, fig. 8, pl. XVII, figs. 1, 2.
Specimen GIN RAN 4656/167 from the Upper Jurassic (Oxfordian), Jebel Sheikh, Anti-Lebanon, Hadar village, near the town of Majdal Shams, Syria.
Material. About 40 tests.
Dimensions (mm). *D* 0.60–0.65, *d* 0.46–0.52, *H* 0.30–0.32, *D*:*d* 1.25–1.30, *d*:*H* 1.53–1.62, h_{am} 0.43–0.61.
Distribution and age. Oxfordian of Europe, Syria; lower Kimmeridgian of Germany, Czechoslovakia and France; Callovian to lower Oxfordian of Madagascar.

Lenticulina polonica (Wisniowski)

Plate XV, fig. 16 a, b

Cristellaria polonica: Wisniowski, 1890, p. 222, pl. III, fig. 3.
Lenticulina polonica: Grigelis, 1985, p. 77, pl. XVI, fig. 1.
Specimen GIN RAN 4656/168 from the Middle Jurassic (Callovian), Jebel Shekif, Anti-Lebanon, Damascus–Beirut Highway 46km from Damascus, Wadi al Karn Syria.
Material. Twelve tests.
Dimensions (mm). *D* 0.42, *d* 0.32, *H* 0.12, *D*:*d* 1.31, *d*:*H* 2.66.
Distribution and age. Middle and upper Callovian of Europe; Callovian of Syria.

Lenticulina primaformis (Mjatliuk)

Plate XVI, fig. 16 a, b

Lenticulina primaformis: Myatlyuk, 1961, p. 146, pl. II, fig. 1.
Marginulinopsis primaformis: Grigelis, 1985, p. 133, pl. XXVII, fig. 8.
Specimen GIN RAN 4656/169 from the Upper Jurassic (Oxfordian), Jebel Shekif, Anti-Lebanon, Rowda village, near the town of Zabadani, Syria.
Material. Sixteen tests.
Dimensions (mm). *L* 0.80–0.96, L_s 0.44, L_u 0.66, *B* (B_s) 0.42, B_u 0.36, *H* (H_u) 0.30, *L*:*B* 4.57, *B*:*H* 1.40.
Distribution and age. Oxfordian of Europe and Syria.

Lenticulina russiensis (Mjatliuk)

Plate XVI, fig. 21 a, b

Cristellaria russiensis: Myatlyuk, 1939, p. 58, pl. IV, figs. 44–46.
Astacolus russiensis: Grigelis, 1985, p. 97, pl. XX, fig. 9.
Specimen GIN RAN 4656/170 from the Upper Jurassic (Oxfordian), Al Ghab rift zone, Coastal Mountains, Ain Khlakem village, Syria.
Material. Over 20 tests.
Dimensions (mm). *D* 0.96, *d* 0.66, *H* 0.38, h_{al} 0.38, *D*:*d* 0.45, *D*:*h* 1.74.
Distribution and age. Upper Oxfordian and Kimmeridgian of eastern European Platform; Kimmeridgian of western Siberia; Oxfordian of Syria.

Lenticulina subalata (Reuss)

Plate XVI, fig. 19 a, b

Cristellaria subalata: Reuss, 1863, p. 76, pl. 8, fig. 10, pl. 9, fig. 1 (*fide Catalogue of Foraminifera*, 1940).
non Lenticulina subalata: Bielecka and Pożaryski, 1954, p. 35, pl. IV, fig. 14; Bielecka, 1975, p. 337, pl. VII, figs. 1, 2, 3, I.
Specimen GIN RAN 4656/171 from the Lower Cretaceous (Barremian to lower Aptian), Jebel Shekif, Anti-Lebanon, Rowda village, near the town of Zabadani, Syria.
Material. About 20 tests.
Dimensions (mm). *D* 0.56, *d* 0.42, *H* 0.24, h_{al} 0.28, h_{am} 0.22, *D*:*d* 1.33, *d*:*H* 1.75.
Distribution and age. Middle Cretaceous (Albian to Turonian) of Germany; Barremian to lower Aptian of Syria.

Lenticulina sublenticularis (Schwager)

Plate XVI, fig. 17 a, b

Cristellaria sublenticularis: Schwager, *in* Waagen, 1866, p. 307, pl. II.
Lenticulina sublenticularis: Grigelis, 1985, p. 68, pl. XIV, figs. 5–9.
Specimen GIN RAN 4656/172 from the Upper Jurassic (Oxfordian), Jebel Shekif, Anti-Lebanon, Hadar village, near the town of Majdal Shams, Syria.
Material. About 15 tests.
Dimensions (mm). *D* 0.38–0.76, *d* 0.32–0.60, *H* 0.24–0.46, *D*:*d* 1.18–1.27, *d*:*H* 1.30–1.33.
Distribution and age. Oxfordian and Kimmeridgian of Europe; Oxfordian of Syria.

Lenticulina tympana Grigelis

Plate XVI, fig. 20 a, b

Lenticulina tympana: Grigelis, 1985, p. 73, pl. I, fig. II, pl. XV, fig. 3.
Specimen GIN RAN 4656/173 from the Upper Jurassic (Oxfordian), Jebel Sheikh, Anti-Lebanon, Hadar village, near the town of Majdal Shams, Syria.
Material. Twelve tests.
Dimensions (mm). *D* 0.86, *d* 0.70, *H* 0.40, h_{al} 0.44, h_{am} 0.34, *D*:*d* 1.23, *d*:*H* 1.75.
Distribution and age. Lower Oxfordian of Lithuania; Oxfordian of Syria.

Lenticulina varians (Bornemann)

Plate XVI, fig. 22

Cristellaria varians: Bornemann, 1854, p. 41, pl. IV, figs. 32–34 (*fide Catalogue of Foraminifera,* 1940).

Lenticulina varians: Bielecka et Pożaryski, 1954, p. 32, pl. IV, II.

Specimen GIN RAN 4656/250 from the Middle Jurassic (Bajocian), Jebel Sheikh, Anti-Lebanon, Arneh village, Syria.

Material. Six tests.

Dimensions (mm). *L* 0.44, *D* 0.32, *H* 0.2.

Distribution and age. Lower to Middle Jurassic of Germany; Middle to Upper Jurassic of Poland; Bajocian of Ukraine, northern Caucasus, Syria.

Genus *Astacolus* de Montfort, 1808

Type species. *Astacolus crepidularis* de Montfort, 1808; *Nautilus crepidulus* Fichtel et Moll, 1798.

Recent; Italy.

Lower Jurassic to Recent; cosmopolitan.

Astacolus folium (Wisniowski)

Plate XVI, fig. 1 a, b

Cristellaria folium: Wisniowski, 1890, p. 216, pl. II, fig. 27.

Astacolus folium: Bielecka, 1960, p. 57, pl. IV, fig. 27; Pyatkova et Permyakova, 1978, p. 72, pl. 25, fig. 2.

Specimen GIN RAN 4656/174 from the Upper Jurassic (Oxfordian), Jebel Shekif, Anti-Lebanon, Damascus-Beirut Highway, 46 km from Damascus, Wadi al Karn, Syria.

Material. Eight tests.

Dimensions (mm). *L* 0.58, B_s 0.28, B_u 0.22, H_s 0.16, H_u 0.14, *L*:*B* 2.07, *B*:*H* 1.75.

Distribution and age. Callovian of Poland and the Ukraine; Oxfordian of Syria.

Astacolus* aff. *incurvatus (Reuss)

Plate XVI, fig. 3 a, b

Specimen GIN RAN 4656/175 from the Lower Cretaceous (Barremian to lower Aptian), Jebel Shekif, Anti-Lebanon, Rowda village, near the town of Zabadani, Syria.

Material. Twelve tests.

Dimensions (mm). *L* 0.38, *B* 0.2, *H* 0.12.

Distribution and age. Barremian and Aptian of Europe and Syria.

Astacolus limataeformis (Mitjanina)

Plate XVI, fig. 2 a, b

Cristellaria limataeformis: Mityanina, 1955, p, 144, pl. IV, figs. 5–7.

Astacolus limataeformis: Grigelis, 1985, p. 92, pl. XIX, fig. 6.

Specimen GIN RAN 4656/176 from the Upper Jurassic (Oxfordian), Jebel Shekif, Anti-Lebanon, Damascus–Beirut Highway, 46 km from Damascus, Wadi al Karn, Syria.

Material. Eleven tests.

Dimensions (mm). *L* 0.52–0.64, *B* (B_s) 0.36–0.40, *H* (H_s) 0.16–0.20, *L*:*B* 1.44–1.60, *B*:*H* 2.0–2.25.

Distribution and age. Callovian of Lithuania, Belorussia, Poland; Oxfordian of Syria.

Astacolus vacillantes Espitalié et Sigal

Plate XVI, fig. 5 a, b

Astacolus vacillantes: Espitalié et Sigal, 1963, p. 24, pl. IV, figs. 15, 16, pl. V, figs. 1–6.

Specimen GIN RAN 4656/177 from the Upper Jurassic (Oxfordian), Jebel Shekif, Anti-Lebanon, Rowda village, near the town of Zabadani, Syria.

Material. About 20 tests.

Dimensions (mm). *L* 0.70, *B* (B_u) 0.44, *H* (H_s) 0.24, *L*:*B* 1.59, *B*:*H* 1.83.

Distribution and age. The hologype, corresponding with our specimens, was described from the Callovian to lower Oxfordian (Coenozone B) of Madagascar; Oxfordian of Syria.

Subfamily **Planulariinae** Putrja, 1970

Gewnus *Planularia* Defrance, *in* de Blainville, 1826

Type species. *Peneroplis auris* Defrance, *in* de Blainville, 1824. Pliocene; Italy.

Triassic to Recent; cosmopolitan.

Planularia tricarinella (Resuss)

Plate XVI, fig. 13 a, b

Cristellaria tricarinella: Reuss, 1863, p. 68, pl. 7, fig. 9, pl. 12, fig. 2–4

Specimen GIN RAN 4656/186 from the Upper Jurassic (Oxfordian), Jebel Shekif, Anti-Lebanon, Rowda village, near the town of Zabadani, Syria.

Material. Eight tests.

Dimensions (mm). *L* 1.1, *B* 0.4, *H* 0.3.

Distribution and age. Bathonian, Callovian, Oxfordian of Germany; Lower Cretaceous of Europe; Oxfordian, Kimmeridgian of central Russia; Oxfordian of Syria.

Planularia beierana (Gümbel)

Plate XVI, fig. 15 a, b

Marginulina beierana: Gümbel, 1862, p. 221, pl. 3, fig. 20.
Cristellaria manubrium: Schwager, 1865, p. 121, pl. 5, fig. 6.
Lenticulina (Planularia) beierana: Seibold et Seibold, 1956, p. 106, pl. 13, fig. 7.
Planularia beierana: Grigelis, 1985, p. 112, pl. XXIII, fig. 7, 8.
Specimen GIN RAN 4656/187 from the Oxfordian, Jebel Sheikh, Anti-Lebanon, Hadar village, Syria.
Material. Eleven tests.
Dimensions (mm). *L* 0.7, *B* 0.42, *H* 0.28.
Distribution and age. Oxfordian to lower Kimmeridgian of Europe; lower Kimmeridgian of Lithuania; Oxfordian of Syria.

Planularia cordiformis (Terquem)

Plate XVI, figs. 11, 12 a, b

Cristellaria cordiformis: Terquem, 1864, p. 203, pl. 9, fig. 14.
Planularia cordiformis: Bielecka et Pożaryski, 1954, p. 40, pl. 5, fig. 21; Hanzlikova, 1965, p. 79, pl. VII, fig. 10; Pyatkova et Permyakova, 1978, p. 78, pl. 27, fig. 6.
Specimens GIN RAN 4656/182 and 4656/183 from the Upper Jurassic (Oxfordian), Jebel Shekif, Anti-Lebanon, Rowda village, near the town of Zabadani, Syria.
Material. About 30 tests.
Dimensions (mm). *L* 0.62, *B* 0.18, *H* 0.08, *L*:*B* 3.44, *B*:*H* 2.25.
Distribution and age. Liassic to Tithonian of Europe; Oxfordian of Syria.

Planularia feifeli Paalzow

Plate XVI, figs. 8 a, b, 9 a, b, 10 a, b

Planularia feifeli: Paalzow, 1932, p. 105, pl. VI, figs. 11, 12,. Grigelis, 1985, p. 110, pl. XXII, fig. 11.
Specimens GIN RAN 4656/179 (pl. XVI, fig. 10) from the Kimmeridgian, Jebel Shekif, Anti-Lebanon, Damascus–Beirut Highway 46 km from Damascus, Wadi al Karn, Syria; 4656/180 and 4656/181 (Pl. XVI, figs. 8, 9) from the Oxfordian, Jebel Shekif, Anti-Lebanon, Rowda village, near the town of Zabadani, Syria.
Material. Twenty-nine tests.

Dimensions (mm). *L* 0.48–1.04, *B* 0.24–0.48, *H* 0.14–0.28, *L*:*B* 2.0–2.18, *B*:*H* 1.71.
Distribution and age. Oxfordian and Kimmeridgian of Europe; Kimmeridgian to lower Portlandian of Madagascar; Oxfordian and Kimmeridgian of Syria.

Planularia madagascariensis Espitalié et Sigal

Plate XVI, figs. 6 a, b, 7 a, b

Planularia madagascariensis: Espitalié et Sigal, 1963, p 28, pl. VI, figs. 8–11, pl. XXXIV, figs. 1–35; Kuznetzova and Gorbachik, 1985, p. 102, pl. XI, figs. 3–5.
Specimens GIN RAN 4656/178, 4656/229 from the Upper Jurassic (Oxfordian), Jebel Shekif, Anti-Lebanon, Rowda village, near the town of Zabadani, Syria.
Material. Six tests.
Dimensions (mm). *L* 0.58–0.8, *B* 0.34–0.40, *H* 0.10, *L*:*B* 1.7–2.0, *B*:*H* 3.4–4.0.
Distribution and age. Callovian to Valanginian of Madagascar; upper Tithonian to Valanginian of the Crimea; Oxfordian of Syria.

Planularia sp. 1

Plate XVI, fig. 14 a, b

Specimen GIN RAN 4656/188 from the Upper Jurassic (Oxfordian), Jebel Sheikh, Hadar village, near the town of Majdal Shams, Syria.
Material. Six tests.
Description. Test small, flattened, moderately elongate, rounded at the base and tapering at the apertural end with curved dorsal, and straight ventral and septal margins; almost the whole test spirally wound, consisting of nine minute triangular chambers, only final chamber broader, inner end does not reach whorl; sutures flush, indistinct; periphery carinate to rounded; septal surface narrow, with tapering ends; aperture small, terminal; wall with smooth, matte surface.
Dimensions (mm). *L* 0.32–0.46, *B* 0.14–0.24, *H* 0.05–0.08, *L*:*B* 1.92–2.29, *B*:*H* 2.8–3.0.
Distribution and age. Oxfordian of Syria.

Family **Vaginulinidae** Reuss, 1860

Subfamily **Vaginulininae** Reuss, 1860

Genus *Citharina* d'Orbigny, *in* de la Sagra

Type species. *Vaginulina (Citharina) strigillata* Reuss, 1846. Cretaceous; Czechoslovakia.
Jurassic to Palaeocene; cosmopolitan.

Citharina entypomatus Loeblich et Tappan

Plate XVII, figs. 1 a, b, 2 a, b

Citharina entypomatus: Loeblich et Tappan, 1950, p. 57, pl. XV, figs. 1–2.

Specimens GIN RAN 4656/189 and 4656/230 from the Upper Jurassic (Oxfordian), Jebel Shekif, Anti-Lebanon, Rowda village, near the town of Zabadani, Syria.

Material. Over 30 tests.

Dimensions (mm). *L* 0.96–2.06, *B* 0.42–0.60, *H* 0.16, *L*:*B* 2.28–3.60, *B*:*H* 2.62–3.74, ∠ 30–33°.

Distribution and age. Oxfordian of South Dakota, USA; Syria.

Citharina lepida (Schwager)

Plate XVII, figs. 3 a, b, 5 a, b

Cristellaria lepida: Schwager, 1867, p. 657, pl. XXXIV, fig. 9.

Citharina lepida: Lutze, 1960, p. 461, pl. III, figs. 2–4.

Citharina aff. *lepida:* Grigelis, 1985, p. 120, pl. XXIV, fig. 7.

Specimens GIN RAN 4656/192 and 4656/193 from the Oxfordian (Plate XVII, fig. 3), the Kimmeridgian (Plate XVII, 5), Jebel Shekif, Anti-Lebanon, Rowda village, near the town of Zabadani, Syria.

Material. About 50 well-preserved tests.

Dimensions (mm). *D* 1.1, *B* 0.8, *H* 0.2, 4656/193: *L* 1.4, *B* 0.8, *H* 0.24.

Distribution and age. Lower Bathonian, lower and middle Oxfordian of Germany; middle Oxfordian of Lithuania; Oxfordian and Kimmeridgian of Syria.

Citharina paralella (Bielecka et Pożaryski)

Plate XVII, fig. 7 a, b

Vaginulina zaglobensis var. *paralella:* Bielecka et Pożaryski, 1954, p. 45, pl. VI, fig. 27.

Citharina paralella: Grigelis, 1985, p. 121, pl. IV, fig. 1, pl. XXV, figs. 3–5; Kuznetsova and Gorbachik, 1985, p. 107, pl. XI, fig. 1.

Specimen GIN RAN 4656/195 from the Upper Jurassic (Oxfordian), Jebel Shekif, Anti-Lebanon, Damascus–Beirut Highway 46km from Damascus, Wadi al Karn, Syria.

Material. Fifteen tests.

Dimensions (mm). *L* 0.76–0.96, *B* 0.36–0.38, *H* 0.28, *L*:*B* 2.11–2.32, *B*:*H* 1.28–1.39.

Distribution and age. Kimmeridgian and Tithonian of Europe; Oxfordian of Syria.

Citharina sokolovae (Mjatliuk)

Plate XVII, figs. 4 a, b, 6 a, b

Vaginulina sokolovae: Myatlyuk, 1961, p. 152, pl. III, fig. 5.
Citharina sokolovae: Grigelis, 1985, p. 118, pl. XXIV, fig. 5.
Specimens GIN RAN 4656/194 and 4656/196 from the Upper Jurassic (Oxfordian), Jebel Shekif, Anti-Lebanon, Rowda village, near the town of Zabadani, Syria.
Material. Over 20 well-preserved tests.
Dimensions (mm). *L* 1.20, *B* 0.44–0.50, *H* 0.10–0.12, *L*:*B* 2.40–2.72, *B*:*H* 4.17–4.40.
Distribution and age. Oxfordian of Europe and Syria.

Subfamily **Marginulininae** Wedekind, 1937

Genus *Marginulinopsis* A. Silvestri, 1904

Type species. *Marginulinopsis densicostata* Thalmann, 1937.
Recent; Atlantic Ocean.
Upper Triassic to Recent; cosmopolitan.

Marginulinopsis irretitus (Schwager)

Plate XVII, fig. 8 a, b

Cristellaria irretita: Schwager, 1865, p. 123, pl. V, fig. II
Lenticulina (Astacolus) irretita: Seibold et Seibold, 1956, p. 117, text fig. 3, pl. VII, fig. 2.
Lenticulina (Hemicristellaria) irretita: Mityanina, 1963, p. 147, pl. V, figs. 5–8.
Astacolu irretitus: Winter, 1970, p. 15, pl. 2, fig. 3–7.
Specimen GIN RAN 4656/197 from the Upper Jurassic (Oxfordian), Jebel Shekif, Anti-Lebanon, Damascus-Beirut Highway 46km from Damascus, Wadi al Karn, Syria.
Material. Eight tests.
Dimensions (mm). *L* 0.32, *B* 0.20, *H* 0.14, *L*:*B* 1.06, *B*:*H* 1.04.
Distribution and age. Oxfordian of Europe and Syria: lower Kimmeridgian of Germany.

Marginulinopsis suprajurassicus (Schwager)

Plate XVI, fig. 4 a, b, Pl. XVII, fig. 9 a, b, 10 a, b

Cristellaria suprajurassica: Schwager, 1865, p. 130, pl. 6, figs. 11, 12.
Lenticulina (Astacolus) suprajurassicus: Seibold et Seibold, 1956, p. 122, text fig. 3, o, p, pl. 7, fig. 4.
Astacolus suprajurassicus: Winter, 1970, p. 17, text fig. II, pl. III, fig. 63.
Specimens GIN RAN 4656/183 and 4656/184 (Pl. XVI, fig. 4, Pl. XVII, fig. 9) from the Upper Jurassic, Jebel Sheikh, near Hadar, Majdal Shams area, Syria; 4656/185 (pl. XVII, fig. 10) from the Upper Jurassic, Jebel Shekif, Anti-Lebanon, Rowda village, near the town of Zabadani, Syria.
Material. Eleven tests.
Dimensions (mm). *L* 0.36–0.58, B_s 0.12–0.18, B_u 0.14–0.20, *H* 0.10–0.18, *L*:*B* 2.90, B_u:*H* 1.11.
Distribution and age. Oxfordian to lower Kimmeridgian of Germany; Oxfordian of Syria.

Family **Polymorphinidae** d'Orbigny, 1839

Subfamily **Guttulininae Kusina,** 1973

Genus *Eoguttulina* Cushman et Ozawa, 1930

Type species. *Eoguttulina anglica* Cushman et Ozawa, 1930. Upper Cretaeceous; England.
Upper Triassic to Upper Cretaceous of Europe, eastern Meditternanean, North and South America.

Eoguttulina bilocularis (Terquem)

Plate XVIII, fig. 1 a, b

Polymorphina bilocularis: Terquem, 1864b, p. 293, pl. II, figs. 9–11.
Eoguttulina bilocularis: Bielecka, 1960, p. 83, pl. VII, fig. 60; Winter, 1970, p. 39, pl. 4, fig. 34.
Specimen GIN RAN 4656/198 from the Upper Jurassic (Oxfordian), Coastal Mountains, Sindianeh village, near the town of Misyaf, Syria.
Material. 18 tests.
Dimensions (mm). *L* 0.42, *D* 0.18, *L*:*D* 2.33.
Distribution and age. Lower, Middle and Upper Jurassic of Europe; Oxfordian of Syria.

Eoguttulina cruciata (Terquem)

Plate XVIII, fig. 2 a, b

Polymorphina cruciata: Terquem, 1874, p. 30, pl. 32, fig. 13.

Eoguttulina cruciata: Pyatkova et Permyakova, 1978, p. 103, pl. XXXXIV, fig. 7.

Specimen GIN RAN 4656/199 from the Upper Jurassic (Oxfordian), Coastal Mountains, Sindianeh village, near the town of Misyaf, Syria.

Material. Seven tests.

Dimensions (mm). *L* 0.45, *D* 0.20–0.25, *L*:*D* 1.8–2.25.

Distribution and age. Bajocian of France, Poland; Oxfordian of Ukraine and Syria.

Eoguttulina sp. 1

Plate XVIII, fig. 3 a, b

Specimen GIN RAN 4656/200 from the Upper Jurassic (Oxfordian), Coastal Mountains, Sindianeh village, near the town of Misyaf, Syria.

Description. Test small, inequilateral-rhomboid, laterally inflated, with two broad chambers visible on each side; irregular oval in cross section; chambers semi-evolute, arranged in spiral at 80–120° (in plan view); sutures narrow, slightly depressed, skewed obliquely to the test; aperture terminal, radiate; wall thin, opaque, surface smooth.

Dimensions (mm). *L* 0.52, *D* 0.34, *L*:*D* 1.53.

Distribution and age. Oxfordian of Syria.

Genus *Globulina* d'Orbigny, *in* de la Sagra, 1839

Type species. *Polymorphina (Globulines) gibba* d'Orbigny, 1826. Miocene, Austria.

Jurassic; cosmopolitan.

Globulina oolithica (Terquem)

Plate XVIII, fig. 4 a, b

Polymorphina oolithica: Terquem, 1874, p. 209, pl. 32, figs. 1–10.

Globulina oolithica: Grigelis, 1985, p. 139, pl. XXIX, fig. 7.

Specimen GIN RAN 4656/201 from the Upper Jurassic (Oxfordian), Coastal Mountains, Sindianeh village, near the town of Misyaf, Syria.

Material. About 30 tests.

Dimensions (mm). *L* 0.39, *D* 0.20, *L*:*D* 1.9.

Distribution and age. Bathonian to Kimmeridgian of Europe, Callovian to lower Oxfordian of Madagascar; Oxfordian of Syria.

Subfamily *Webbinellinae* Rhumbler, 1904

Genus *Bullopora* Quenstedt

Type species. *Bullopora rostrata:* Quenstedt, 1857. Upper Jurassic; Germany. Jurassic to Cretaceous, cosmopolitan.

Bullopora rostrata Quenstedt

Plate XVIII, fig. 5

Bullopora rostrata: Quenstedt, 1857, p. 580, pl. 73, fig. 28; Winter, 1970, p. 40, pl. 4, fig. 139; Kuzina, 1976, p. 122, pl. XXIII, fig. 1.
Specimen GIN RAN 4656/202 from the Lower Cretaceous (Barremian to lower Aptian), Al Ghab rift zone, Coastal Mountains, Al Bustan village, Syria.
Material. Five tests.
Dimensions (mm). *L* 0.64, *D* 0.12, *d* (tubes) 0.04.
Distribution and age. Upper Jurassic of Europe; Tithonian, Barremian to lower Aptian of Syria.

Family **Conorboididae** Thalmann, 1952

Subfamily **Conorboidinae** Reuss, 1963

Genus *Conorboides* Hofker, *in* Thalmann, 1952

Type species. *Conorboides mitra* Hofker, 1951. Albian; the Netherlands, Jurassic to lower Cretaceous of Europe, eastern Mediterranean and North America.

Conorboides querdahensis Grigelis et K. Kuznetsova, *sp. nov.*

Plate XVIII, figs. 6 a, b, 7 a, b, 8 a–c

"querdahensis" (Latin) from Querdaha, the locality.
Holotype GIN RAN 4656/203, Syria, paratypes GIN RAN 4656/204 and 4656/205 from the Upper Jurassic (Oxfordian), Coastal Mountains, Dahr al Killin village, near the town of Misyaf, Syria.
Material. Forty tests.
Description. Test trochospiral, small to medium sized, plano-convex, rounded or ovate in outline; up to two whorls visible from the convex dorsal side; chambers half-moon-shaped, increasingly rapidly as added, with the first whorl very small and similar to the proloculus; six to seven chambers in the final whorl, with their inner ends merging in a narrow umbilicus on the flattened ventral side; periphery tapering; sutures narrow, flush and curved on the dorsal side, slightly depressed on ventral side; aperture a narrow, inner umbilical slit; apertural flap indistinct due to poor preservation; wall calcareous, surface smooth, shiny.
Dimensions (mm) of holotype and other specimens. D_1 0.44–0.64, D_2 0.34–0.44, *H* 0.12, *H*:*D* 0.28.

This species is characterized by the peculiar shape of the test and the spiral structure, and so it is easily detected in assemblages.
Distribution and age. Oxfordian of Syria.

Conorboides paraspis (Schwager)

Plate XVIII, figs. 9 a–c, 10

Rosalina paraspis: Schwager, 1866, p. 310, text fig. 16 (*fide Catalogue of Foraminifera*, 1940).
Conorboides ex gr. paraspis: Hanzlikova, 1965, p. 94, pl. VIII, figs. 3, 4.
Specimen GIN RAN 4656/206 (fig. 9) from the Upper Jurassic (Oxfordian) Jebel Shekif, Anti-Lebanon, Rowda village, near the town of Zabadani, Syria; 4656/207 (fig. 10) from the Upper Jurassic (Oxfordian), As-Satteh, the Palmyrides, Wadi Hayan, Syria.
Material. Sixteen tests.
Dimensions (mm). *D* 0.24, *H* 0.12, *H*:*D* 0.5 (fig. 9).
Remarks. This species is rare and inadequately studied. Our specimens are comparable with those figured by Hanzlikova (1965), but differ in being smaller and having less chambers in the final whorl.
Distribution and age. First described from the Oxfordian of the French Alps; upper Oxfordian to Kimmeridgian (Klentnice Beds) of Czechoslovakia; Oxfordian of Syria.

Family **Ceratobuliminidae** Cushman, 1927

Subfamily **Ceratobuliminae** Cushman, 1927

Genus *Ceratolamarckina* Troelsen, 1954

Type species. *Ceratobulimina tuberculata* Brotzen, 1948. Palaeocene; Denmark. Jurassic to Palaeocene; cosmopolitan.

Ceratolamarckina subspeciosa Bogdanovich et Markarjeva

Plate XVIII, fig. 11 a–c

Ceratolamarckina subspeciosa: Bogdanovich and Makarjeva, 1959, p. 11, text figs. 2, 4, 5.
Specimen GIN RAN 4656/208 from the Upper Jurassic (Oxfordian), Jebel Shekif, Anti-Lebanon, Damascus-Beirut Highway 46km from Damascus, Wadi al Karn, Syria.
Material. Nine tests.
Dimensions (mm). *D* 0.19, *H* 0.12, *H*:*D* 0.63.
The apertured structure of the genus was described in Palaeocene specimens (Loeblich et Tappan, 1988, p. 441). The small size of the Jurassic forms allows, to a certain degree, a tentative determination of the genera of Upper Jurassic species

such as *Ceratolamarckina speciosa* Dain, *C. prescula* Kassimova and *C. uncata* Vuke.

Distribution and age. Oxfordian of northern Caucasia, Syria.

Genus *Cancrisiella* Dain, 1980

Type species. *Ceratocancris ambitiosus* Dain, 1972. Kimmeridgian; Polar Urals. Upper Jurassic to Lower Cretaceous of Europe, eastern Mediterranean, Asia.

Cancrisiella rowdaensis Grigelis et Kuznetsova, *sp. nov.*

Plate XVIII, fig. 12 a, b

"rowdaensis" (Latin) from Rowda, the locality.

Holotype GIN RAN 4656/209 from the Upper Jurassic (Oxfordian), Jebel Shekif, Anti-Lebanon, Rowda village, near the town of Zabadani, Syria.

Material. Thirteen well-preserved tests.

Description. Test trochospiral, small, almost circular in plan view, with convex dorsal and flattened ventral sides, even in outline; periphery rounded; more than two whorls on the spiral side, with five chambers in the early whorl and three chambers in the final whorl; chambers narrow, elongate on the dorsal side and trapeziform on the ventral side, slightly inflated, separated by narrow, slightly depressed sutures; apertural face of the final chamber is somewhat elevated above the slightly depressed umbilicus and has a short, tongue-like lobe with a slit-like aperture beneath it; internal structure of aperture may be lost in the less well-preserved specimens; wall calcareous with smooth surface.

Dimensions (mm) of holotype. *D* 0.20–0.22, *H* 0.18, *H*:*D* 0.8–0.9.

Upper Jurassic specimens of the genus are inadequately studied. They are reported here for the first time from the Oxfordian.

Distribution and age. Oxfordian of Syria.

Genus *Paulina* Grigelis, 1977

Type species. *Paulina furssenkoi*, Grigelis, 1977. Oxfordian; Lithuania. Middle and Upper Jurassic of Europe and eastern Mediterranean.

Paulina paula (Pazdro)

Plate XVIII, fig. 26 a, b

Conorboides paulus: Pazdro, 1969, p. 76, pl. VIII, figs. 4–8.

Paulina paula: Grigelis, 1985, p. 144, pl. XXX, figs. 4–8.

Specimen GIN RAN 4656/251 from the Upper Jurassic (Oxfordian), Coastal Mountains, the eastern Maareen near the the town of Querdaha, Syria.

Material. Ten tests.

Dimensions (mm). D_1, 0.32, D_2, 0.28, *H* 0.2, *H*:D_1 0.6.

Distribution and age. Bathonian of Poland, Lithuania and Syria.

Subfamily **Reinholdellinae** Seiglie et Bermudez, 1965

Genus *Pseudolamarckina* Mjatliuk, 1959

Type species. *Pulvinulina rjasanensis* Uhlig, 1883. Callovia; Russia (Ryazan).

Pseudolamarckina hadari Grigelis et K. Kuznetsova, *sp. nov.*

Plate XVIII, fig. 13 a–c

"hadari" (Latin) from Hadar, the locality.

Holotype GIN RAN 4656/210 from the Upper Jurassic (Oxfordian), Anti-Lebanon, Jebel Shekif, Hadar village, near the town of Majdal Shams, Syria.

Material. Eleven specimens with satisfactory preservation.

Description. Test trochospiral, medium sized, plano-convex, almost circular in plan view, slightly irregular in outline; dorsal portion moderately convex, two or more flatly coiled whorls with two or more chambers; six to seven chambers in the final whorl; chambers in the first (earlier) whorl narrow, triangular, in the second (final) whorl they are elongate and wing like; spiral and septal sutures flush, limbate; ventral portion flattened; rounded-triangular chambers in the final whorl, separated by narrow, flush sutures, are visible on the ventral side; small umbilical lobe in the umbilical area (generally indistinct due to poor preservation); peripheral margin tapering; aperture slit-like, interiomarginal, with a loop in the middle of the margin of the final chamber (indistinct); inner structure of the aperture unknown; wall calcareous with a smooth surface, hyaline.

Dimensions (mm) of holotype. D_1 0.50, D_2 0.40, H 0.16, $H{:}D_1$ 0.32.

Distribution and age. Oxfordian of Syria.

Genus *Lamarckella* Kaptarenko-Chernousova, 1956

Type species. *Lamarckella media* Kaptarenko-Chernousova, 1956. Upper Bajocian; Ukraine.

Lower and Middle Jurassic of the Ukraine and Syria.

Lamarckella media Kaptarenko-Chernousova

Plate XVIII, fig. 17 a, b

Lamarckella media: Kaptarenko-Chernousova, 1956, p. 59, pl. 1, fig. 8, 1959, p. 94, pl. XI, figs. 14, 15, pl. XII, figs. 1–3; Pyatkova and Permyakova, 1978, p. 114, pl. 40. fig. 3.

Specimen GIN RAN 4656/211 from the Middle Jurassic (Bajocian), Anti-Lebanon, Jebel Sheikh, Arneh village, Syria.

Material. Five well-preserved tests.

Dimensions (mm). D_1 0.38, D_2 0.29, H 0.23.

Distribution and age. Aalenian and Bajocian of Ukraine, Poland and Sweden; Bajocian of Moldavia, northern Causcasus, Syria.

Family **Epistominidae** Wedekind, 1937

Subfamily **Epistomininae** Wedekind, 1937

Genus *Epistomina* Terquem, 1883

Type species. *Epistomina regularis* Terquem, 1883. Upper Bajocian; France. Lower Jurassic to Lower Cretaceous; cosmopolitan.

Epistomina coronata Terquem

Plate XVIII, figs. 14–16

Epistomina coronata: Terquem, 1883, p. 378, pl. 43, fig. 9; 1969, p. 54, pl. IV, figs. 3, 4, pl. XIII, figs. 5, 7; Grigelis, 1985, p. 148, pl. XXXII, fig. 6.
Specimen GIN RAN 4656/212, 4656/213, 4656/214 from the Middle Jurassic (Bajocian), Anti-Lebanon, Jebel Sheikh, Arneh village, Syria.
Material. Six tiny, well-preserved tests.
Dimensions (mm). D_1 0.1–0.2, D_2 0.09–0.18, H 0.05–0.08.
Remarks. Our specimens differ in being half the size of those reported from the Bajocian of France, Poland, and from the upper Bathonian of Lithuania.
Distribution and age. Aalenian and Bajocian of Ukraine and Poland; Bajocian of Moldavia, northern Caucasus, Syria; upper Bathonian of Lithuania.

Epistomina nemunensis Grigelis

Plate XVIII, fig. 23 a–c

Epistomina nemunensis: Grigelis, 1985, p. 157, pl. VI, fig. 4, pl. XXXV, fig. 3.
Specimen GIN RAN 4656/215 from the Upper Jurassic (Oxfordian), Anti-Lebanon, Jebel Sheikh, Hadar village, near the town of Majdal Shams, Syria.
Material. Eighteen test with satisfactory preservation.
Dimensions (mm). D_1 0.40–0.60, D_2 0.40–0.36, H 0.30, $H{:}D_1$ 2.0.
Distribution and age. Oxfordian of Lithuania, Belorussia, the Ukraine, Moscow syncline, Caspian area, Mangyshlak, Caucasus and Syria.

Epistomina paralimbata Grigelis

Plate XVIII, fig. 24 a–c

Epistomina paralimbata: Grigelis, 1985, p. 155, pl. VI, fig. 1, pl. XXXIV, fig. 6.
Specimen GIN RAN 4656/216 from the Upper Jurassic (Oxfordian), Anti-Lebanon, Jebel Sheikh, Hadar village, near the town of Majdal Shams, Syria.
Material. Seven tests.
Dimensions (mm). D_1 0.82, D_2 0.62, H 0.38; degree of convexity, $h_v : h_d$ 2.8.
Distribution and age. Oxfordian of Ukraine, Lithuania and Syria.

Epistomina uhligi Mjatliuk

Plate XVIII, fig. 25 a–c

Epistomina uhligi: Myatlyuk, 1953, p. 219, pl. II, fig. 2; Grigelis, 1985, p. 150, pl. XXXIII, fig. 4.
Specimen GIN RAN 4656/217 from the Upper Jurassic (Oxfordian), Anti-Lebanon, Jebel Sheikh, Hadar village, near the town of Majdal Shams, Syria.
Material. Six tests.
Dimensions (mm). D 0.32, H 0.22, $D{:}H$ 1.45.
Distribution and age. Upper Callovian, Oxfordian and Kimmeridgian of Europe; Oxfordian of Syria.

Epistomina turgidula Pazdro

Plate XVIII, figs. 18–22

Epistomina turgidula: Pazdro, 1969, p. 66, pl. VII, fig. 1, pl. XIV, figs. 3, 4; Grigelis, 1985, p. 148, pl. XXXII, fig. 3.
Specimens GIN RAN 4656/218–4656/222 from the Middle Jurassic (upper Bathonian), Coastal Mountains, Wadi Jahannam, Syria.
Material. Thirteen tests with satisfactory preservation.
Dimensions (mm). D_1 0.33–0.44, D_2 0.26–0.4, H 0.18–0.25, $D_1{:}D_2$ 1.1–1.3, $D_2{:}H$ 1.24–2. There are 7–9 chambers in the final whorl.
Remarks. In shape and size of the test our specimens are fully comparable with those described from the Bathonian and the Callovian of Poland (Pazdro, 1969). They differ from specimens described from the upper Bathonian of Lithuania (Grigelis, 1985), in the larger size and greater number of chambers in the final whorl.
Distribution and age. Middle Bathonian and Callovian of Poland; upper Bathonian of Lithuania and Syria.

Family **Globuligerinidae** Loeblich et Tappan, 1984

Subfamily **Globuligerininae** Loeblich et Tappan, 1984

Test wall tubercular or with occasional ridges, unevenly porous, pores filling space between tubercles or ridges.

Genus *Globuligerina* Bignot et Guyader, 1971.

Type species. *Globigerina oxfordiana* Grigelis, 1958. Oxfordian; Lithuania. Middle to Upper Jurassic; cosmopolitan.

Globuligerina bathoniana (Pazdro)

Plate XV, figs. 14 a, b

Globuligerina bathoniana: Pazdro, 1969, p. 45, pls II–IV, figs. 1–16; Banner *et al.*, 1988, pl. I, fig. 4.

Specimens GIN RAN 4656/157 from the Middle Jurassic (upper Bathonian), Coastal Mountains, Wadi Jahannam, Syria.,

Material. About 20 tests.

Dimensions (mm) of specimen 4656/157. D_1 0.46, D_2 0.38, H 0.39.

Distribution and age. Middle Bathonian of Poland; Bathonian of Crimea, the Caucasus, Syria.

Globuligerina oxfordiana (Grigelis)

Plate XV, fig. 24

Globigerina oxfordiana: Grigelis, 1958, p. 110, text fig. Bignot and Guyader, 1971, pl. I, figs. 1–4, pl. 2, figs. 3, 4.

Globuligerina oxfordiana: Grigelis, 1985, p. 179, pl. VIII, fig. 6, pl. XXXIV, fig. 3.

Specimen GIN RAN 4656/247 from the Upper Jurassic (lower Oxfordian), Palmyrides, As-Satteh, Wadi Hayan, north-east of Palmyra, Syria.

Material. Nine tests.

Dimensions (mm). D_1 0.30–0.36, D_2 0.24–0.30, H 0.19–0.20.

Distribution and age. Lower Oxfordian of Lithuania, Eastern European platform, Paris Basin, Sweden, Canada, the Crimea and Syria.

CHAPTER 8
CONCLUSIONS

A foraminiferal fauna that is rich in both taxonomic composition and in numbers of, was studied from the Jurassic of Syria (Lias–Tithonian inclusive). This fauna can be classified with the cyclamminid-pfenderinid type, which inhabited the tropical and subtropical Jurassic Tethyan basin. It shows the following unusual features: a high degree of endemism, a predominance of benthonic species, rare to uncommon planktonic species, a high generic (105 genera from 46 families) and species (more than 300 species) diversity, and a high productivity and population density.

Detailed study of the foraminifera from numerous sections (94 exposures in over 50 sections) allowed the small-scale stratigraphic subdivision of the Jurassic. Palaeontological evidence is first provided for the Lias, the Aalenian and the Bajocian, and the Bathonian and the Oxfordian are divided into substages. Foraminiferal zones have been recognized in all the stratigraphic units studied.

There are different levels of foraminiferal zonation for the Jurassic of Syria: from the standard stratigraphic zones, which have an almost global extent, to local zones, ecozones and faunal marker beds. The former include the lower Oxfordian *Lenticulina brueckmanni–Globuligerina oxfordiana* Zone and the Tithonian *Anchispirocyclina lusitanica* Zone.

The *Lenticulina volubilis–Epistomina coronata*, the *Lenticulina polymorpha-Globuligerina bathoniana* and the *Alveosepta jaccardi–Lenticulina quenstedti* zones, reported from the Bajocian, the Bathonian and the upper Oxfordian, respectively, provide examples of local zones, traced in Syria, the Crimea, Caucasus and, in part, Western Europe. The following ecozones are recognized: the *Timidonella sarda* Ecozone, confined to the upper Bajocian of the Anti-Lebanon; the *Haurania deserta–Protopeneroplis striata* and the *Kilianina blancheti-Meyendorffina bathonica* ecozones (lower and upper Bathonian, respectively, of the Coastal Mountains), and the *Kurnubia palastiniensis–Palaeopfenderina salernitana* Zone from the Callovian of the Coastal Mountains. Faunal marker beds were recognized in some regions of Syria, in incomplete Liassic, Aalenian, Bajocian, Bathonian, Oxfordian and Kimmeridgian sections.

Analysis of the taxonomic composition of communities and their geographical ranges makes it possible to recognize three types of faunal groupings (subtypes of fauna), differing at a family level in the ratio of dominant to minor components. The first type, characteristic of the Bathonian and Callovian of the Coastal Mountains, the Bathonian of the Palmyrides and the Kurd-Dag, and the Tithonian of the Anti-

Lebanon and the Coastal Mountains, is dominated by tropical Tethyan endemics of the families Pfenderinidae, Cyclamminidae, Dictyoconidae, Coskinolinidae and Ventrolaminidae. The second type is dominated by boreal–cosmopolitan faunal elements of the families Lenticulinidae, Vaginulinidae, Epistominidae, Polymorphinidae and Lituolidae, with the Tethyan endemics rare to absent. The range and stratigraphic position of these communities are typical to the Bajocian, Bathonian, Callovian and lower Oxfordian of the Anti-Lebanon. The third type includes communities of a mixed composition, with varying ratio of Tethyan endemics to migrant species. Such an assemblage composition was recorded in the Oxfordian of the Coastal Mountains and in the Kimmeridgian of the Anti-Lebanon.

The geographical ranges of genera from the Jurassic communities imply that almost all the Tethyan endemic genera, as well as subtropical generic taxa, reported from the northern margin of Tethys in the Crimea, the Caucasus, eastern Europe, also occur in Syria. Their migration westward in a roughly latitudinal direction was confined to the African–Mediterranean province. The generic composition of the communities, their endemism, taxonomic diversity and high population density enable us to distinguish the Jurassic eastern Mediterranenan as a separate Arabian subprovince of the African-Mediterranean province. It may be assumed that in Jurassic times these Tethyan palaeobasins were the site of the appearance and dispersal of benthonic foraminiferal faunas, migrating from there throughout the Mediterranean realm.

The variations in the foraminiferal faunas caused by the dynamics of the Mediterranean Jurassic marine basins allow us to determine a number of phases, differing in the composition, structure and distribution of foraminiferal communities. In extent, most of the phases are equivalent to a geological age (or stage in terms rock units). Based on the biological features of foraminifera discussed, two major stages (megaphases) in their evolution can be recognized, namely the early to middle Jurassic and late Jurassic to early Cretaceous megaphases. Their recognition is based on the following criteria: the morphotype of the dominant taxa, the degree of endemism, environmental tolerance, rate of evolution, rate at which different coiling modes appear and the extent of their geographical ranges. Comparison of the phases and megaphases suggests that evolutionary changes in faunas took place much more slowly than faunal changes directly related to abiotic environmental factors.

The most obvious times of rapid change in the composition of the faunas, and the appearance of new taxa are: at the base of Bathonian; in the upper Bathonian; at the beginning of Oxfordian; and at the base of Tithonian. All of these levels are marked by the appearance of new *genera*.

In the Middle Jurassic (Aalenian–Callovian), all the new genera appearing there are tropical endemics. From the late Jurassic (Oxfordian–Tithonian) up to the early Cretaceous (Berriasian–Barremian), the new elements of the communities are represented exclusively by sub-Tethyan genera whose ranges are much wider and often exceed the confines of the tropical region of the Tethys.

The Jurassic/Cretaceous boundary in Syria is considered in a new way. Evidence from the evolution of foraminifera suggests that pre-Cretaceous uplift and erosion occurred only over part of the Syrian region. The duration of the pause in deposition at the Jurassic/Cretaceous boundary was shorter than has been assumed previously, i.e. Tithonian/Aptian and, in the most complete sections, is confined to parts of the Berriasian, Valanginian and lower Hauterivian. Continuous sections of Jurassic/Cretaceous boundary deposits (in the Anti-Lebanon and the Coastal Mountains) show a successive change in the faunal composition from the Jurassic to the Cretaceous, when faunas are studied at the species level only.

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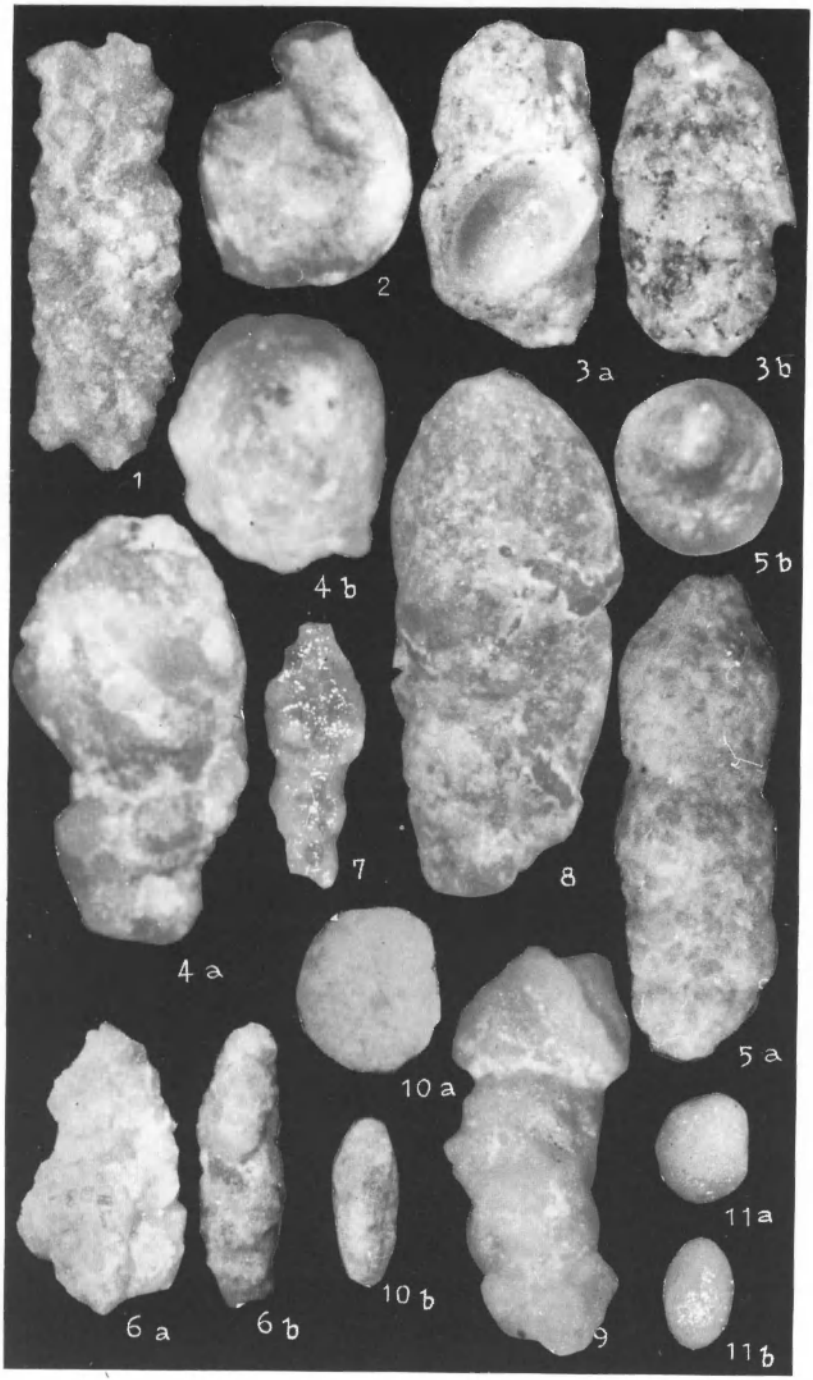
PLATE SECTION

PLATE I



EXPLANATION TO PLATES

All figures are ×42, unless otherwise stated.

PLATE I

1. *Rhizammina rudis* Kaptarenko Sample 140, Dahr Al Killin, exposure 9a, Callovian.
2. *Lituotuba nodus* Kosyreva Sample 51, Wadi al Karn, exposure 5, Callovian.
3. *Reophax barnardi* Said et Barakat Sample 134, Al Bustan, Barremian–lower Aptian, specimen with ostracod valve agglutinated in the wall. **a**, **b**, lateral views.
4. *Reophax hounstoutensis* Lloyd Sample 12, Wadi al Karn, exposure 1, Kimmeridgian. **a** lateral view, **b** apertural view.
5. *Reophax horridus* (Schwager) Sample 9, Wadi al Karn, exposure 1, Oxfordian. **a** lateral view, **b** apertural view.
6. *Reophax folkestoniensis* Chapman Sample 124, Al Bustan, Barremian–lower Aptian. **a**, **b** lateral views.
7. *Reophax sterkii* Haeusler Sample 449–3, Rowda, exposure 34, Oxfordian, lateral views.
8. *Reophax ex gr. toarcensis* Makarjeva, with *Bullopora rostrata* Quenst. test on the surface. Sample 9, Wadi al Karn, exposure 5, Oxfordian.
9. *Reophax metensis* Franke Sample 595, Wadi Jahannam, exposure 39, upper Bathonian, lateral view.
10. *Evolutinella evoluta* (Alekseeva) Sample 133, Al Bustan, Barremian–lower Aptian. **a** lateral view, **b** periphery.
11. *Haplophragmoides* cf. *rotundatus* Barnard Sample 446–2, Rowda, exposure 34, Oxfordian. **a** lateral view, **b** periphery.

PLATE II

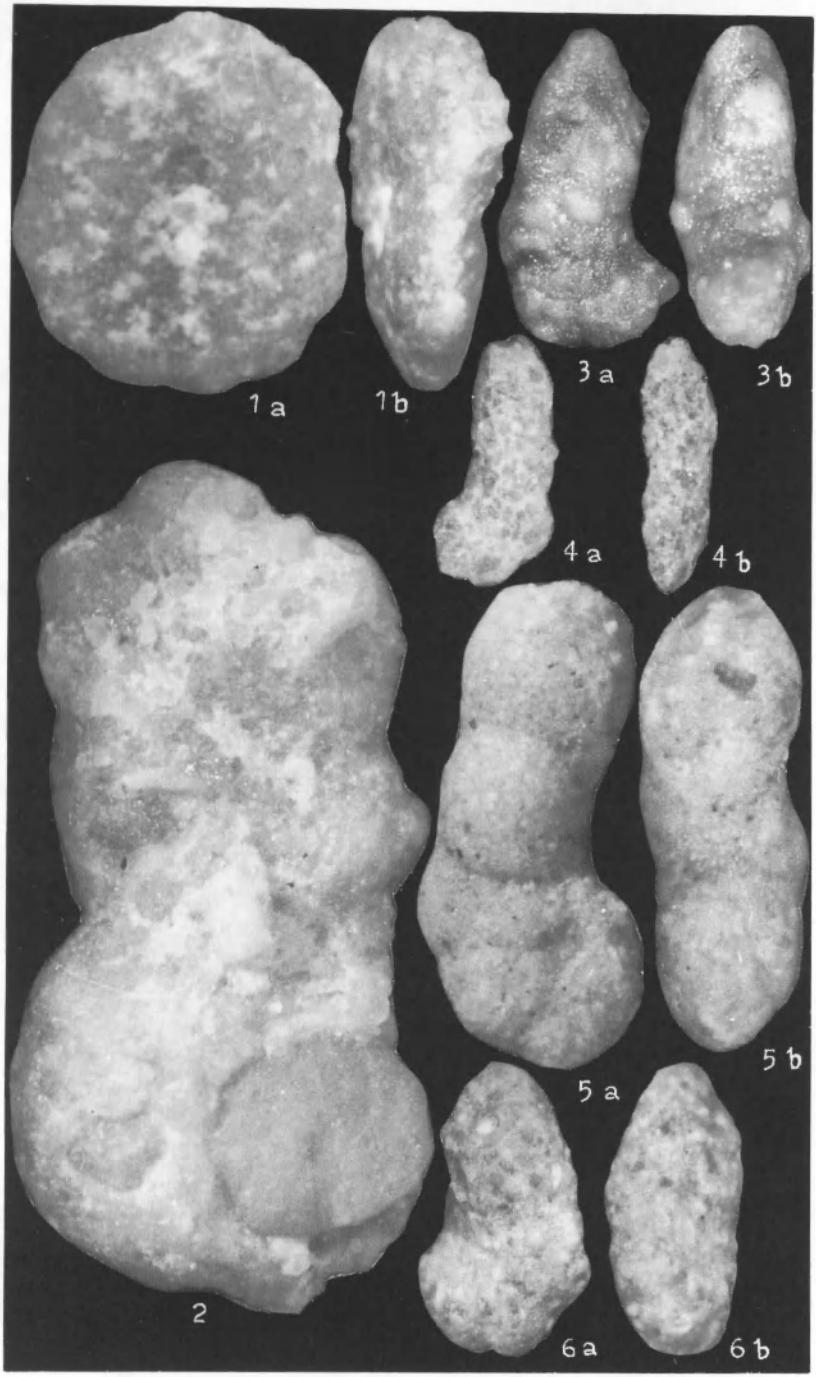


PLATE II

1. *Evolutinella* sp. 1 Sample 168, Bekraka, exposure 11, Oxfordian. **a** lateral view, **b** periphery.

2. *Kutsevella albustanensis* Grigelis et K. Kuznetzova, *sp. nov.* Large specimen with *Choffatella* test agglutinated in the wall, sample 137; Al Bustan, Barremian–lower Aptian. lateral view.

3. *Ammobaculites coprolithiformis* (Schwager) Sample 446–1, Rowda, exposure 34, Oxfordian. **a** lateral view, **b** periphery.

4. *Ammomarginulina subcretacea* (Cushman et Alexander) Sample 134, Al Bustan, Barremian–lower Aptian, **a** lateral view, **b** periphery.

5, 6. *Ammobaculites hagni* Bhalla et Abbas **5**: sample 278, Ain Khlakem, exposure 20, Oxfordian; **a** lateral view, **b** periphery. **6**: sample 688, Hadar, exposure 41, Oxfordian; **a** lateral view, **b** periphery.

PLATE III

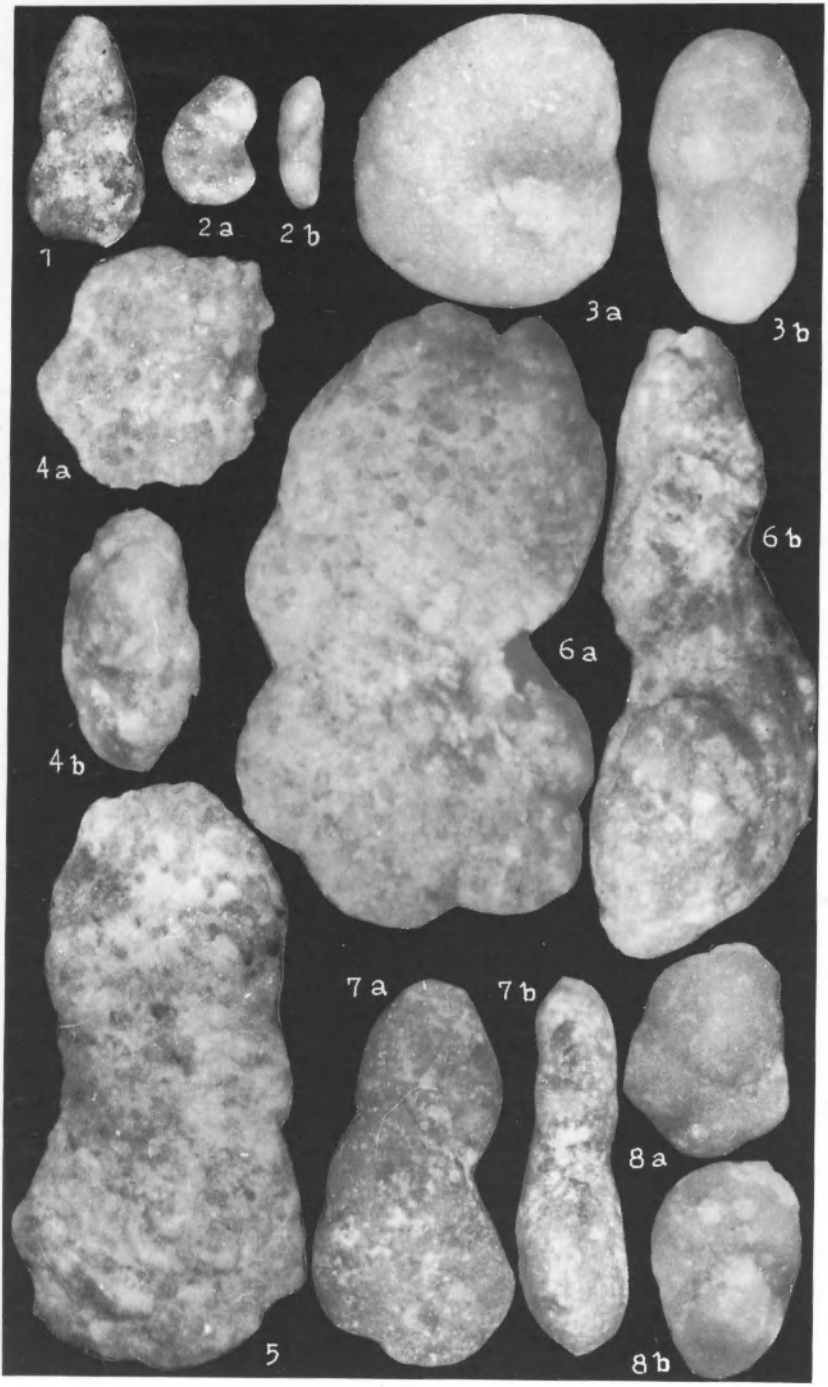


PLATE III

1. *Ammocbaculites sequanus* Mohler Sample 441–1, Rowda, exposure 34, Oxfordian. Lateral view.

2. *Ammobaculites suprajurassicus* (Schwager) Sample 446–2, Rowda, exposure 34, Oxfordian. **a** lateral view, **b** periphery.

3. *Haplophragmoides* sp. 1 Sample 277, Ain Khlakem, exposure 20, Oxfordian. **a** lateral view, **b** periphery.

4, 5. *Ammobaculites tobolskensis* Levina **4**: juvenile specimen in which the adult uniserial part is not developed, sample 10, Wadi al Karn, exposure 1, Oxfordian, **a** lateral view, **b** periphery. **5**: adult specimen with uniserial part, lateral view, locality and age the same.

6. *Kutsevella ex gr. infravolgensis* (Mjatliuk) Sample 134, Al Bustan, Barremian–lower Aptian. **a** lateral view, **b** periphery.

7. *Ammobaculites* sp. 5 Sample 431, Rowda, exposure 33, Tithonian. **a** lateral view, **b** periphery.

8. *Ammobaculites* sp. Juvenile specimen, sample 262, Teir Jamleh, Oxfordian, view 19. **a** lateral view, **b** periphery.

PLATE IV

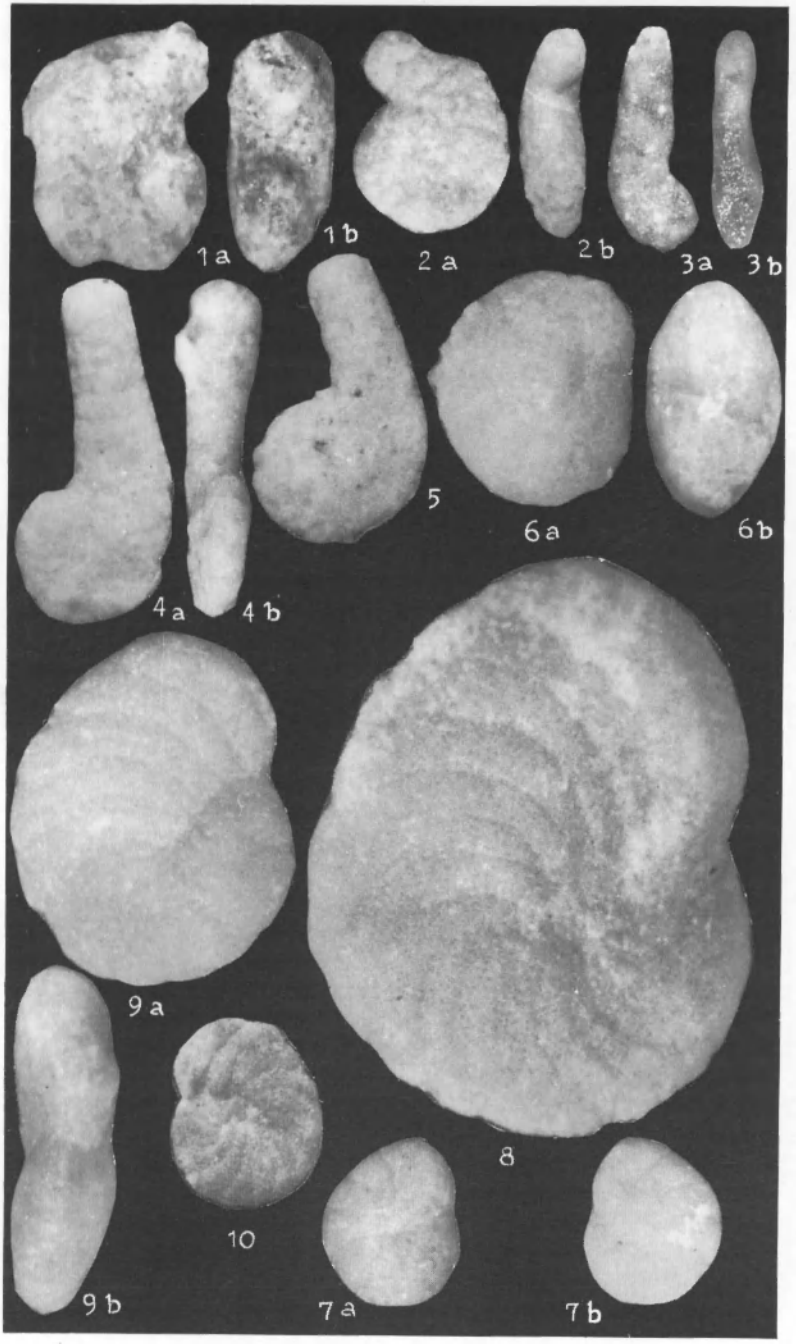


PLATE IV

1. *Kutsevella ex gr. infravolgensis* (Mjatliuk) Sample 134, Al Bustan, exposure 22, Barremian–lower Aptian. **a** lateral view, **b** periphery.

2, 4, 5. *Lituola* aff. *compressa* Cushman et Glažewski **2**: sample 134, Al Bustan, exposure 22, Barremian–lower Aptian. **4**: sample 133, locality and age the same. **5**: sample 134, locality and age the same, **a** lateral view, **b** periphery.

3. *Lituola podolica* Cushman et Glažewski Sample 446–2, Rowda, exposure 34, Oxfordian. **a** lateral view, **b** periphery.

6. *Debarina* sp. Sample 307a, Al Bustan, exposure 22, Barremian–lower Aptian. **a** lateral view, **b** periphery.

7. *Recurvoides concavus* (Bartenstein and Brand) Sample 133, Al Bustan, exposure 22, Barremian–lower Aptian. **a**, **b** opposite lateral views.

8, 9, 10. *Choffatella decipiens* Schlumberger **8**: sample 817, Sad al Karn, exposure 51; Tithonian. **9**: sample 308, Al Bustan, exposure 22; Barremian–lower Aptian. **10**: sample 816, Sad al Karn, exposure 51, Tithonian. **a** lateral view, **b** periphery.

PLATE V

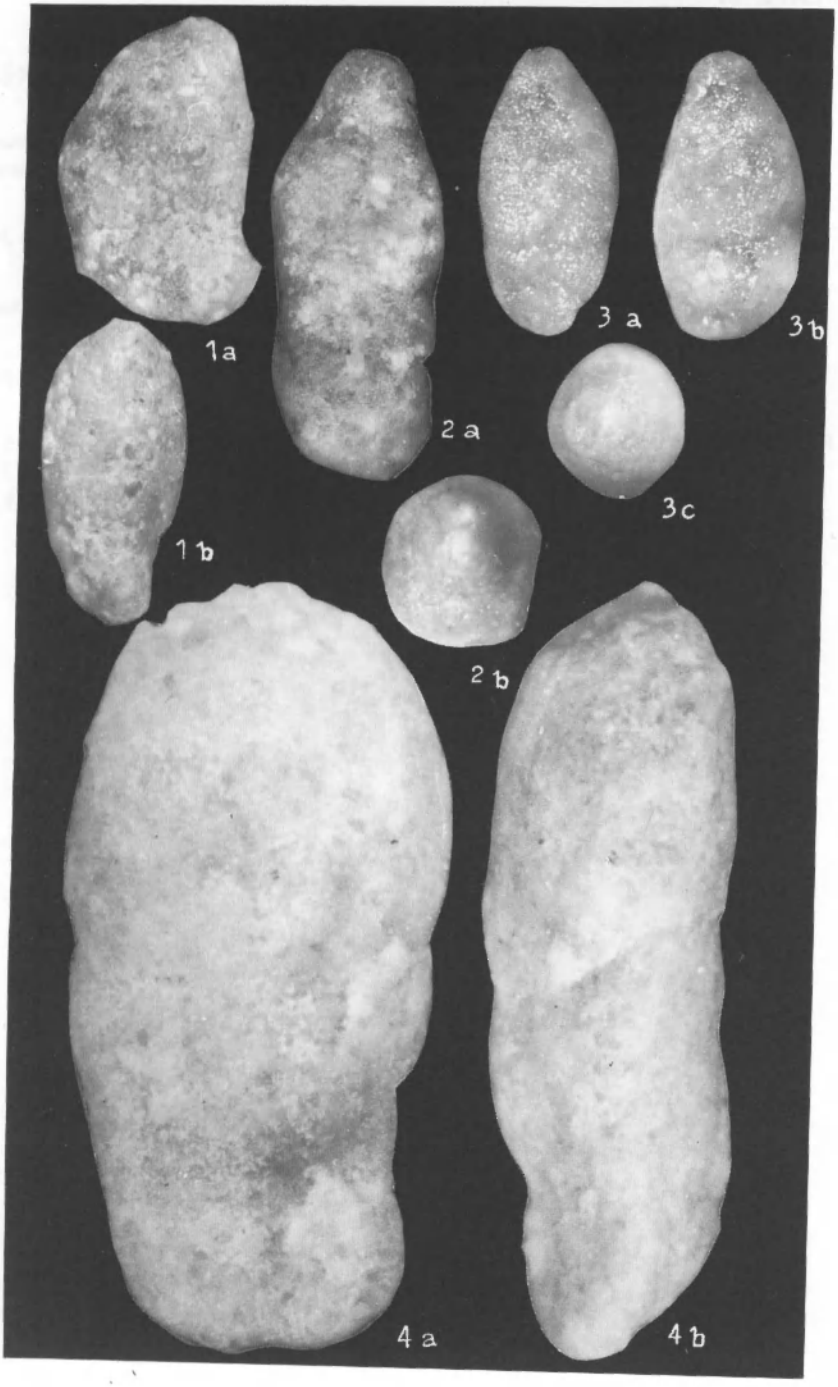


PLATE V

1. *Haplophragmium subaequale* (Mjatliuk) Sample 441, Rowda, exposure 34, Oxfordian. **a** lateral view, **b** periphery.

2, 3. *Haplophragmium aequale* (Roemer) **2**: sample 449–3, Rowda, exposure 34, Oxfordian; **a** lateral view, **b** apertural surface. **3**: sample 449–3, Rowda; **a**, **b** lateral views, **c** apertural surface.

4. *Haplophragmium ex gr. monstratus* (Dain) Sample 277, Ain Khlakem, exposure 20, Oxfordian. **a** lateral view, **b** periphery.

PLATE VI

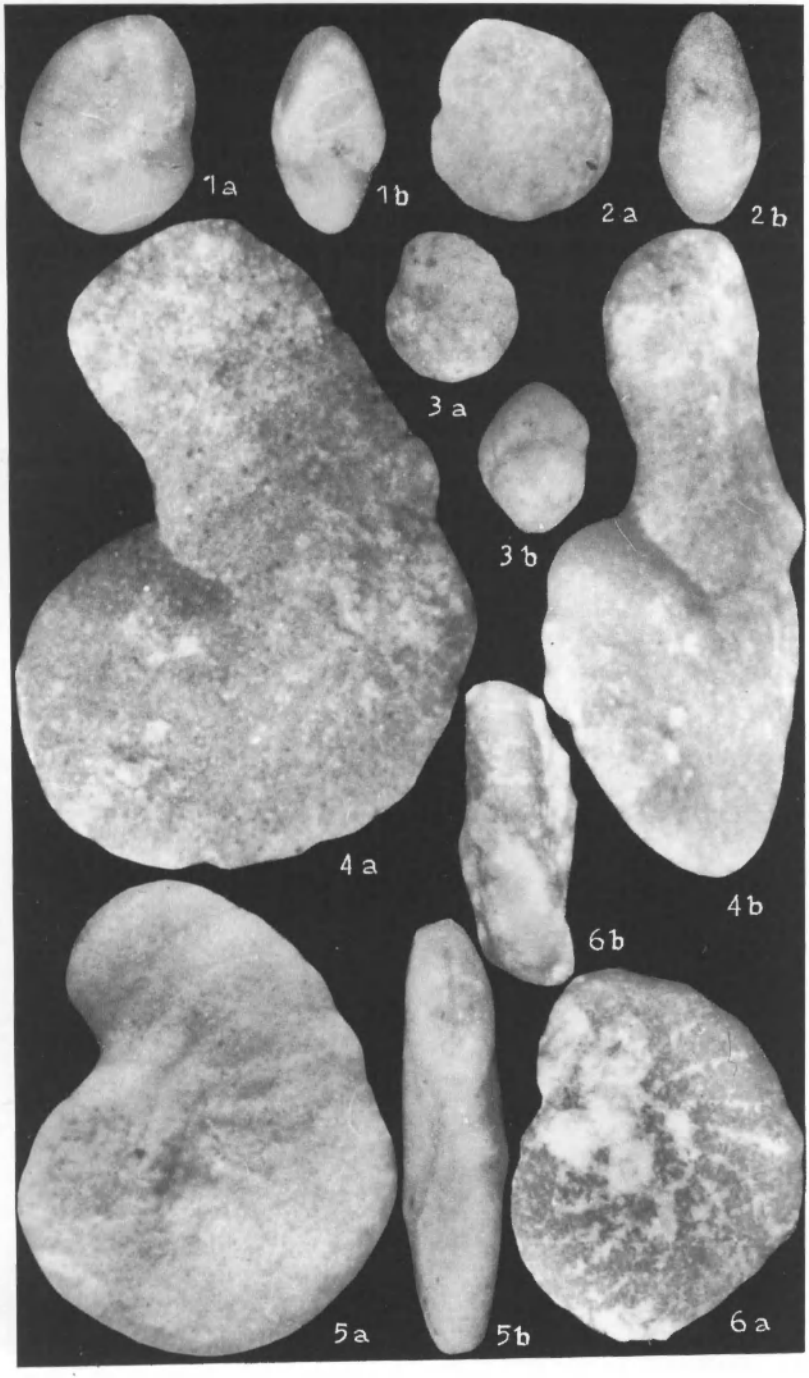


PLATE VI

1. *Melathrokerion* sp. 1 Sample 272, Ain Khlakem, exposure 20, Oxfordian. **a** lateral view, **b** periphery.
2. *Melathrokerion eospirialis* Gorbatchik Sample 90, Wadi al Karn, exposure 6, Tithonian. **a** lateral view, **b** periphery.
3. *Melathrokerion spirialis* Gorbatchik Juvenile specimen, sample 307a, AL Bustan, exposure 22, Barremian–lower Aptian. **a** lateral view, **b** periphery.
4. *Charentia* aff. *evoluta* (Gorbatchik) Sample 300, Al Bustan, exposure 22, Neocomian. **a** lateral view, **b** periphery.
5. *Charentia arabica* Tobolina, K. Kuznetsova et Grigelis *sp. nov.* Sample 272, Ain Khlakem, exposure 20, Oxfordian. **a** lateral view, **b** periphery.
6. *Charentia evoluta* (Gorbatchik) Sample 93–1, Wadi al Karn, exposure 6, Tithonian. **a** lateral view, **b** periphery.

PLATE VII

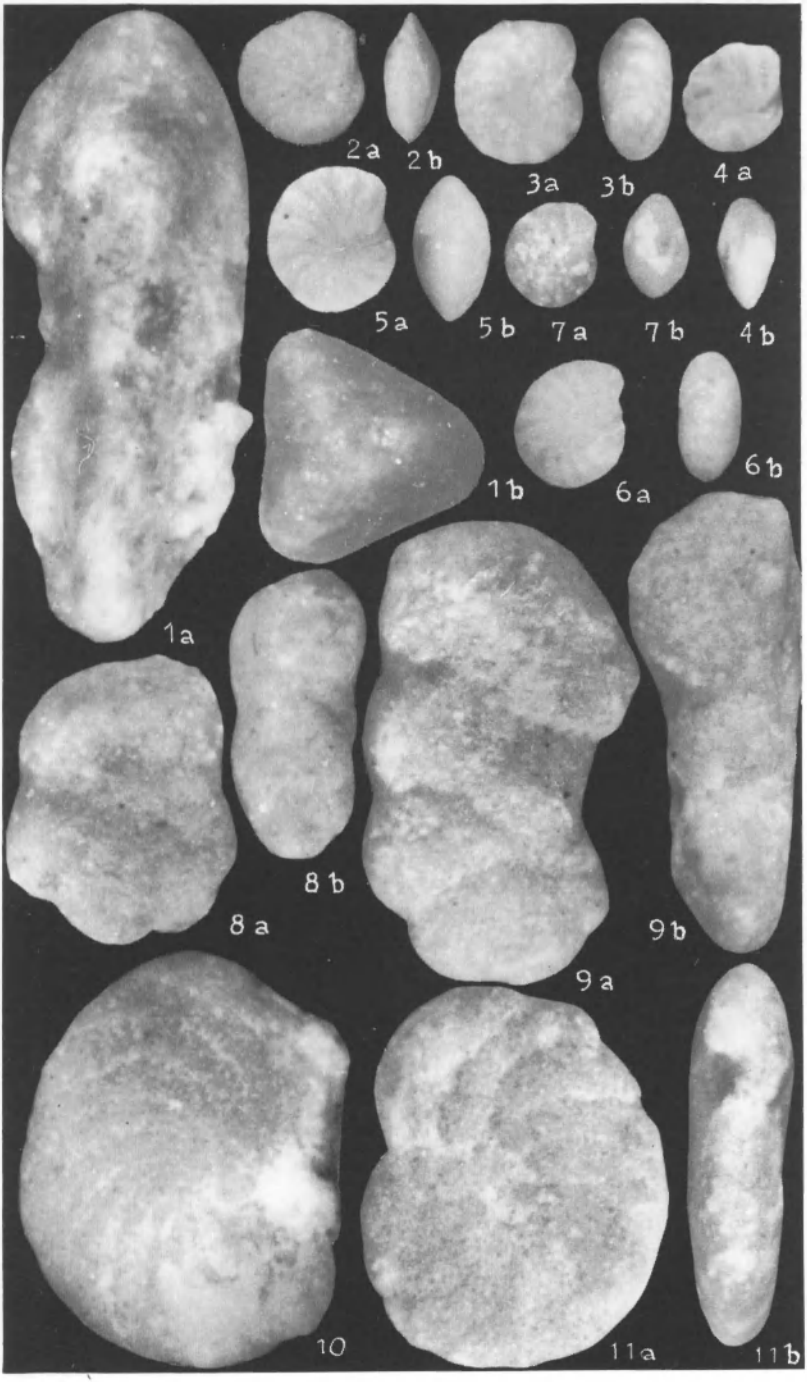


PLATE VII

1. *Triplasia elegans* (Mjatliuk) Sample 12, Wadi al Karn, exposure 1, Kimmeridgian. **a** lateral view, **b** apertural surface.

2–6. *Nautiloculina oolithica* Mohler **2**: sample 150, Sindianeh, exposure 10, Oxfordian; **a** lateral view **b** periphery. **3**: sample 12, Wadi al Karn, exposure 1, Kimmeridgian; **a** lateral view, **b** periphery. **4**: sample 138, Dahr Al Killin, outcrop 9a, Callovian; **a** lateral view, **b** periphery. **5**: sample 272, Ain Khlakem, exposure 20, Oxfordian; **a** lateral view, **b** periphery. **6**: sample 307a, Al Bustan, exposure 22, Barremian–lower Aptian; **a** lateral view, **b** periphery.

7. *Nautiloculina* sp. 1 Sample 93, Wadi al Karn, exposure 6, Tithonian, **a** lateral view, **b** periphery.

8, 9. *Everticyclammina virguliana* (Koechlin) Sample 278, Ain Khlakem, exposure 20, Oxfordian. **8**: juvenile specimen; **9**: adult specimen, **a** lateral view, **b** periphery.

10. *Choffatella alkarnensis* Tobolina et K. Kuznetsova, *sp. nov.* Sample 90, Wadi al Karn, exposure 6, Tithonian. **a** lateral view.

11. *Alveosepta jaccardi* (Schrodt) Sample 272, Ain Khlakem, exposure 20, Oxfordian. **a** lateral view, **b** periphery.

PLATE VIII

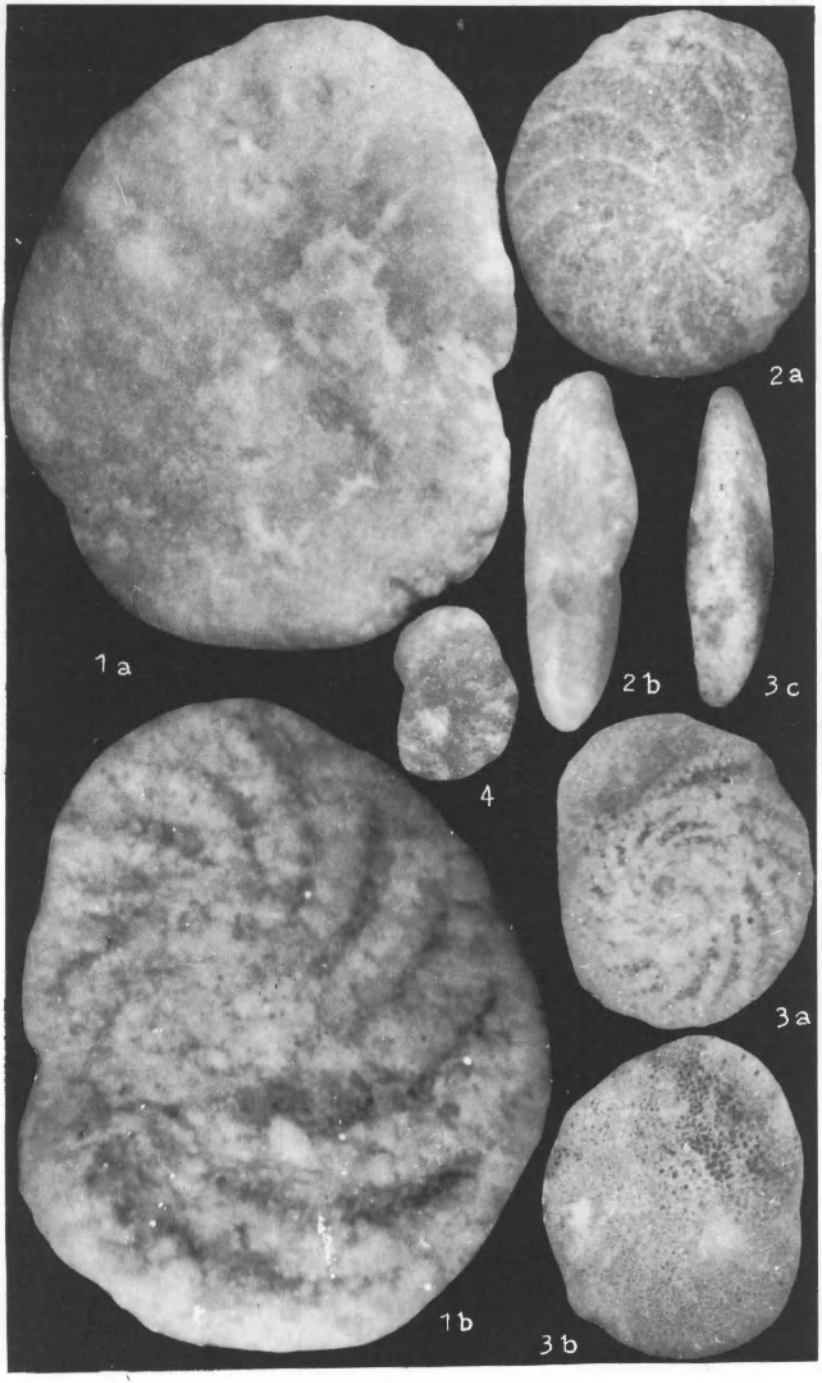


PLATE VIII

1. *Pseudocyclammina maynci* Hottinger Sample 168, Bekraka, exposure 11, Oxfordian. **a**, **b**, opposite lateral views.
2. *Choffatella decipiens* Schlumberger Sample 11, Rowda, exposure 7, Barremian–lower Aptian. **a** lateral view, **b** periphery.
3. *Alveosepta powersi* (Redmond) Sample 430, Rowda, exposure 33, Tithonian. **a**, **b** opposite lateral views **c** periphery.
4. *Dhrumella evoluta* Redmond Sample 595, Wadi Jahannam, upper Bathonian, lateral view.

PLATE IX

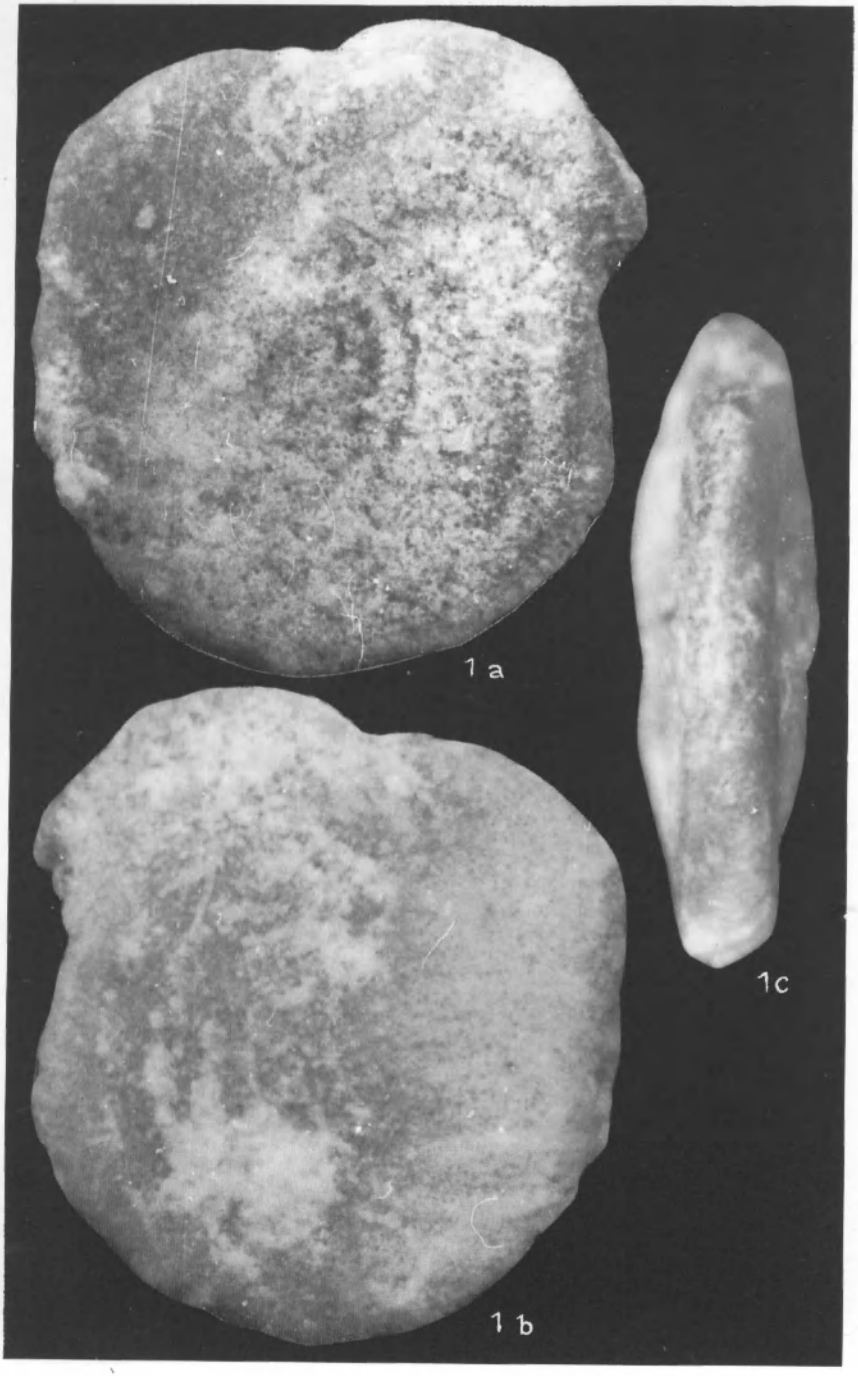


PLATE IX

1. *Anchispirocyclina lusitanica* (Egger) Sample 93–1, Wadi al Karn, exposure 6. **a**, **b** lateral views of opposite sides, **c** periphery.

PLATE X

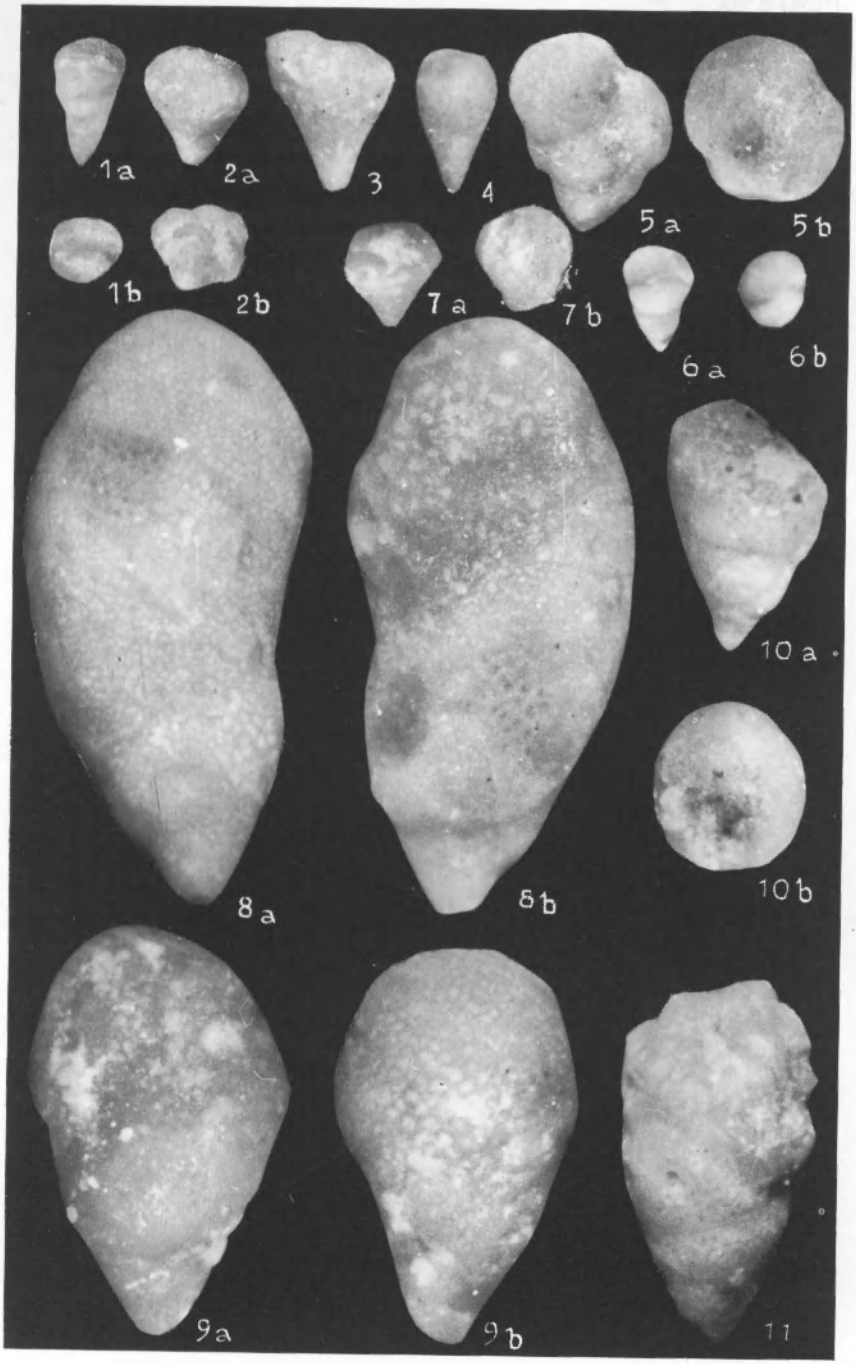


PLATE X

1. *Marssonella jurassical* Mitjanina Sample 440–1, Rowda, exposure 34, Oxfordian. **a** lateral view, **b** apertural surface.

2–4. *Redmondoides medius* (Redmond) Sample 604, Wadi Jahannam, exposure 39, upper Bathonian. **2: a** lateral surface; **2: b** apertural view; **3**, **4:** lateral views.

5. *Eomarssonella querdahensis* K. Kuznetsova et Grigelis, *sp. nov.* Sample 609, Wadi Jahannam, exposure 39, upper Bathonian. **a** lateral view, **b** apertural view.

6. *Marssonella haeusleri* (Groiss) Sample 12, Wadi al Karn, exposure 1, Kimmeridgian. **a** lateral view, **b** apertural view.

7. *Verneulinoides jannamensis* Grigelis et K. Kuznetsova, *sp. nov.* Sample 595, Wadi Jahannam, exposure 39, upper Bathonian. **a** lateral view, **b** apertural view.

8–11. *Steinkella steinekei* Redmond **8**, **9:** sample 221, Wadi Shkeir, exposure 14, Oxfordian lateral views., **10**, **11:** sample 150, Sindianeh, exposure 10, Oxfordian. **10:** juvenile specimen, **a** lateral view, **b** apertural view. **11** lateral view.

PLATE XI

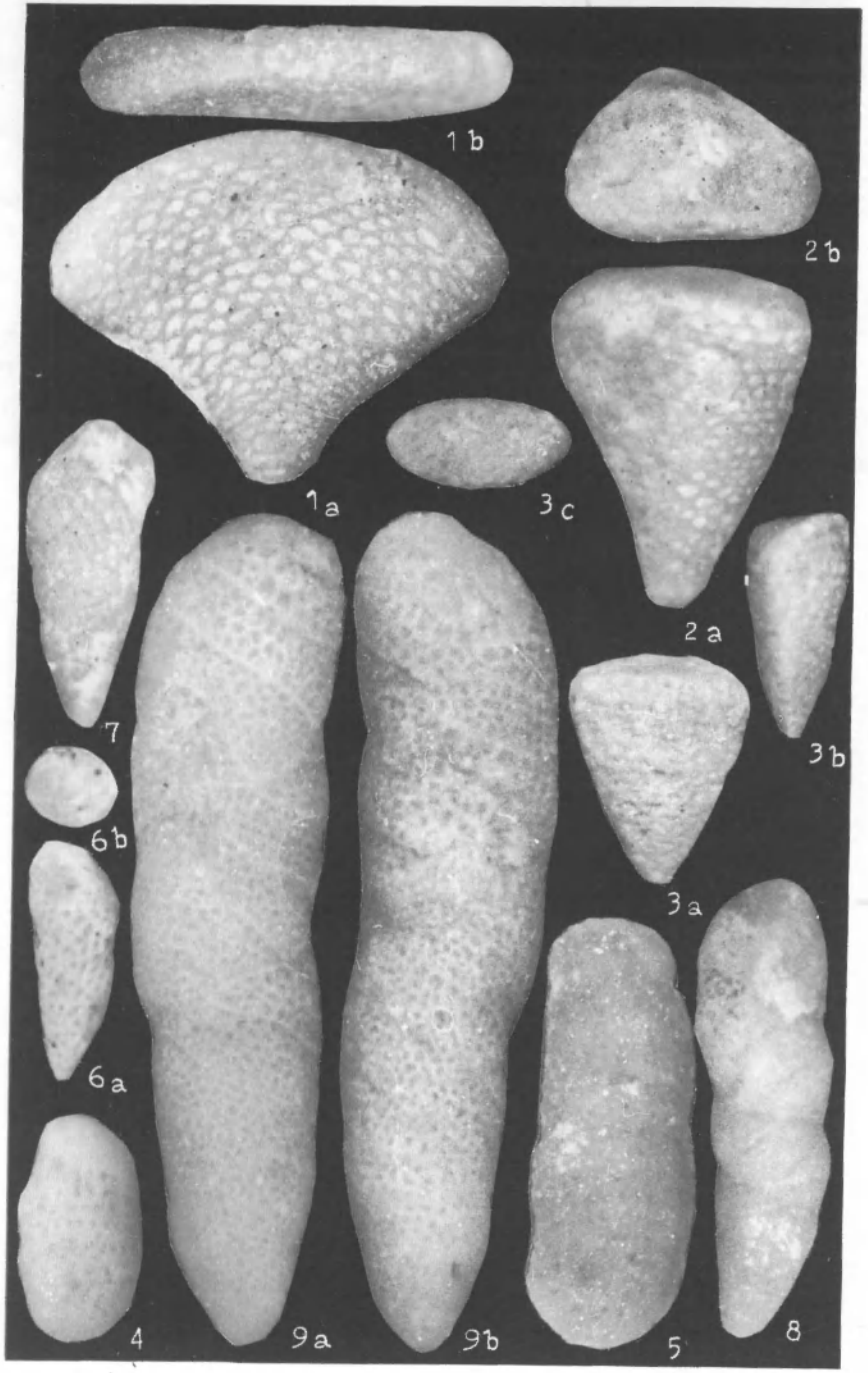


PLATE XI

1–3. *Kilianina blancheti* Pfender **1**: sample 604, Wadi Jahannam, exposure 39, upper Bathonian; **a** lateral view, **b** apertural view. **2**: sample 604, locality and age the same; **a** lateral view, **b** apertural surface. **3**: sample 604, locality and age the same; **a**, **b** lateral views, **c** apertural surface.

4, 5. *Meyendorffina bathonica* Aurouze et Bizon Sample 595, Wadi Jahannam, exposure 39, upper Bathonian. Lateral views.

6. *Praekurnubia crusei* Redmond Sample 54, Wadi al Karn, exposure 5, Callovian. **a** lateral view, **b** apertural view.

7, 8. *Kurnubia bramkampi* Redmond **7**: sample 604, Wadi Jahannam, exposure 39, upper Bathonian; lateral view. **8**: sample 140, Dahr Al Killin, exposure 9. Bathonian; lateral view.

9. *Kurbubia palastiniensis* Henson Sample 292, Teir Jamleh, exposure 21, Oxfordian. Adult specimen, **a**, **b** lateral view.

PLATE XII

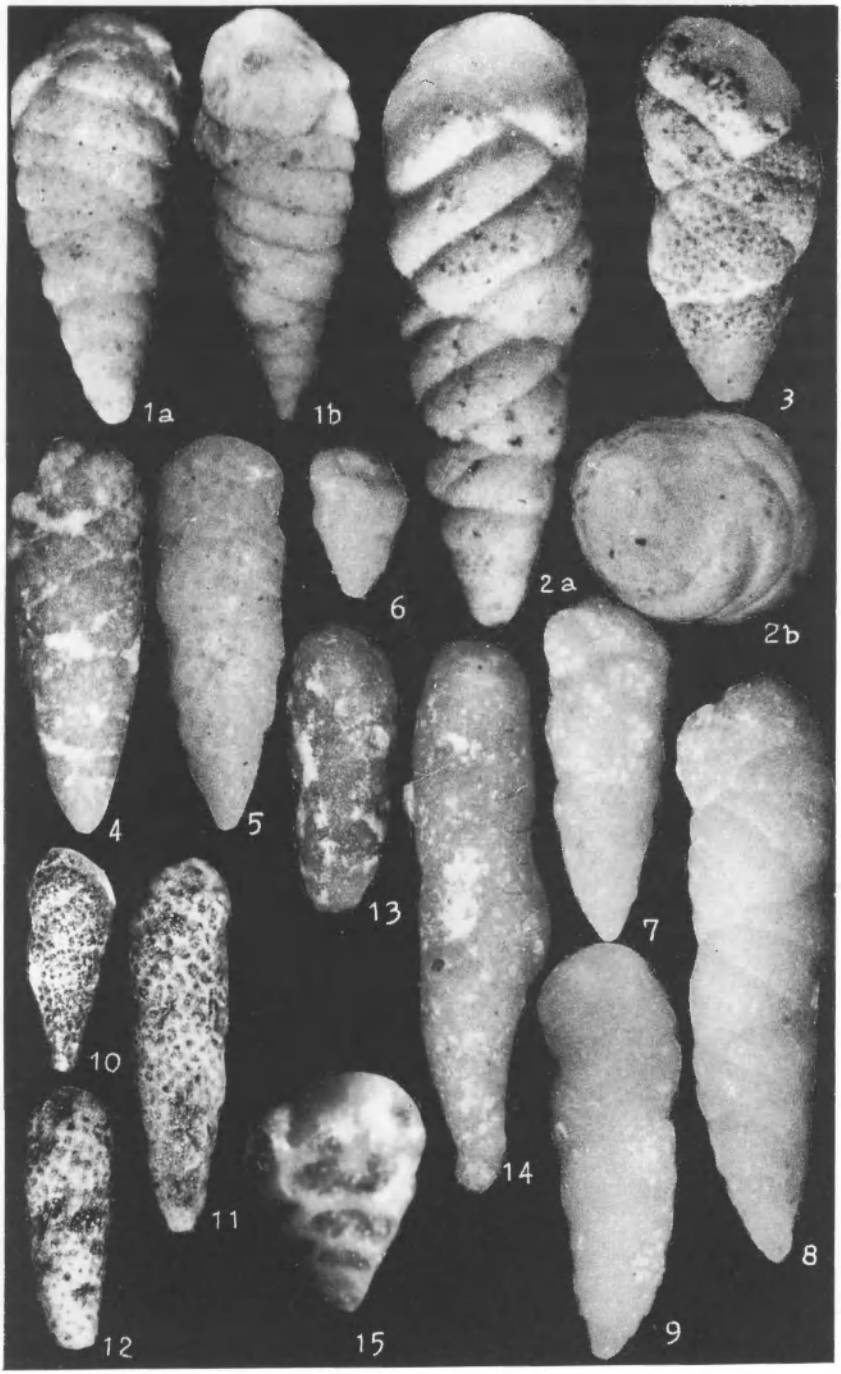


PLATE XII

1. *Palaeopfenderina salernitana* (Sartoni et Crescenti) Sample 786, Wadi Jahannam, exposure 39, upper Bathonian. **a**, **b** lateral views.

2. *Kurnubia morrisi* Redmond Sample 272, Ain Khlakem, exposure 20, Oxfordian. **a** lateral view, **b** apertural view.

3. *Steinekella steinekei* Redmond Sample 272, Ain Khlakem, exposure 20, Oxfordian. Lateral view.

4. *Kurnubia palastiniensis* Henson Sample 93, Wadi al Karn, exposure 6, Tithonian. Lateral view.

5, 6. *Kurnubia wellingsi* (Henson) Sample 150, Sindianeh, exposure 10, Oxfordian, **5**: adult specimen, **6**: juvenile specimen; lateral views.

7–9. *Kurnubia jurassica* (Henson) Sample 308, Al Bustan, exposure 22, Barremian–lower Aptian. Lateral view of tests.

10–12. *Kurnubia variabilis* Redmond Sample 1, Wadi al Karn, exposure 1, Callovian. Lateral views of test.

13–14. *Haurania deserta* Henson **13**: sample 595, Wadi Jahannam, exposure 39, upper Bathonian; lateral view; macrospheric generation. **14**: sample 595, locality and age the same; microspheric generation.

15. *Redmondoides lugeoni* (Septfontaine) Sample 970, Maareen, exposure 69, upper Bathonian. Lateral view.

PLATE XIII

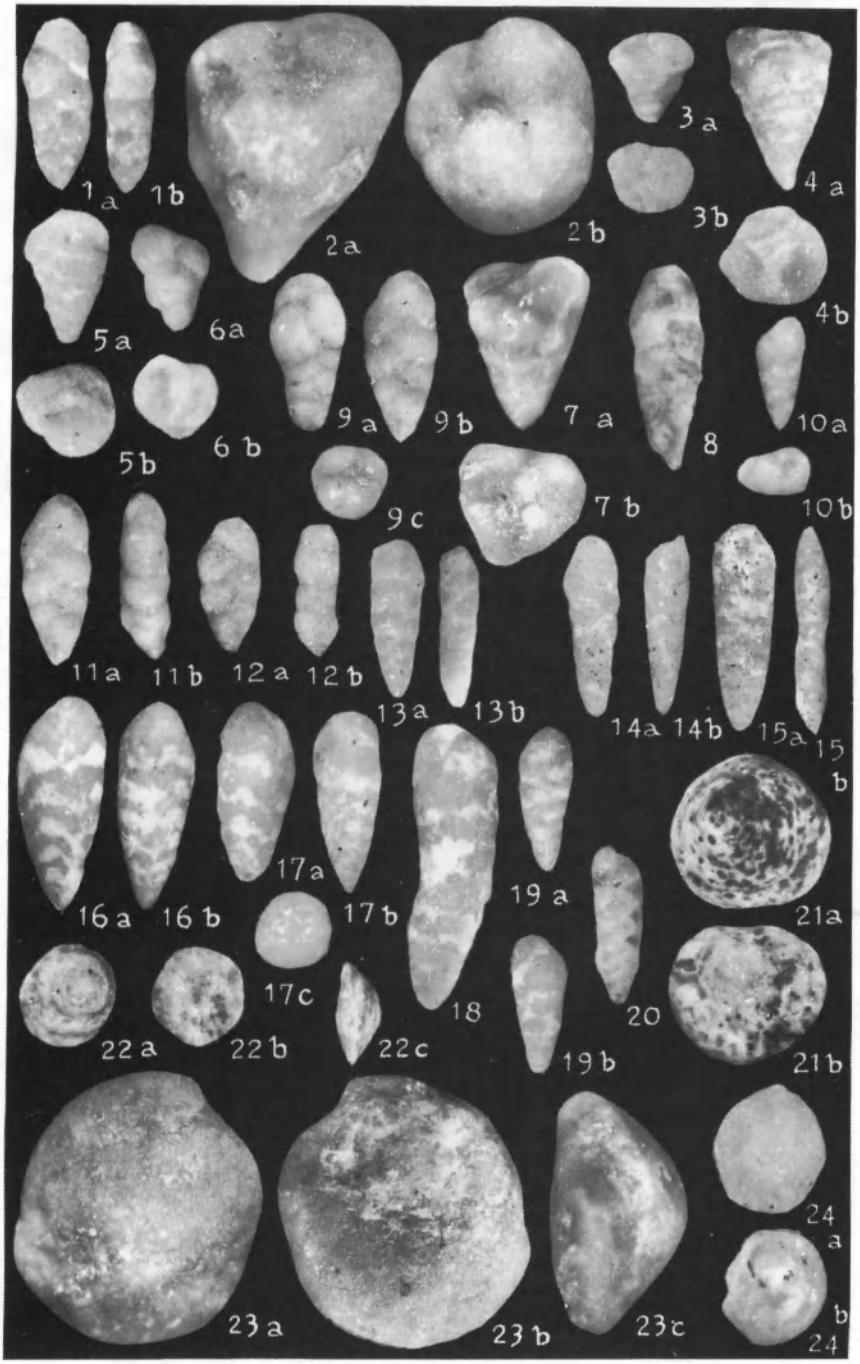

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PLATE XIII

1. *Arenovirguliana aegyptiaca* Said et Barakat Sample 81, Wadi al Karn, exposure 6, Oxfordian. **a** lateral view, **b** periphery.

2. *Verneuilinoides osowiensis* (Bielecka) Sample 455, Rowda, exposure 34, Oxfordian. **a** lateral view, **b** apertural view.

3–5. *Verneuilinoides minuta* Said et Barakat **3**, **4**: sample 150, Sindianeh, exposure 10, Oxfordian. **5**: sample 150, locality and age the same; **a** lateral view, **b** apertural view.

6. *Verneuilinoides subminuta* (Gorbatchik) Sample 249, Rowda, exposure 7, Barremian–lower Aptian. **a** lateral view, **b** apertural view.

7. *Tritaxia* sp. Sample 448–1, Rowda, exposure 34, Oxfordian. **a** lateral view, **b** apertural view.

8. *Belorussiella textularioides* (Reuss) Sample 249, Rowda, exposure 7, Barremian–lower Aptian. Lateral view.

9, 11. *Palaeogaudryina magharaensis* Said et Barakat **9**: sample 446–2, Rowda, exposure 34, Oxfordian; **a**, **b** lateral views, **c** apertural views. **11**: sample 446–2, Rowda, exposure 34, Oxfordian.

10, 12. *Palaeogaudryina varsoviensis* (Bielecka et Pożaryski) **10**: sample 10, Wadi al Karn, exposure 1, Oxfordian: **a** lateral view, **b** apertural view; **12**: sample 441, Rowda, exposure 4, Oxfordian; **a** lateral view, **b** periphery.

13–17, 19,20 *Riyadhella regularis* Redmond **13–15**: sample 604, Wadi Jahannam, exposure 39, upper Bathonian; **a** lateral view, **b** periphery. **16**, **17**: sample 595, Wadi Jahannam, exposure 39, upper Bathonian; **a**, **b** lateral view, **c** apertural view. **19**: sample 604, Wadi Jahannam, exposure 39, upper Bathonia; **a**, **b** lateral views; **20**: sample 639, Jdaida, exposure 40, lateral view.

18. *Redmondoides primitivus* (Redmond) Sample 595, Wadi Jahannam, exposure 30, upper Bathonian. Lateral view.

21, 22, 24. *Trocholina conosimilis* Subbotina et Srivastava Sample 604, Wadi Jahannam, exposure 39, upper Bathonian. **a** dorsal view, **b** ventral view, **c** periphery.

23. *Trocholina transversarii* Paalzow Samle 455, Rowda, exposure 34, Oxfordian, **a** dorsal view, **b** ventral view, **c** periphery.

PLATE XIV

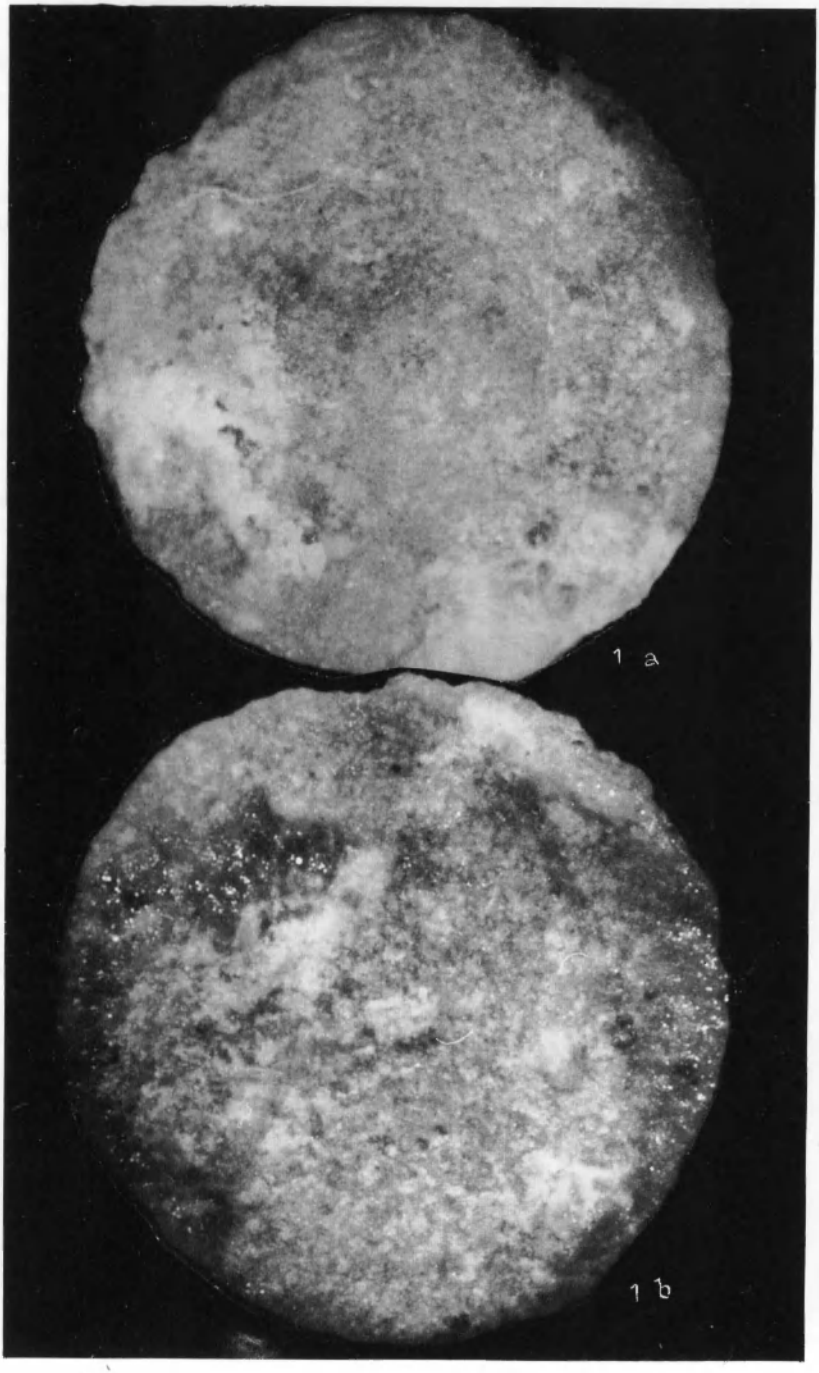

PLATE XIV

1. *Palorbitolina lenticularis* (Blumenbach) Sample 111, Rowda, expossure 7, Barremian–lower Aptian. **a**, **b** opposite lateral views.

PLATE XV

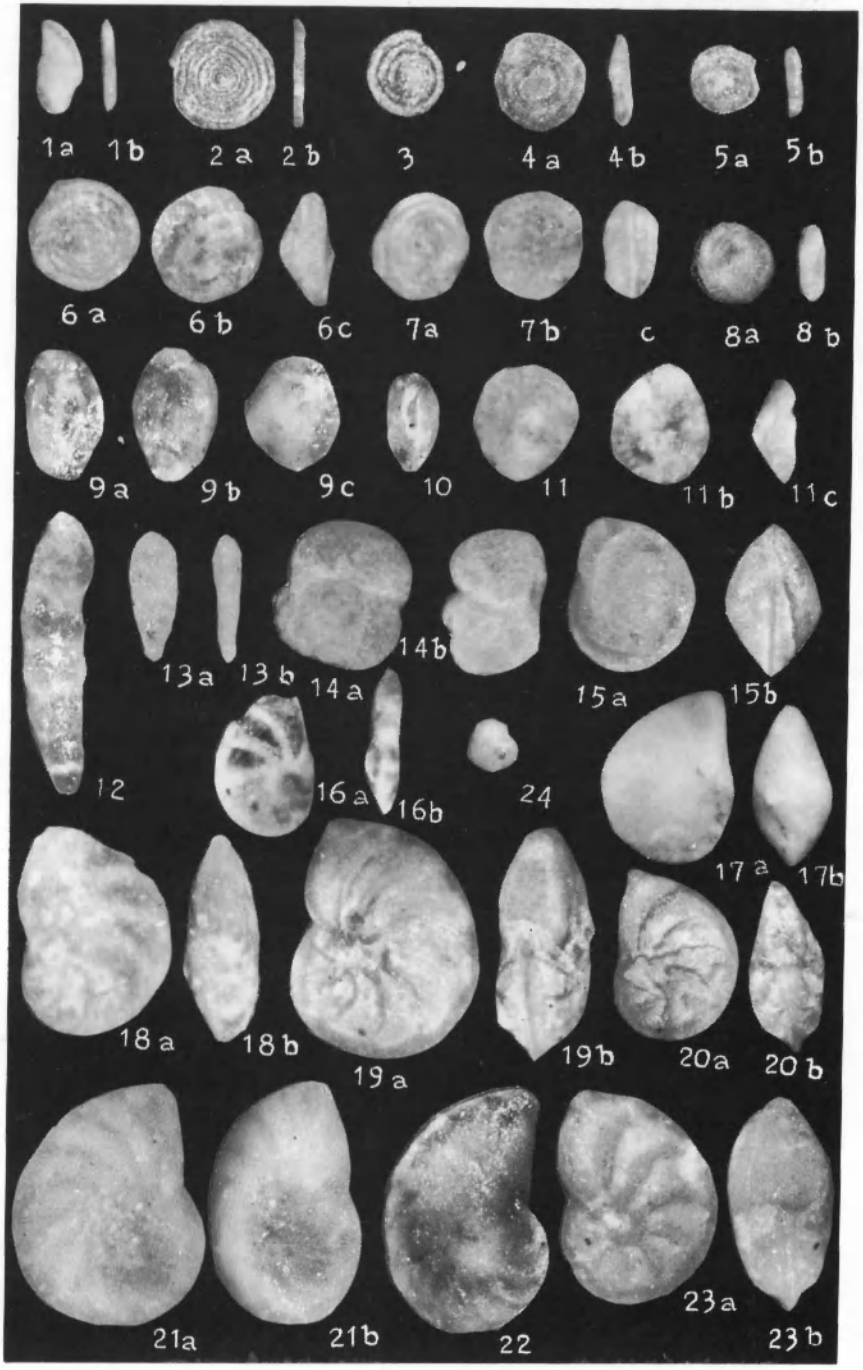
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PLATE XV

a. laterial view, **b**. periphery, except for Fig 6, 7, 9, 10, 11 and 14.

1. *Ophthalmidium sagittum* (E. Bykova) Sample 8, Wadi al Karn, exposure 1, lower Oxfordian.

2, 4, 5. *Spirillina kuebleri* Mjatliuk Sample 684, Hadar, exposure 1, Oxfordian.

3. *Spirillina eichbergensis* (Kübler et Zwingli) Sample 38, Arneh, exposure 4, Callovian. lateral view.

6. *Turrispirillina amoena* Dain Sample 679, Hadar, exposure 41, Oxfordian. **a**, **b** lateral views **c** periphery.

7. *Globospirillina neocomiana* (Moullade) Sample 430, Rowda, Tithonian–Berriasian. **a** dorsal side, **b** ventral side, **c** periphery.

8. *Spirillina kuebleri* Mjatliuk Sample 76, Wadi al Karn, exposure 1, Oxfordian.

9, 10. *Quinqueloculina jurassica* Bielecka et Styk **9**: sample 446–2, Rowda, exposure 34, Oxfordian; **a**, **b**, lateral views **c** periphery. **10**: locality and age the same.

11. *Patellina subcretacea* Cushman et Alexander Sample 249, Rowda, exposure 7, Barremian–lower Aptian. **a** dorsal view, **b** ventral view, **c** periphery.

12. *Prodentalina brueckmanni* (Mjatliuk) Sample 449–3, Rowda, exposure 34, Oxfordian. Lateral view.

13. *Geinitzinita wolinensis* Bielecka Sample 76–1, Wadi al Karn, exposure 6. Oxfordian.

14. *Globuligerina bathoniana* (Pazdro) Sample 609, Wadi Jahannam, exposure 39, upper Bathonian. **a** dorsal view, **b** lateral view.

15. *Lenticulina nostra* Grigelis Sample 585, Hadar, exposure 41, Oxfordian. Juvenile specimen.

16. *Lenticulina polonica* (Wisniowski) Sample 51, Wadi al Karn, exposure 5. Callovian.

17. *Lenticulina nuda* (Reuss) Sample 249, Rowda, exposure 7, Barremian–lower Aptian.

18–20. *Lenticulina brueckmanni* (Mjatliuk) Sample 81, Wadi al Karn, exposure 6; upper Oxfordian. **19**: sample 682. **20**: sample 684, Hadar, exposure 41; Oxfordian.

21. *Lenticulina hebetata* (Schwager) Sample 446–2, Rowda, exposure 34, Oxfordian, lateral views.

22. *Lenticulina suturalis–costata* (Franke) Sample 681, Hadar, exposure 41, Oxfordian.

23. *Lenticulina quenstedti* (Gümbel) Sample 694, Hadar, exposure 41, Oxfordian.

24. *Globuligerina oxfordiana* (Grigelis) Sample 733, As–Satteh, exposure 44, Oxfordian.

PLATE XVI

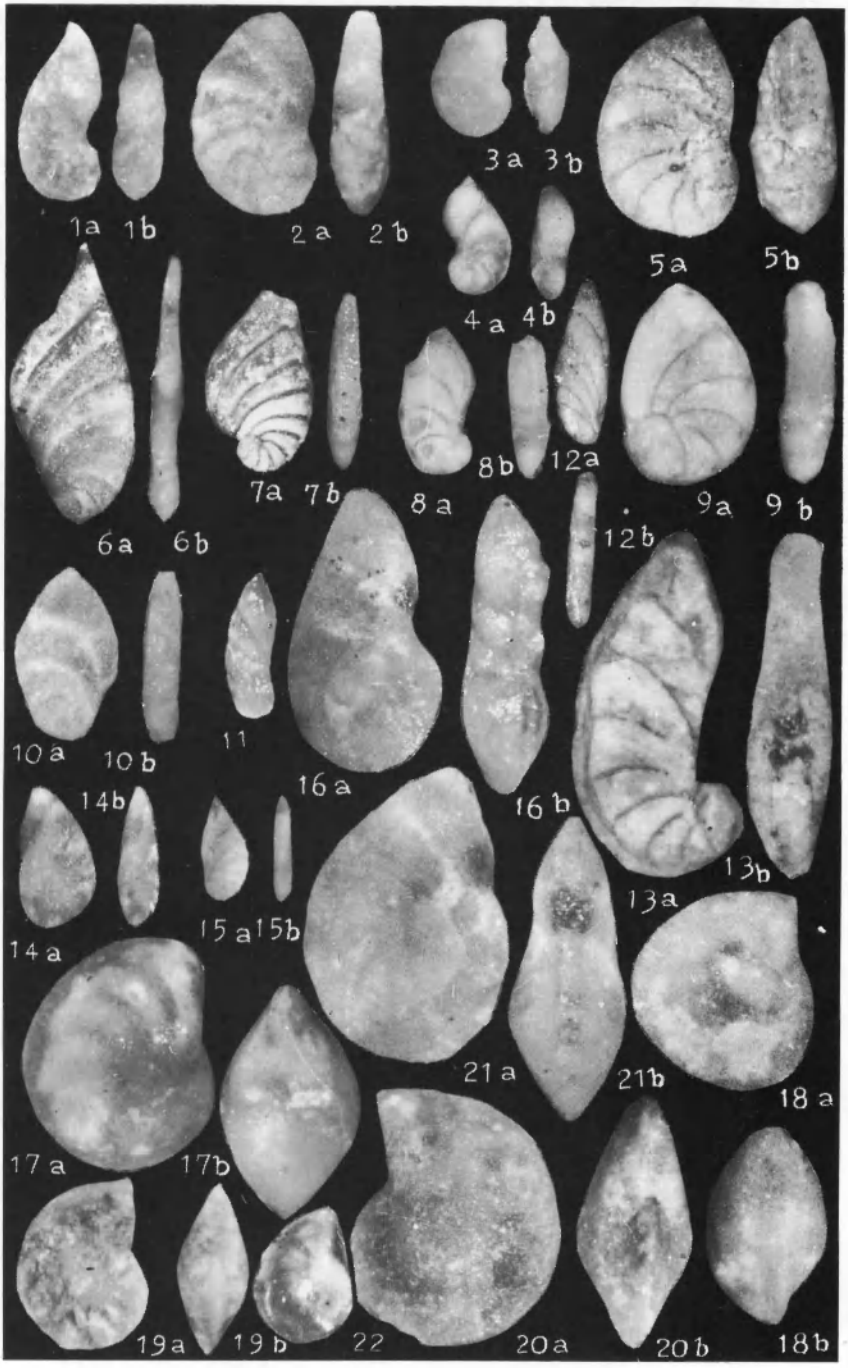
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PLATE XVI

a: lateral view, **b**: periphery.

1. *Astacolus folium* (Wisniowski) Sample 8, Wadi al Karn, exposure 1.

2. *Astacolus limataeformis* (Mitjanina) Sample 8, Wadi al Karn, exposure 6, Oxfordian.

3. *Astacolus* aff. *incurvatus* (Reuss) Sample 111–1, Rowda, exposure 7, Barremian–lower Aptian.

4. *Marginulinopsis suprajurassicus* (Schwager) Sample 687, Hadar, exposure 41, Oxfordian.

5. *Astacolus vacillantes* Espitalié et Sigal Sample 441–1, Rowda, exposure 34, Oxfordian.

6, 7. *Planularia madagascariensis* Espitalié et Sigal Sample 449–4, Rowda, exposure 34, Oxfordian.

8–10. *Planularia feifeli* Paalzow **8**: sample 442, Rowda, exposure 34, Oxfordian **9**: sample 440–1, Rowda, exposure 34, Oxfordian; **10**: sample 13, Wadi al Karn, exposure 1, Kimmeridgian.

11, 12. *Planularia cordiformis* (Terquem) Sample 449–4, Rowda, exposure 34, Oxfordian.

13. *Planularia tricarinella* (Reuss) Sample 442, Rowda, exposure 34, Oxfordian.

14. *Planularia* sp. 1 Sample 685, Hadar, exposure 41, Oxfordian.

15. *Planularia beierana* (Gümbel) Sample 689, Hadar, exposure 41, Oxfordian.

16. *Lenticulina primaformis* (Mjatliuk) Sample 449, Rowda, exposure 34, Oxfordian.

17. *Lenticulina sublenticularis* (Schwager) Sample 685, Hadar, exposure 41, Oxfordian.

18. *Lenticulina hebetata* (Schwager) Sample 76, Wadi al Karn, exposure 6, Oxfordian.

19. *Lenticulina subalata* (Reuss) Sample 249, Rowda, exposure 7, Barremian–lower Aptian.

20. *Lenticulina tympana Grigelis* Sample 681, Hadar, exposure 41, Oxfordian.

21. *Lenticulina russiensis* (Mjatliuk) Sample 278, Ain Khlakem, exposure 20, Oxfordian.

22. *Lenticulina varians* (Bornemann) Sample 27, Arneh, exposure 2, Bajocian.

PLATE XVII

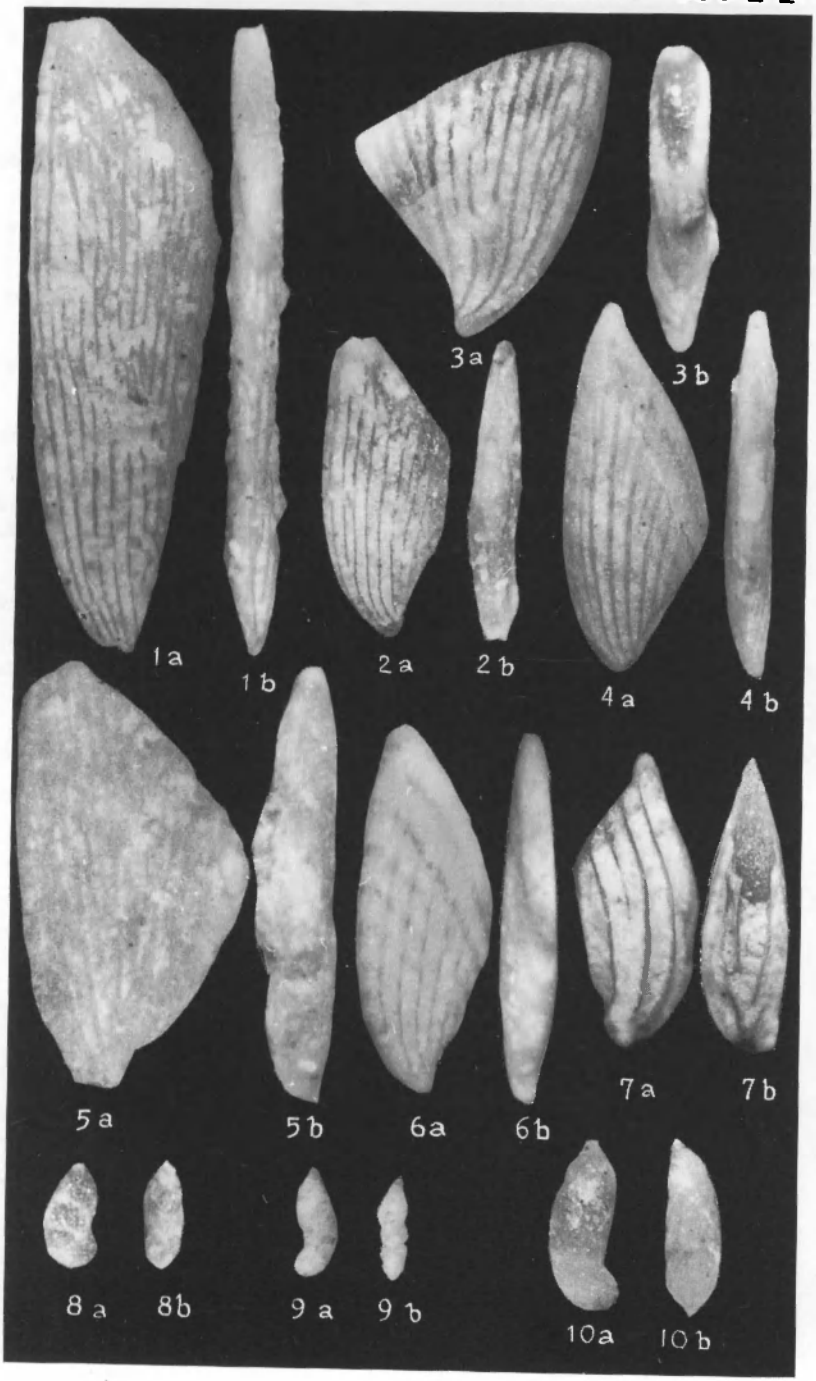


PLATE XVII

1, 2. *Citharina entypomatus* Loeblich et Tappan **1**: sample 441, Rowda, exposure 34, Oxfordian; **a** lateral view, **b** periphery. **2**: sample 441–1, Rowda, exposure 34, Oxfordian, **a** lateral view, **b** periphery.

3, 5. *Citharina lepida* (Schwager) **3**: sample 441–1, Rowda, exposure 34, Oxfordian; **5**: sample 13, Wadi al Karn, exposure 1, Kimmeridgian, **a** lateral view, **b** periphery.

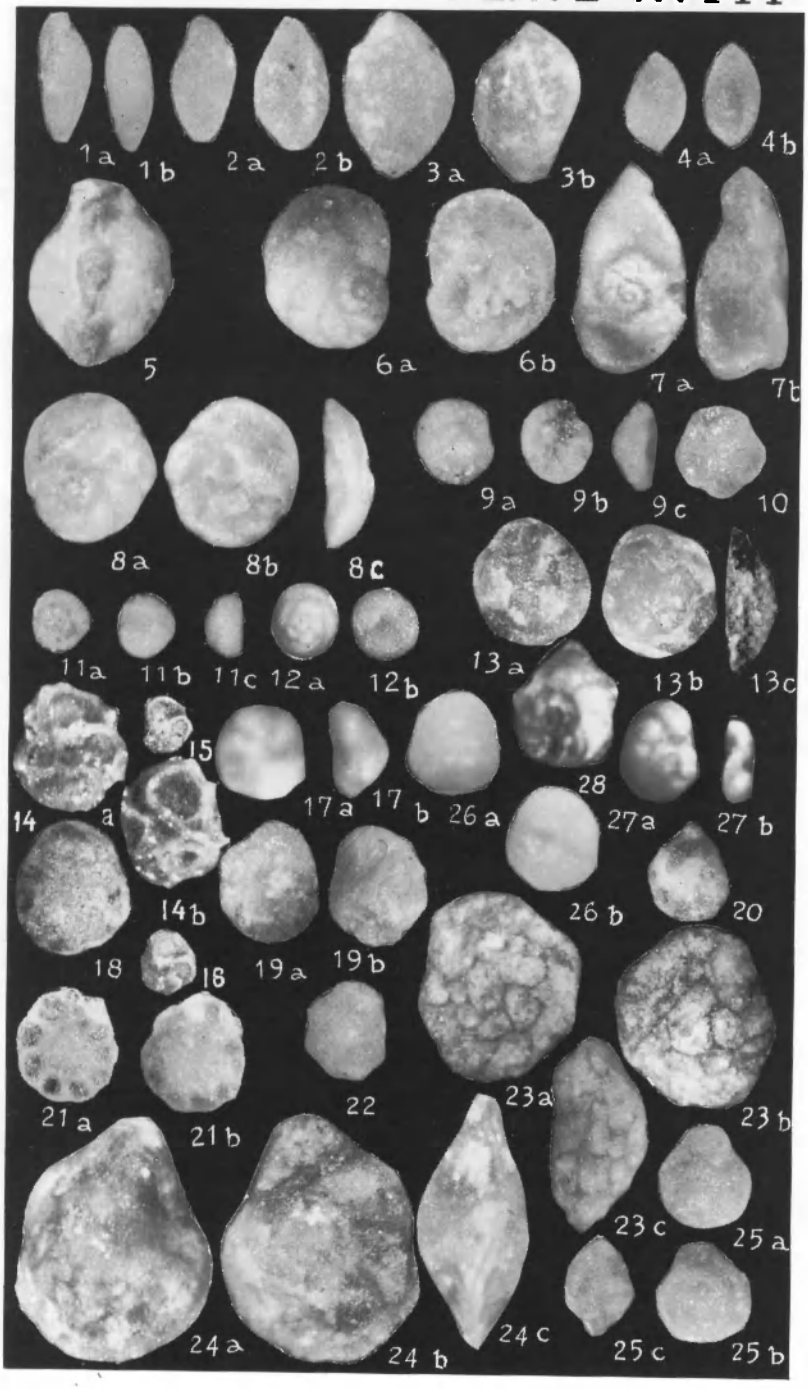
4, 6. *Citharina sokolovae* (Mjatliuk) **4**: sample 440–1, Rowda, exposure 34, Oxfordian. **6**: sample 440–1, Rowda exposure 34, Oxfordian; **a** lateral view, **b** periphery.

7. *Citharina paralella* (Bielecka et Pożaryski) Sample 686, Hadar, exposure 41, Oxfordian. **a** lateral view, **b** periphery.

8. *Marginulinopsis irretitus* (Schwager) Sample 8, Wadi al Karn, exposure 1, Oxfordian, **a** lateral view, **b** periphery.

9, 10. *Marginulinopsis suprajurassicus* (Schwager) Sample 442, Rowda, exposure 34, Oxfordian, **a** lateral view, **b** periphery.

PLATE XVIII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11c
12a
12b
13a
13b
13c
14
a
15
17a
17b
26a
27a
27b
28
14b
26b
20
18
18
19a
19b
21a
21b
22
23a
23b
23c
25a
24a
24b
24c
25c
25b

PLATE XVIII

1. *Eoguttulina bilocularis* (Terquem) Sample 150, Sindinaeh, exposure 10, Oxfordian. **a**, **b** lateral views.

2. *Eoguttulina cruciata* (Terquem) Sample 150, Sindianeh, exposure 10, Oxfordian. **a**, **b** lateral views.

3. *Eoguttulina* sp. 1 Sample 150, Sindianeh, exposure 10, Oxfordian. **a**, **b** lateral views.

4. *Globulina oolithica* (Terquem) Sample 150, Sindianeh, exposure 10, Oxfordian. **a**, **b** lateral views.

5. *Bullopora rostrata* Quenstedt on *Melathrokerion* sp. test Sample 135, Al Bustan, Barremian–lower Aptian.

6–8. *Conorboides querdahensis* Grigelis et K. Kuznetsova *sp. nov.* **6**: paratype, sample 140, Dahr Al Killin, exposure 9, Oxfordian; **a** dorsal side **b** ventral side. **7**: paratype, sample 140, abnormal test, locality and age the same; **a** dorsal view, **b** ventral view. **8**: holotype, sample 140, locality and age the same; **a** dorsal view, **b** ventral view, **c** periphery.

9, 10. *Conorboides paraspis* (Schwager) **9**: sample 443–1, Rowda, exposure 34, Oxfordian, **a** dorsal view, **b** periphery, **c** ventral **10**: sample 737, As–Satteh, Oxfordian, dorsal view.

11. *Ceratolamarckina subspeciosa* Bogdanovich et Makarjeva Sample 8, Wadi al Karn, exposure 1, Oxfordian, **a** dorsal view, **b** ventral view, **c** periphery.

12. *Cancrisiella rowdaensis* Grigelis et K. Kuznetsova *sp. nov.* Sample 449–1, Rowda, exposure 34, Oxfordian, holotype, **a** dorsal view, **b** ventral view.

13. *Pseudolamarckina hadari* Grigelis et K. Kuznetsova *sp. nov.* Sample 685, Hadar, exposure 41, Oxfordian, holotype, **a** ventral view, **b** dorsal view, **c** periphery.

14–16. *Epistomina coronata* Terquem Sample 27, Arneh, exposure 2, Bajocian; **14 a**: dorsal view, **14 b**: ventral view, ×84; **15**: dorsal view; **16**: ventral view, locality and age the same, ×42.

17. *Lamarckella media* Kaptarenko–Chernousova Sample 27, Arneh, exposure 2, **a** ventral view, **b** periphery.

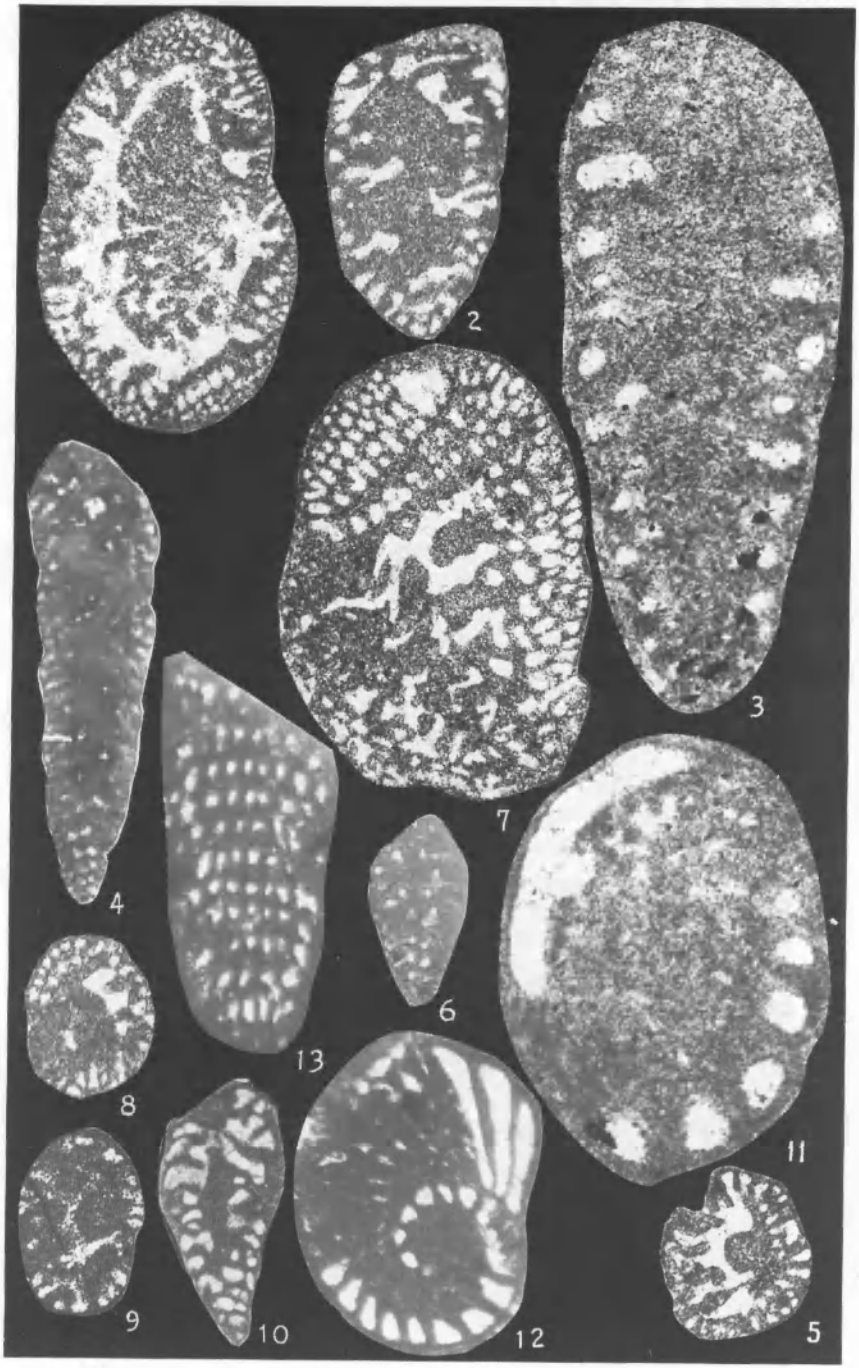
18–22. *Epistomina turgidula* Pazdro **18**: sample 849, Wadi Jahannam, exposure 39, upper Bathonian. **19**: sample 849, locality and age the same; **a** ventral view, **b** dorsal view. **20**: sample 849; locality and age the same. **21**, **22**: sample 595; locality and age the same.

23. *Epistomina nemunensis* Grigelis Sample 687, Hadar, exposure 41, Oxfordian. **a** ventral view, **b** dorsal view, **c** periphery.

24. *Epistomina paralimbata* Grigelis Sample 682, Hadar, exposure 41, Oxfordian. **a** ventral view, **b** dorsal view, **c** periphery.

(Continued on page 247)

PLATE XIX



(Continued from page 245)

25. *Epistomina uhligi* Mjatliuk Sample 685, Hadar, exposure 41, Oxfordian. **a** ventral side, **b** dorsal side, **c** periphery.

26. *Paulina paula* (Pazdro) Sample 970, Maareen village, upper Bathonian. **a** dorsal side, **b** ventral side.

27. *Conorboides scutuliformis* (E. Seibold et I. Seibold) Sample 1073, Braj village, exposure 74, Callovian. **a** dorsal side, **b** periphery.

PLATE XIX

1, 2. *Palaeopfenderina salernitana* (Sartoni et Crescenti) **1**: sample 434, Rowda, exposure 34, Callovian; oblique transverse section, ×42. **2**: sample 60, Wadi Jahannam, outcrop 39, upper Bathonian; axial section, ×42.

3. *Pfenderella arabica* Redmond Sample 259–15, Wadi Fawuar, exposure 37, Callovian. Axial section, ×84.

4, 5. *Kurnubia palastiniensis* Henson **4**: sample 308, Al Bustan, exposure 22, Neocomian, axial section; ×42. **5**: sample 433, Rowda, exposure 34, Callovian, transverse section, ×42.

6. *Praekurnubia crusei* Redmond Sample 595, Wadi Jahannam, exposure 39, upper Bathonian. Axial section, ×42.

7–9. *Kurnubia palastiniensis* Henson **7**: sample 86, Wadi al Karn, exposure 6, Kimmeridgian, oblique transverse section, ×84. **8**: sample 86, Wadi al Karn, exposure 6, Kimmeridgian, transverse section, ×42. **9**: sample 94, Wadi al Karn, exposure 6, Tithonian, transverse section, ×42.

10. *Kurnubia bramkampi* Redmond Sample 140, Dahr Al Killin, exposure 9, Callovian, axial section, ×42.

11, 12. *Palaeopfenderina trochoidea* (Smout et Sugden) **11**: sample 259–15, Wadi Fawuar, exposure 37, Callovian, transverse section, ×84; **12**: sample 897, Shuekha, exposure 59, upper Bathonian, longitudinal section, ×33.

13. *Haurania deserta* Henson Sample 878, Maareen exposure 58, upper Bathonian, longitudinal section, ×42.

PLATE XX

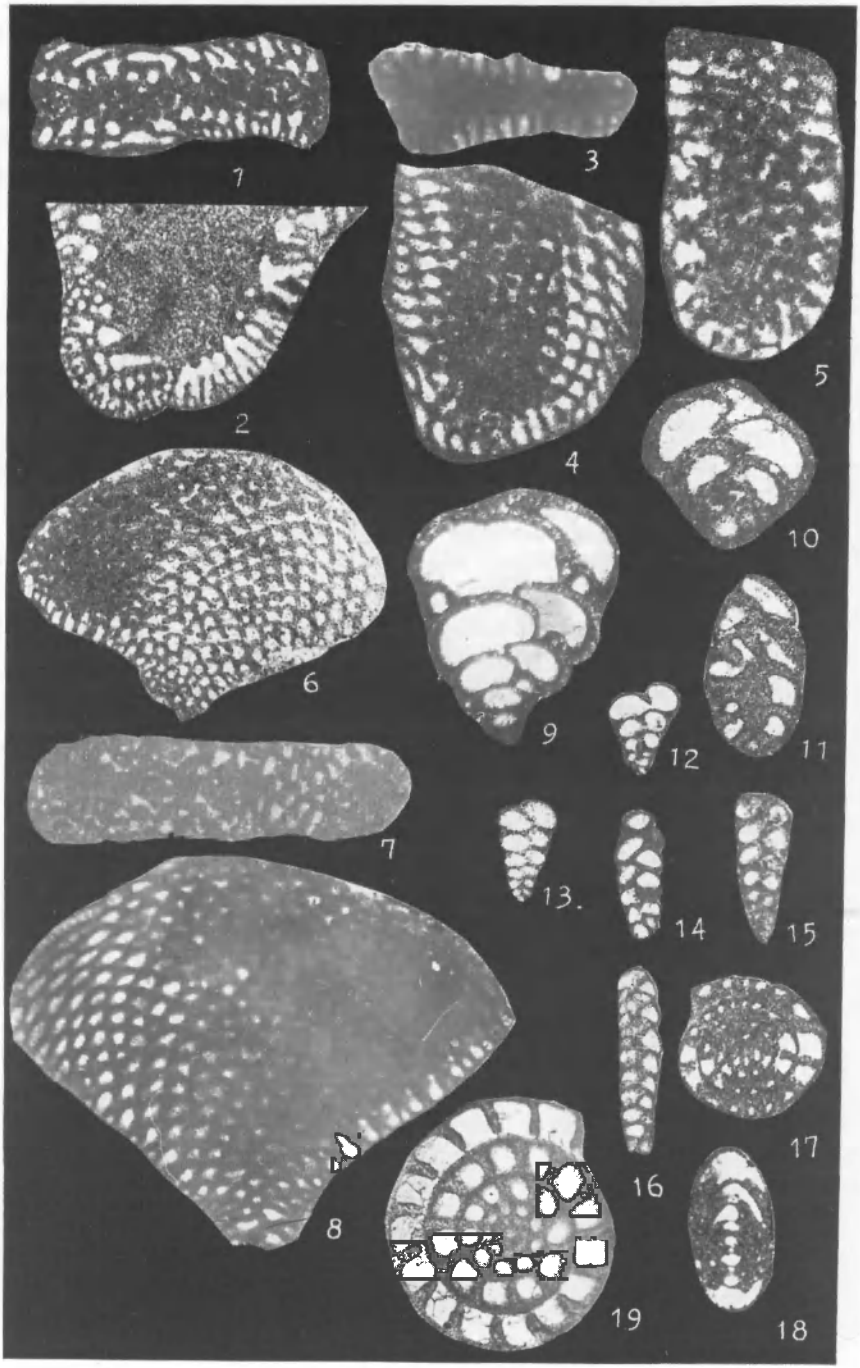


PLATE XX

All figures ×50, except Figure 19.

1–4, 6–8. *Kilianina blancheti* Pfender **1**: sample 603, Wadi Jahannam, exposure 39, upper Bathonian, transverse section, ×50; **2**: longitudinal section; **3**: sample 603, transverse section; **4**: sample 603,; **6**: sample 601, longitudinal section; **7**: sample 601, transverse section; **8**: sample 601, longitudinal section, locality and age the same.

5. *Meyendorffina bathonica* Aurouze et Bizon. Sample 603, Wadi Jahannam, exposure 39, upper Bathonian. Axial section.

9, 10. *Redmondoides lugeoni* (Septfontaine) **9**: sample 439, Rowda, exposure 34, Callovian, longitudinal section; **10**: sample 432, locality and age the same, longitudinal section.

11. *Palaeopfenderina salernitana* (Sartoni et Crescenti) Sample 432, Rowda, exposure 34, Callovian. Longitudinal section.

12. *Pseudomarssonella plicata* (Redmond) Sample 603, Wadi Jahannam, exposure 39, upper Bathonian. Longitudinal section.

13. *Redmondoides primitivus* (Redmond) Sample 603, Wadi Jahannam, exposure 39, upper Bathonian. Longitudinal section.

14, 15. *Riyadhella regularis* Redmond **14**: sample 603, Wadi Jahannam, exposure 39, upper Bathonian, longitudinal section; **15**: sample 603, locality and age the same. Longitudinal section.

16. *Riyadhella elongata* Redmond Sample 603, locality and age the same. Longitudinal section.

17–19. *Nautiloculina* sp. 1 **17**: sample 91, Wadi al Karn, exposure 7, Tithonian, equatorial section, ×42. **18**: sample 91, transverse section, ×42. **19**: sample 817, (to be continued) Sad al Karn, exposure 51, Tithonian, locality and age the same, Equatorial section. ×62.

PLATE XXI

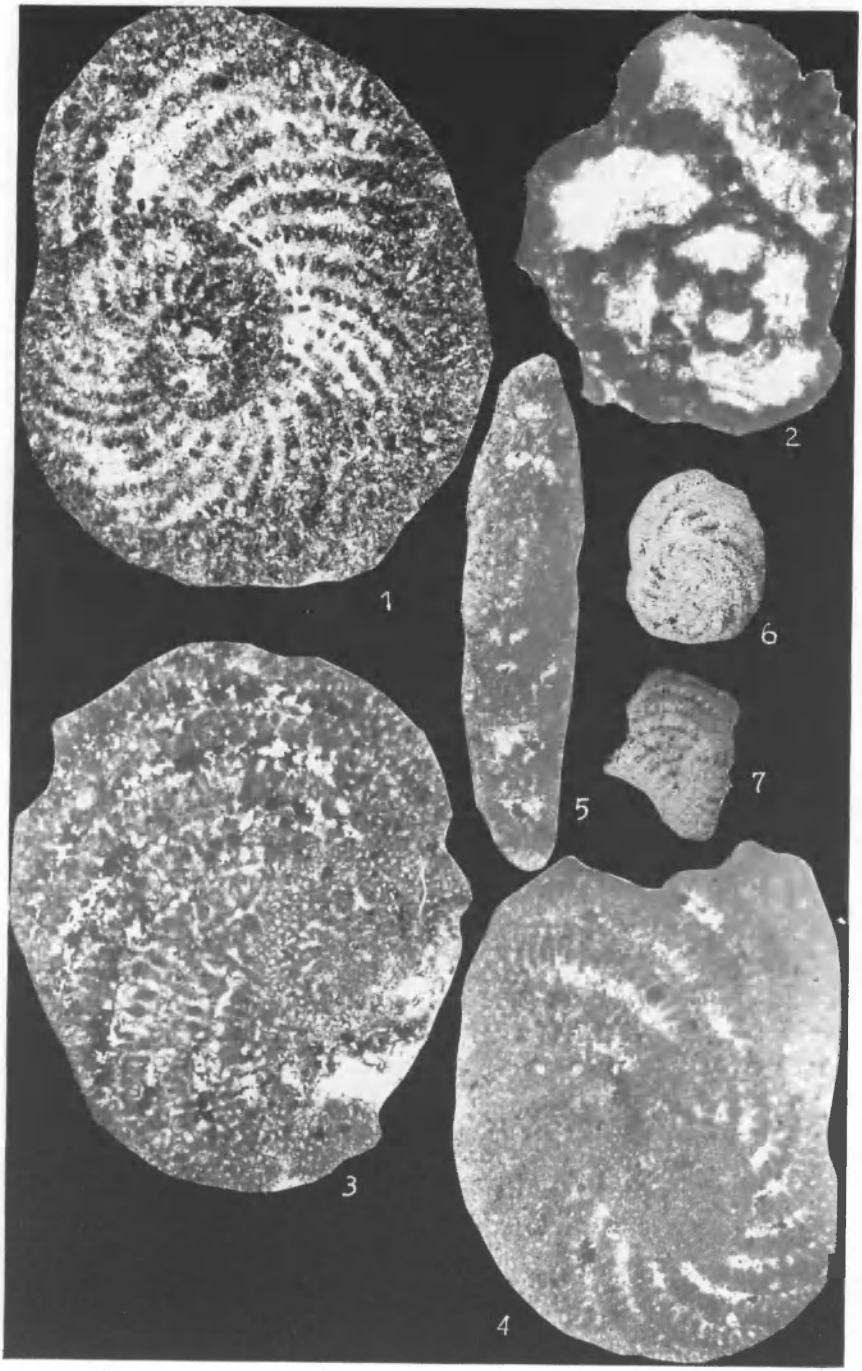


PLATE XXI

1. *Choffatella decipiens* Schlumberger Sample 249, Rowda, exposure 7, Barremian–lower Aptian. Equatorial section.

2. *Everticyclammina virguliana* (Koechlin) Sample 134, Dahr Al Killin. Equatorial section.

3. *Anchispirocyclina lusitanica* (Egger) Sample 91, Wadi al Karn, exposure 1, Tithonian. Equatorial section.

4, 5. *Pseudocyclammina calloviensis* Tobolina et K. Kuznetsova *sp. nov.* **4**: sample 1, Wadi al Karn, exposure 1, Callovian; equatorial section. **5**: sample 1, locality and age the same; axial section.

6, 7. *Alveosepta powersi* (Redmond) **6**: sample 816, Sad al Karn, exposure 51, Tithonian; equatorial section ×11. **7**: Sample 1222, exposure 91, Qadmous, Tithonian–Neocomian; equatorial section, ×11.

PLATE XXII

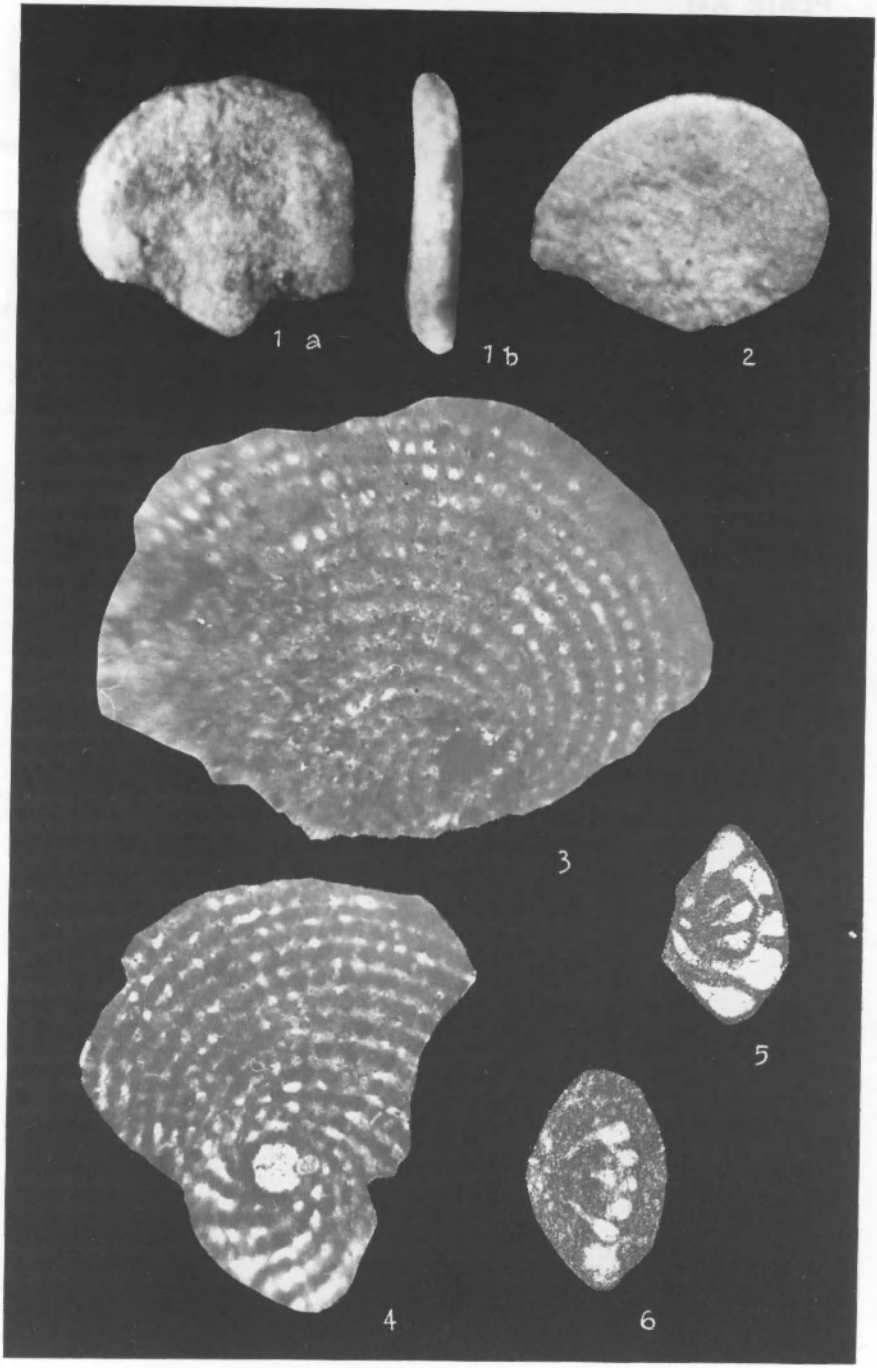


PLATE XXII

1–4. *Timidonella sarda* Bassoullet, Chabrier et Fourcade Sample 1012, Arneh village, exposure 71, upper Bajocian; **1a** lateral side, **1b**: periphery, ×42. **2**: lateral view, macrospheric generation, ×42. **3**: sample 1012, longitudinal section, macrospheric generation ×84. **4**: sample 1012, longitudinal section, macrospheric generation, locality and age the same, ×84.

5, 6. *Protopeneroplis striata* Weynschenk **5**: sample 555, Nicola Quarry, exposure 38; Bathonian, oblique section, ×62. **6**: sample 657, Jdaida, exposure 40, Bathonian; oblique section, ×62.

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Zonal Stratigraphy and Foraminifera of the Tethyan Jurassic (Eastern Mediterranean)

K. I. Kuznetsova, *Geological Institute, Moscow, Russia*
A. A. Grigelis, *Department of Geology, Vilnius University, Lithuania*
J. Adjamian, E. Jarmakani and L. Hallaq, *General Establishment of Geology and Mineral Resources, Damascus, Syria*

This unique monograph establishes a zonal subdivision for Syrian Jurassic deposits within the Lias-Tithonian stratigraphy interval based on the detailed study of the evolution and development of foraminiferal assemblages. The book describes the most complete and representative Jurassic sections in Anti-Lebanon, the Coastal Mountains, Kurd-Dag and Palmyrides. Careful analysis of foraminiferal assemblages reveals their composition, structure, temporal evolution, and spatial distribution in various structural facies zones of Syria, and also identifies eight stages and two megaphases of Jurassic foraminifera evolution. The study of generic regions of foraminifera in the Eastern Mediterranean, South-Western Europe and North Africa suggests that the territory of Syria in the Jurassic period was the centre of the creation and distribution of foraminiferal benthic assemblages. Thus the Arabian subprovince can be distinguished as an independent paleobiochore in the African-Mediterranean Tethys Province.

About the authors

Dr Kuznetsova is the Head Scientist at Moscow Geological Institute where she has been actively involved in research in the field of Jurassic stratigraphy since 1960. Her co-authors are all specialists in the field and have collaborated on various projects concerning the geology of Syria.

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