Turkish Journal of Earth Sciences (Turkish J. Earth Sci.), Vol. 20, 2011, pp. 847–856. Copyright ©TÜBİTAK
doi:10.3906/yer-0910-6 First published online 22 February 2011

Early Oligocene Larger Foraminiferal Biostratigraphy of the Qom Formation, South of Uromieh (NW Iran)

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Received 16 November 2009; revised typescript received 15 September 2010; accepted 03 January 2011

Abstract: The marine strata of the Qom Formation south of Uromieh (Baranduz) yielded a moderately diverse larger benthic foraminiferal fauna resembling the fauna already described from European marine sequences. The fauna allowed the author to correlate the larger foraminiferal assemblage of northwestern Iran with the standard shallow benthic zonation. The assemblage is dominated by hyaline and porcellaneous forms including *Operculina, Nummulites, Neorotalia, Penarchaias, Victoriella, Peneroplis, Praerhapydionina, Spirolina, Halkyardia, Planorbulina, Dendritina, Borelis* and *Bullaveolina.* This faunal assemblage is also accompanied by coralline alga *Subterraniphyllum thomasii*. The presence of *Nummulites* cf. *fichteli* and *N.* cf. *vascus* in the absence of *Lepidocyclina* allows correlation of the foraminiferal fauna of the studied section with the SBZ 21 shallow benthic zone, indicating early–middle Rupelian age. Planktonic foraminiferal data from the overlying marly succession support the assigned age using larger benthic foraminifera.

Key Words: Oligocene, Qom Formation, larger benthic foraminifera, NW Iran

Qom Formasyonu (Uromieh Güneyi, KB İran) Erken Oligosen İri Bentik Foraminifer Biyostratigrafisi

Özet: Uromieh güneyinde (Baranduz, KB İran) nispeten zengin bir foraminifer çeşitliliğine sahip olan denizel Qom Formasyonu'nun Oligosen bentik foraminifer toplulukları Avrupa havzalarında aynı zaman diliminde tanımlanan foraminifer gruplarına benzerlik göstermektedir. Bu benzerlik kuzeybatı İran bölgesinde tanımladığımız Oligosen bentik foraminiferlerinin Avrupa'da tanımlanan standart zonasyon (SBZ) kapsamında irdelenmesini mümkün kılmaktadır. Tanımlanan bentik foraminiferlerin önemli bir kısmı hayalin ve porselen kavkılı gruplara ait olup *Operculina, Nummulites, Neorotalia, Penarchaias, Victoriella, Peneroplis, Praerhapydionina, Spirolina, Halkyardia, Planorbulina, Dendritina, Borelis* ve *Bullaveolina* ile temsil edilir. Bu topluluklarla beraber kırmızı alg *Subterraniphyllum thomasii*'de tayin edilmiştir. Tanımlanan foraminifer topluluklarında *Nummulites* cf. *fichteli* ve *Nummulites* cf. *vascus*'un varlığı, ve aynı zamanda Lepidocyclinidae'nin yokluğu göz önüne alınarak çalışılan seviyeler SBZ 21 ile (erken–orta Rupeliyen) deneştirilmiştir. Çalışılan istifin üst kısımlarındaki ince kırıntılılardan elde edilen planktonik foraminifer yaş verileri erken–orta Rupeliyen yaş konağını desteklemektedir.

Anahtar Sözcükler: Oligosen, Qom Formasyonu, iri bentik foraminifer, KB İran

Introduction

This study describes the larger benthic foraminiferal biostratigraphy of the Lower Oligocene carbonate strata of the Qom Formation cropping out few kilometres south of Uromieh. The Oligo–Miocene strata of the Qom Formation extend from the central basin of Iran to the northwest and are considered to constitute the main petroleum prospect in central Iran. The section studied (Figure 1) includes part of the region in northwestern Iran (Uromieh-Takab) which was recently prospected for petroleum exploration studies by the National Iranian Oil Company (NIOC).

Owing to economic reasons most previous studies were focused on the central part of the basin (Furrer & Soder 1955; Bozorgnia 1965; Chahida *et al.* 1977; Rahaghi 1973, 1980; Daneshian & Dana 2006). Furrer & Soder (1955) subdivided the Oligo–Miocene marine strata of the Qom Formation in its type locality into six lithostratigraphic units including a- to f-members (a– basal limestone, b– sandy marl, c– alternating marl and limestone, d– evaporites,

e– green marls, f– top limestone). Bozorgnia (1965) expanded the subdivision into ten units using lithological and palaeontological characteristics. He left Rupelian strata unnamed and correlated them with the lower part of the Lower Asmari Formation in south Iran (Zagros Mountains).

The lithological units of the Qom Formation laterally change over a relatively short distance, therefore the correlation of units exposed at the surface as well those encountered in drilled and under drilling wells needs a biostratigraphic subdivision based on larger benthic foraminifera, which are the main representatives of the foraminiferal association in those units. Adams & Bourgeois (1967) prepared a biostratigraphic subdivision for the Oligo–Miocene Asmari Formation in south Iran. As foraminiferal assemblages in central and southern Iran are similar, the biozonal scheme of Adams & Bourgeois (1967) was followed later in the Central Iranian Basin by different authors (e.g., Daneshian & Dana 2007) to correlate the Oligo–Miocene marine strata in these two basins (Qom and Asmari formations). However, based on the current knowledge of larger benthic foraminifera, the biostratigraphic subdivision of Adams & Bourgeois (1967) remains uncertain, at least for the Oligo–Miocene boundary. The only recent comparison of foraminiferal assemblages from central Iran (Abadeh area) with those from Europe is by Reuter *et al*. (2007), who recognized and correlated the lepidocyclinid fauna from this area with the SBZ 22b Zone of Cahuzac & Poignant (1997).

The aim of this study is to determine the age of the Oligocene marine beds of the Qom Formation, based on larger foraminifera in the study area and comparison of the recognized assemblages with coeval assemblages from Europe. An advance in the knowledge of Oligo–Miocene biostratigraphy in central Iran is of great importance to oil exploration. Planktonic foraminifera from the overlying succession were also studied by the present author and their biostratigraphic data were used to validate the results obtained from larger benthic foraminifera.

Geological Setting and Location of the Study Section

The present tectonic status of central Iran is a result of the final collision of the African/Arabian and Iranian plates. The process originated during subduction of African-Arabian plate beneath the Iranian plate and started during the Mesozoic (Coleman-Sadd 1982). In many localities in Central Iran non-marine Oligocene deposits (Lower Red Formation) unconformably overlie Eocene volcanics (Stöcklin & Setudehnia 1971; Berberian and King 1981). These strata are followed by the laterally extensive marine succession of limestones and marls of the Qom Formation (Rupelian–Burdigalian), exposed in different parts of the Central Iranian Basin (Bozorgnia 1965; Rahaghi 1973, 1976, 1980; Okhravi & Amini 1998; Daneshian & Dana 2007; Reuter *et al*. 2007). The Qom Formation itself is overlain conformably by non-marine siltstone and evaporite dominated beds of the Upper Red Formation (Stöcklin & Setudehnia 1971). This study deals with a section measured in the Qom Formation south of Uromieh. During the time of deposition, the investigated basin was situated at the Eurasian margin of the Tethyan seaway.

Materials and Methods

This study is based on samples collected from a surface exposure of the Qom Formation in the Baranduz section, south of Uromieh, at 37°20.59′ N, 44°56.26′ E (Figure 1). The foraminiferal fauna was studied in non-oriented thin sections, since the hard and compacted carbonate rocks did not allow collection of matrix-free foraminiferal specimens. The generic classification follows Loeblich & Tappan (1987), Hottinger *et al*. (1991) and Hottinger (2007).

Lithostratigraphy

The Baranduz stratigraphic section starts with a relatively thick polymictic conglomerate, overlying disconformably the Eocene shallow marine carbonate beds and underlying strata of the Qom Formation. The base of the Qom Formation is characterized by medium- to thick-bedded limestones with abundant porcellaneous benthic foraminifera such as *Dendritina rangi*, d'Orbigny 1826 (Plate II, Figures 1 & 2); *Penarchaias glynnjonesi* (Henson 1950) (Plate II, Figure 5); *Spirolina* cf. *cylindracea* (Lamarck 1804) (Plate II, Figure 9); *Peneroplis thomasi*, Henson 1950 (Plate II, Figure 8); *Austrotrillina* spp., *Borelis* sp. (Plate II, Figure 6); *Bullaveolina* sp. (Plate II, Figure

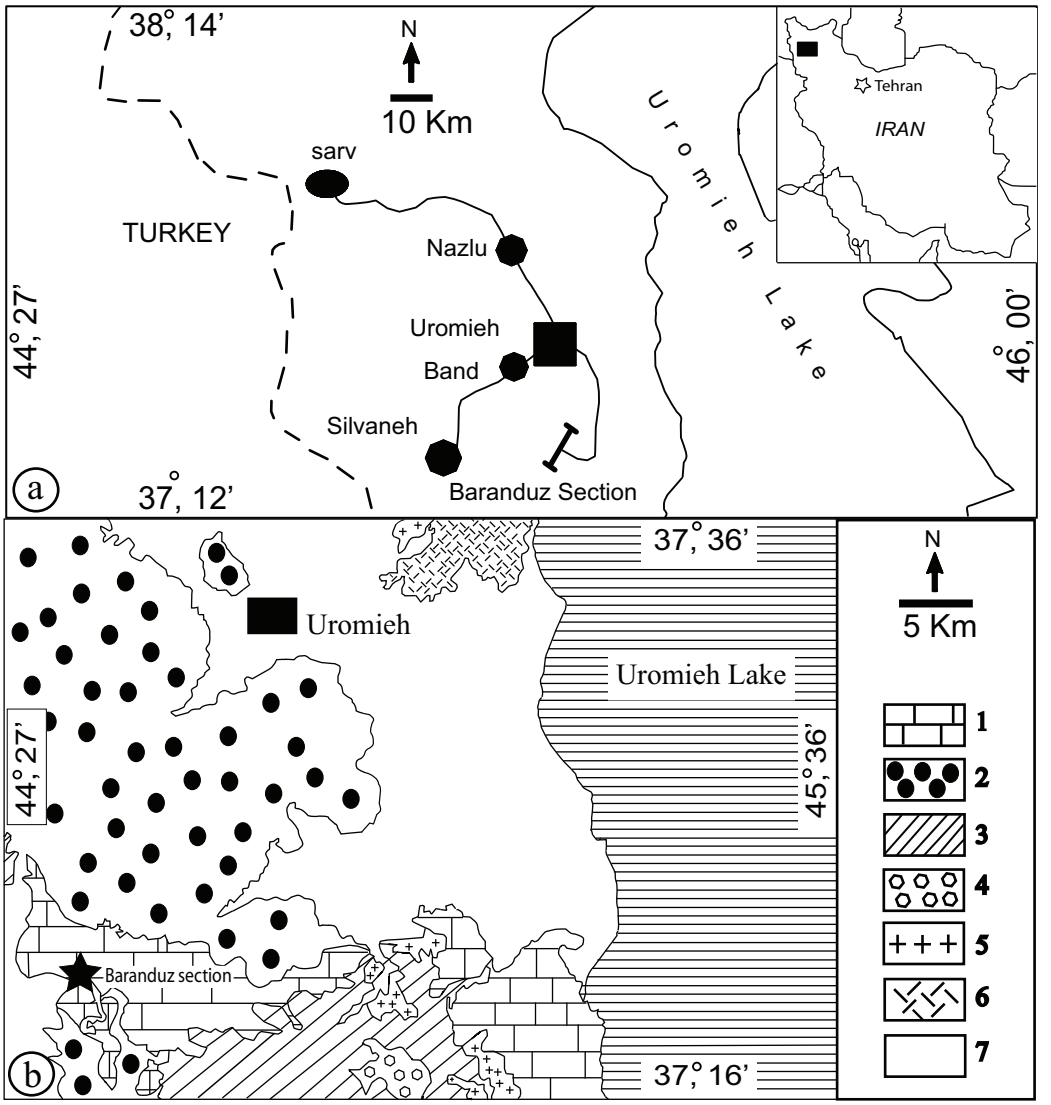

Figure 1. **(a)** Location map of the studied section. **(b)** Geological map of the study area (simplified from Shahrabi 1985). 1– Oligocene carbonates (Qom Formation), 2– Oligocene marls intercalated with sandstones and conglomerates (Qom Formation), 3– undifferentiated Permian and older strata, 4– undifferentiated Triassic–Jurassic strata, 5– volcanics, 6– Miocene tuff, sandstone, siltstone and conglomerate, 7– Quaternary sediments.

7) and *Praerhapydionina delicata* Henson 1950 (Plate II, Figures 3 & 4). Associated assemblages of small benthic foraminifera are dominated by *Triloculina tricarinata* d'Orbigny 1826 (Plate II, Figure 10); *Triloculina trigonula* (Lamarck 1804) (Plate II, Figure 12); *Textularia* spp., *Quinqueloculina* spp., *Spiroloculina* sp. (Plate II, Figure 11); polymorphinids and valvulinids. Calcareous plankton is scarce.

Up section the sedimentary sequence of the formation is followed by thick-bedded and massive limestones. The larger foraminiferal assemblage is gradually dominated by hyaline forms belonging to *Nummulites* cf. *fichteli*, Michelotti 1841 (Plate I, Figure 1); *Nummulites* cf. *vascus*, Joly & Leymeri 1848 (Plate I, Figures 3 & 4); *Neorotalia lithothamnica* (Uhlig 1886) (Plate I, Figures 9 & 10); *Operculina complanata* (Defrance 1822) (Plate I, Figure 5); *Heterostegina* sp. (Plate I, Figure 2); *Asterigerina* sp. (Plate I, Figure 12); *Planorbulina bronnimanni*, Bignot & Decrouez 1982 (Plate I, Figures 8 & 13); *Planorbulina* sp., (Plate I,

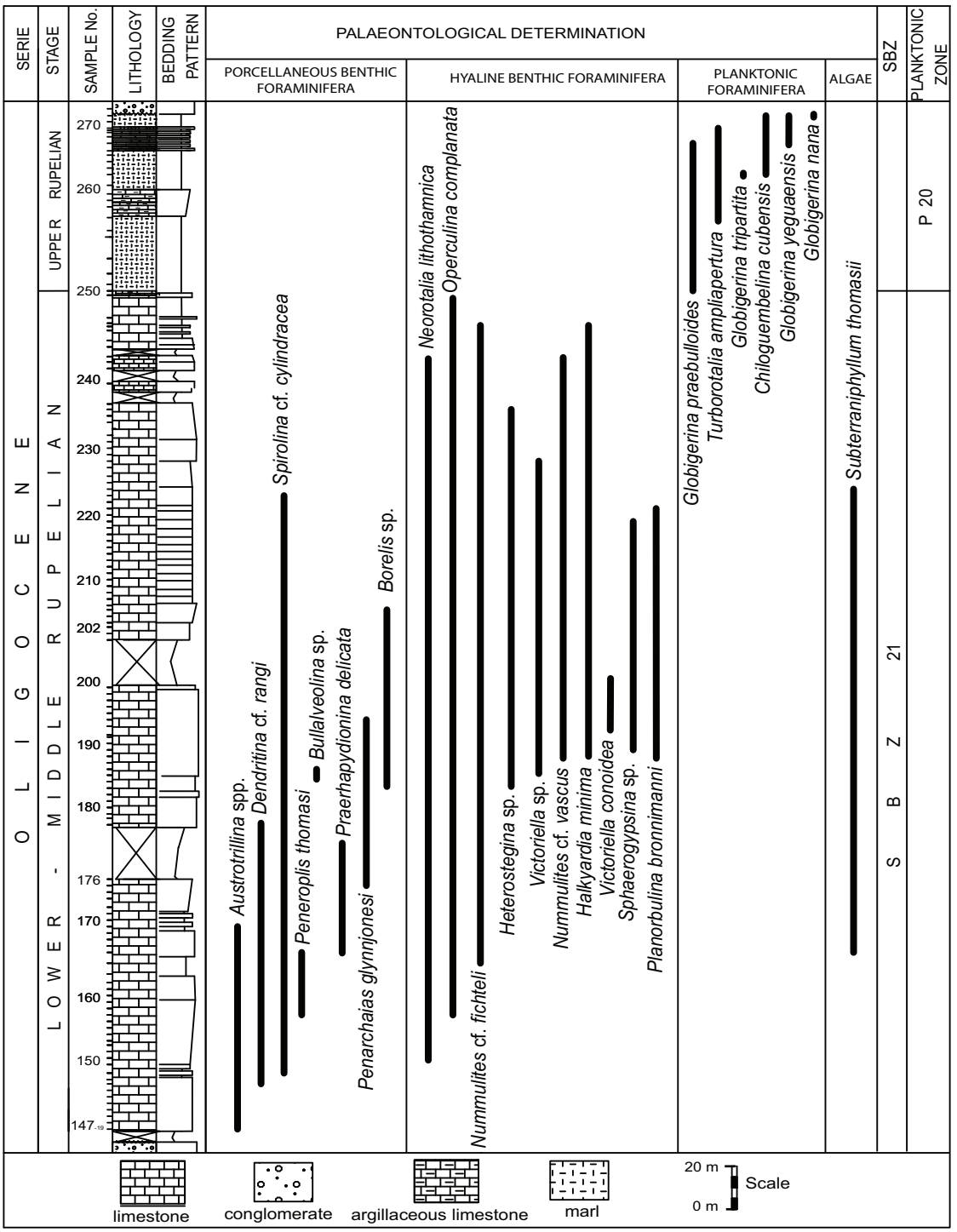

Figure 2. Stratigraphic distribution of the foraminiferal taxa in the Baranduz section.

Figure 7); *Victoriella conoidea* (Rutten 1914) (Plate I, Figure 6) and *Halkyardia minima*, (Liebus 1911) (Plate I, Figure 11). The coralline alga *Subterraniphyllum thomasii*, Elliott 1957 (Plate II, Figure 13); red algal and coral fragments also coexist. The carbonate strata are topped by calcareous marls and argillaceous limestones. This interval is enriched by planktonic foraminifera including *Turborotalia ampliapertura*

(Bolli 1957), *Globigerina praebulloides*, Blow 1959, *Globigerina tripartita*, Koch 1926, *Paragloborotalia nana* (Bolli 1957), *Subbotina yeguaensis* (Weinzierl & Applin 1929) and *Chiloguembelina cubensis* (Palmer 1934). Finally, the section is overlain by a polymictic conglomerate with an erosional base.

Biostratigraphy

The Oligocene deposits in the Baranduz section reflect an environment changing from very shallow inner ramp to deep marine outer ramp. The shallow marine unit is characterized by the presence of larger benthic foraminifera, which include *Nummulites* cf. *fichteli* (with an average proloculus diameter of 0.36 mm), *Nummulites* cf. *vascus*, *Planorbulina bronnimanni*, *Halkyardia minima*, *Victoriella conoidea*, *Heterostegina* sp., *Sphaerogypsina* sp., *Penarchaias glynnjonesi*, *Spirolina* cf. *cylindracea*, *Praerhapydionina delicata*, *Borelis* sp., *Bullalveolina* sp., *Austrotrillina* spp. and *Dendritina rangi*. In order to identify the zonal assignment for the Qom Formation in the section studied, the important biostratigraphic markers in the assemblage mentioned above are *Nummulites* cf. *fichteli* and *Nummulites* cf. *vascus*. Their ranges were given by Cahuzac & Poignant (1997) as SBZ 21 to 22b, ranging from the early Rupelian to the early Chattian. The SBZ 22a Subzone is characterized by the coexistence of *Nummulites* and lepidocyclinids (Cahuzac & Poignant 1997).

Racey (1994) claimed that the occurrence of *Nummulites* in the absence of *Eulepidina* indicates an early Oligocene age, and their coexistence indicates a late Oligocene age. Jones & Racey (1994) reported the occurrence of *Nummulites* without *Eulepidina* in the Rupelian, and *Nummulites* together with *Eulepidina* in the late Rupelian–early Chattian. Within the Baranduz section *Nummulites* cf. *fichteli* and *Nummulites* cf. *vascus* occur together with *Operculina complanata*, *Victoriella conoidea*, *Neorotalia lithothamnica*, *Planorbulina bronnimanni* and *Halkyardia minima* but lepidocyclinids are not observed. Therefore, it can be concluded that the presence of the aforementioned association characterizes the SBZ 21 Zone for the shallow marine carbonates of the section studied. This unit is overlain by calcareous marls containing planktonic foraminifera. The presence of *Turborotalia ampliapertura, Globigerina praebulloides*, *Globigerina tripartita*, *Paragloborotalia nana*, *Subbotina yeguaensis* and *Chiloguembelina cubensis* indicates the P20 zone of Spezzaferri (1994), suggesting a late Rupelian age.

Conclusions

The recognized larger benthic foraminiferal fauna in northwestern Iran allowed the author to compare the studied assemblage with coeval assemblages in the Middle East and Europe. The early to middle Rupelian SBZ 21 Zone is reported for the first time from Iran. The zone is characterized by the assemblage of *Nummulites* cf. *fichteli* and *Nummulites* cf. *vascus,* accompanied by *Heterostegina* sp., *Victoriella conoidea*, *Neorotalia lithothamnica*, *Planorbulina bronnimanni*, *Operculina complanata*, *Dendritina rangi*, *Penarchaias glynnjonesi*, *Praerhapydionina delicata*, *Spirolina* cf. *cylindracea* and *Peneroplis thomasi*. Planktonic foraminifera of the P20 Zone were determined from the deep marine overlying strata. Most of above-mentioned larger foraminiferal taxa correspond to those already described from Europe. Therefore, the European standard shallow benthic zonation can be extended to northwestern Iran.

Acknowledgments

This study was carried out in NIOC Exploration Directorate as a part of a Central Iran Project. The author would like to acknowledge the authorities of NIOC for financial support and for permission to publish this paper. The author also thanks Ercüment Sirel, Ercan Özcan and György Less for their help and discussion.

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Plate 1

Figure 1. *Nummulites* cf. *fichteli* Michelotti 1841; sample no. RCH 227
Figure 2. *Heterostegina* sp., sample no. RCH 214
Figures 3 & 4. *Nummulites* cf. *vascus* Joly & Leymerie 1848; sample no. RCH 239
Figure 5. *Operculina complanata* (Defrance 1822); sample no. RCH 215
Figure 6. *Victoriella conoidea* (Rutten 1914); sample no. RCH 192
Figure 7. *Planorbulina* sp., sample no. RCH 201
Figures 8 & 13. *Planorbulina bronnimanni* Bignot & Decrouez 1982; Sample nos. RCH 191 & 217
Figures 9 & 10. *Neorotalia lithothamnica* (Uhlig 1886); sample nos. RCH 211 & 212
Figure 11. *Halkyardia minima* (Liebus 1911); sample no. RCH 232
Figure 12. *Asterigerina* sp., sample no. RCH 239
Scale bars represent 0.2 mm.

Plate 1

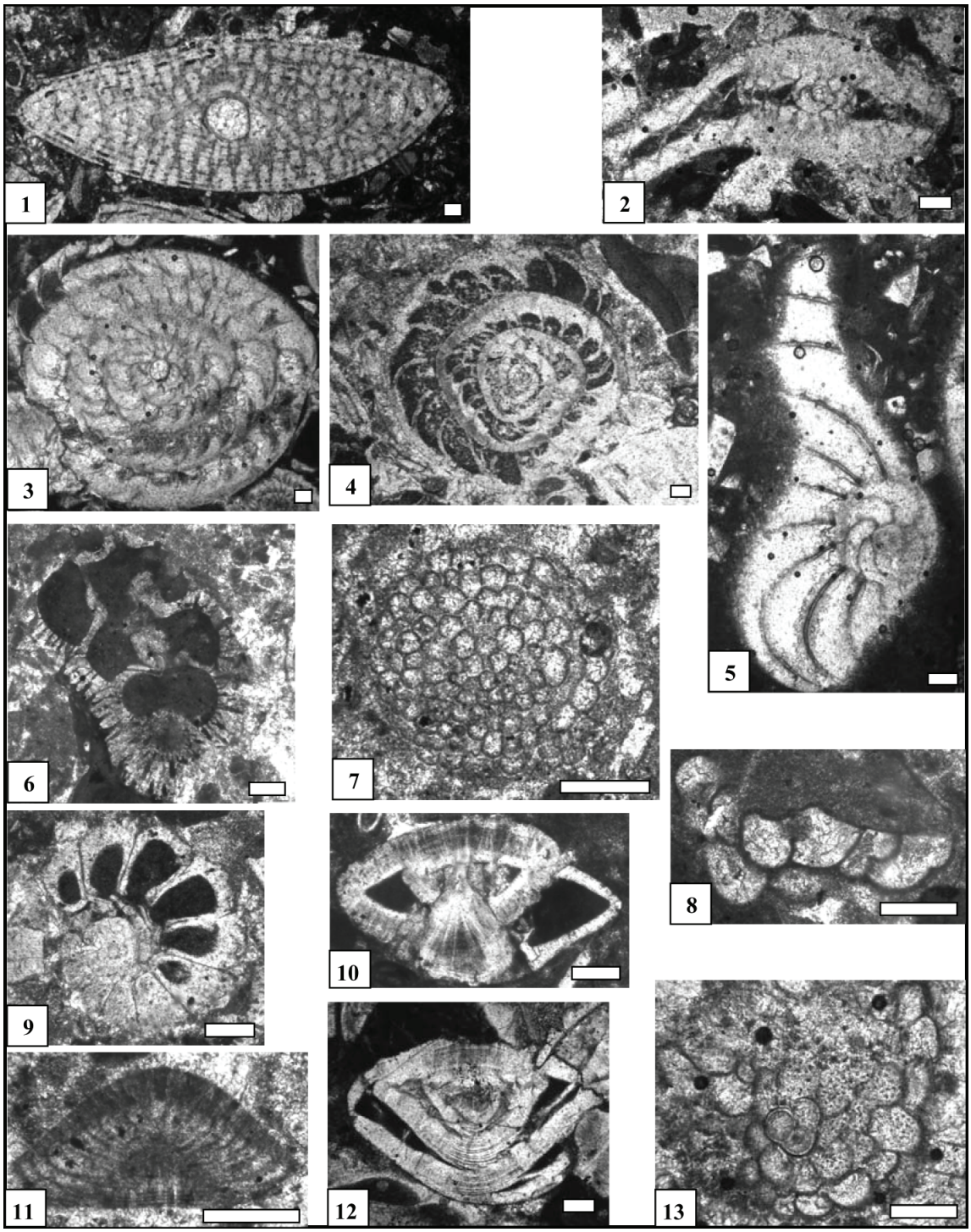

Plate 2

Figures 1 & 2. *Dendritina rangi* d'Orbigny 1826; sample nos. RCH 170 & 166
Figures 3 & 4. *Praerhapydionina delicata* Henson 1950; sample nos. RCH 177 & 179
Figure 5. *Penarchaias glynnjonesi* (Henson 1950); sample no. RCH 177
Figure 6. *Borelis* sp., sample no. RCH 192
Figure 7. *Bullalveolina* sp., sample no. RCH 184
Figure 8. *Peneroplis thomasi* Henson 1950; sample no. RCH 160
Figure 9. *Spirolina* cf. *cylindracea* (Lamarck 1804); sample no. RCH 170
Figure 10. *Triloculina tricarinata* d'Orbigny 1826; sample no. RCH 163
Figure 11. *Spiroloculina* sp., sample no. RCH 171
Figure 12. *Triloculina trigonula* (Lamarck, 1804); sample no. RCH 160
Figure 13. *Subterraniphyllum thomasii* Elliott 1957; sample no. RCH 177
Scale bars represent 0.2 mm.

Plate 2