Al-Sulevani and Al-Badrani *Iraqi Journal of Science, 2021, Vol. 62, No. 5, pp: 1605-1621*
DOI: 10.24996/ijs.2021.62.5.23

ISSN: 0067-2904

Calcareous Nannofossils Biostratigraphy of Tanjero Formation at Azmer Anticline, Sulimaniya, Northern Iraq

Rahme Fares Al-Sulevani , Omar Ahmed Al-Badrani*
Department of Geology, College of Science, Mosul University, Mosul, Iraq

Received: 14/7/2020 Accepted: 17/11/2020

Abstract
Seventy three species of calcareous nannofossils are recorded from the studied section of Tanjero Formation at Azmer anticline, Sulimaniya, Northern Iraq. The studied section reveals four biozones arranged in an ascending order from oldest to youngest as follows; *Tranolithus phacelosus* Interval Biozone (CC23) Part, *Rienhardtites lives* Interval Biozone (CC24), *Arkhangelskilla cymbiformis* Interval Biozone (CC25), and *Nephrolithus frequens* Rang Biozone (CC26) Part. These biozones are correlated with other calcareous nannofossil biozones of both local and regional sections, leading to conclude a possible age of Late Campanian-Maastrichtian.

Key words: Calcareous nannofossils, Biostratigraphy, Cretaceous, Iraq.

الطباقية الحياتية لمتحجرات النانو الكلسية لتكوين تانجيرو في طية ازمر، السليمانية، شمالي العراق

رحمة فارس السليفاني* ، عمر احمد البدراني
قسم علوم الارض، كلية العلوم، جامعة الموصل، الموصل، العراق

الخلاصه
شخص ثلاثة وسبعون نوعا تابعا لمتحجرات النانو الكلسية في تكوين تانجيرو، الذي ينكشف في طية ازمر الواقعة ضمن محافظة السليمانية، شمالي العراق. تم تحديد اربعة انطقة حياتية هي من الاقدم الى الاحدث كما يلي؛ *Tranolithus phacelosus* Interval Biozone (CC23), *Rienhardtites lives* Interval Biozone (CC24), *Arkhangelskilla cymbiformis* Interval Biozone (CC25), *Nephrolithus frequens* Rang Biozone (CC26). تمت مضاهاة الانطقة المسجلة مع المقاطع المحلية والاقليمية، وتم استنتاج عمر الكامبانيان المتاخر الى الماسترختيان للمقطع قيد الدراسة الحالية.

Introduction

Tanjero Formation is exposed in the high folded zone of Iraq. It was first defined and described from Sirwan valley, 2 Km to the south of Kani Karweshkan village, near Halabja town, Sulimaniya, Northern Iraq [1], laying at Azmer anticline. Tanjero Formation is composed of sandstone, claystone, and shale from the bottom, followed by a common vertical alternation of marls and limestone at the upper part of the studied section. Therefore, the lower part is deposited under deep marine shelf environments, while the upper part is deposited under open marine environments (Fig.1). Tanjero Formation is correlated with Shiranish Formation in northern Iraq [2, 3], but it is almost younger.

* Email: omarbadrani@uomosul.edu.iq

The aim of the present work is to determine the age of the Tanjero Formation by using calcareous nannofossils.

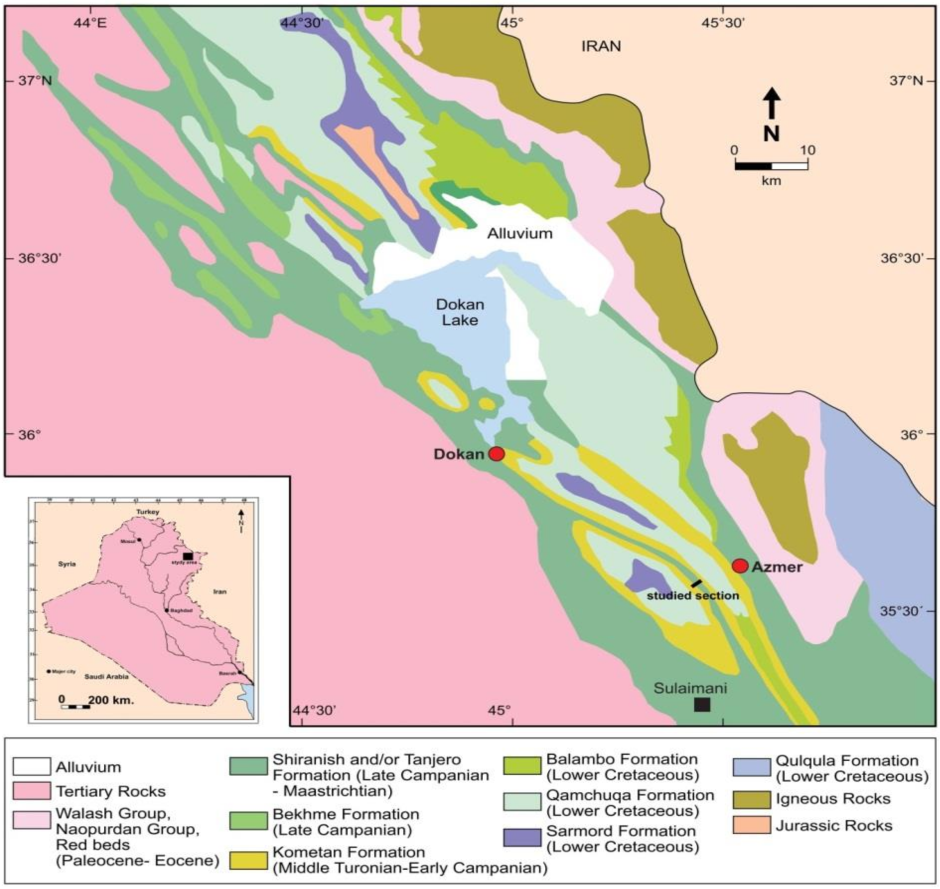


Figure 1-Location map of Tanjero Formation in Azmer anticline, Northern Iraq [4, 5].

Materials and methods

Fifty samples of marl, marly limestone , siltstone, and shale were selected for studying the calcareous nannofossils by using thin sections (under transmitted- light microscope). The calcareous nannofossils were extracted by using the method described in an earlier work (H) [6]. It is favorable extraction method for microfossils that can be properly examined when extracted from the rocks. Sample preparation was performed based on decanting and smear slide techniques, which provide a method for producing slides of calcareous nannofossils by using a small amount of the disaggregated sample, which is placed in distilled water with the addition of a drop of cellosize to act as a dispersant. To make permanent mounts, the slide and residue were allowed to dry at a low temperature away from possible sources of contamination. A drop of the mounting medium (Canada Balsam) was placed on a clean dry cover slip which was dropped over the residue. to the preparation was allowed to dry before examination with the transmitted light microscope.

Results and discussion

1 - Systematic Paleontology

I- Heterococcolith

Family: Chistozygaceae, Rood, Hay and Barnard

Genus *Bukyrlithus* Black

Bukyrlithus ambiguus Black (Pl.1, Fig.1)

Genus *Chiastozygus* Gartner

Chiastozygus platyrhethum Hill (Pl.1, Fig.2)

Chiastozygus sp. (Pl.1, Fig.3)

Genus *Glaukolithus* Reinhardit

Glaukolithus diplogammus Deflander and Fert (Pl.1, Fig.4)

Genus *Reinhardtites* Perch- Nielsen
Reinhardtitus levis Prins and Sissingh in Sissingh (Pl.1, Fig.5)
Genus *Staurolithites* Caratini
Staurolithites flavus Burnett (Pl.1, Fig.6)
Staurolithites imbricatus (Gartner) Burnett (Pl.1, Fig.7)
Staurolithites laffittei Caratini (Pl.1, Fig.8)
Genus *Tranolithus* Stover
Tranolithus phacelosus Stover (Pl.1, Fig.9)
Genus *Zeugrhabdotus* Reinhardt
Zeugrhabdotus embergeri (Noël) Perch-Nielsen (Pl.1, Fig.10)
Family Crepidolithaceae Black
Genus *Neocrepidolithus* Romein
Neocrepidolithus watkinsii Pospichal and Wise (Pl.1, Fig.11)
Family Eiffellithaceae Reinhardt
Genus *Eiffellithus* Reinhardt
Eiffellithus eximius (Stover) Perch-Nielsen (Pl.1, Fig.12)
Eiffellithus gorkae Reinhardt (Pl.2, Fig.1)
Eiffellithus parallelus Perch-Nielsen (Pl.2, Fig.2)
Eiffellithus turriseiffeli (Deflander and Fert) Reinhardt (Pl.2, Fig.3)
Eiffilithus cf. *parvus* Watkins and Bergen (Pl.2, Fig.4)
Eiffilithus sp. (Pl.2, Fig.5)
Family Rhagodiscaeae Hay
Genus *Rhagodiscus* Reihardit
Rhagodiscus splendens (Deflandre) Verbeek (Pl.2, Fig.6)
Family Axopodorhabdaceae Wind and Wise in Wise and Wind
Genus *Cribrocorona* Perch-Nielsen
Cribrocorona gallica (Stradner) Perch- Nielsen (Pl.2, Fig.7)
Genus *Cribrosphaerella* Deflandre in Piveteau
Cribrosphaerella dania Perch-Nielsen (Pl.2, Fig.8)
Cribrosphaerella ehrenbergii (Arkhangelsky) Deflandre (Pl.2, Fig.9)
Cribrosphaerella romanica Reinhardt (Pl.2, Fig.10)
Genus *Nephrolithus* Gorka
Nephrolithus frecuens Górka (Pl.2, Fig.11)
Nephrolithus sp. (Pl.2, Fig.12)
Family Prediscosphaeraceae Rood et al.
Genus *Prediscosphaera* Vekshina
Prediscosphaera cf.*grandis* Perch-Nielsen (Pl.3, Fig.1)
Family Cretarhabdaceae Thierstein
Genus *Retecapsa* Black
Retecapsa crenulata (Bramlette and Martini) Grün in Grün and Allemann (Pl.3, Fig.2)
Family Watznaueriaceae Rood et al.
Genus *Cyclagelosphaera* Noël
Cyclgelosphaera margerelii Noël (Pl.3, Fig.3)
Genus *Watznauria* Reinhardt
Watznaueria barnesae (Black and Barnes) Perch-Nielsen (Pl.3, Fig.4)
Watznauria biporta Bukry (Pl.3, Fig.5)
Family Arkhangelskiellaceae Bukry, emend. Bown and Hampton
Genus *Arkhangelskiella* Vekshina
Arkhangelskiella cymbiformis Vekshina (Pl.3, Fig.6)
Arkhangelskiella maastrichtiensis Burnett (Pl.3, Fig.7)
Arkhangelskiella sp. (Pl.3, Fig.8)
Genus *Broinsonia* Bukry
Broinsonia parca (Stradner, 1963)Bukry (Pl.3, Fig.9)
Broinsonia sp. (Pl.3, Fig.10)

Genus *Gartnerago* Bukry
Gartnerago segmentatum (Stover) Thierstein (Pl.3, Fig.11)
Gartnerago sp. (Pl.3, Fig.12)
II- Holococcolith
Family Calyptrosphaeraceae Boudreaux and Hay
Genus *Calculites* Prins and Sissingh in Sissingh
Calculites obscurus(Deflander) Prins and Sissingh in Sissingh (Pl.4, Fig.1)
Calculites ovalis (Stradner) Prins and Sissingh in Sissingh (Pl.4, Fig.2)
Calculites sp. (Pl.4, Fig.3)
Genus *Russellia* Risatti
Russellia bukryi Risatti (Pl.4, Fig.4)
Russellia laswellii Risatti (Pl.4, Fig.5)
III- Nannolith
Family Microrhabdulaceae Deflandre
Genus *Lithraphidites* Deflandre
Lithraphidites acutus Verbeek and Manivit in Manivit et al. (Pl.4, Fig.6)
Lithraphidites carniolensis Deflandre (Pl.4, Fig.7)
Lithraphidites grossopectinatus, Bukry (Pl.4, Fig.8)
Lithraphidites praequadratus Roth (Pl.4, Fig.9)
Lithraphidites cf. *praequadratus* Roth (Pl.4, Fig.10)
Lithraphidites quadratus Bramlette and Martini (Pl.4, Fig.11)
Lithraphidites cf. quadratus Bramlette and Martini (Pl.4, Fig.12)
Lithraphidites sp. (Pl.5, Fig.1)
Genus *Microrhabdulus* Deflandre
Microrhadulus decuratus Deflandre (Pl.5, Fig.2)
Microrhadulus stradneri Bramlette and Martini (Pl.5, Fig.3)
Microrhabdulus undosus Perch-Nielsen (Pl.5, Fig.4)
Microrhadulus sp. (Pl.5, Fig.5)
Family Polycyclolithaceae Forchheimer
Genus *Micula* Vekshina
Micula adumbrata Burnett (Pl.5, Fig.6)
Micula clypeata Lees and Bown (Pl.5, Fig.7)
Micula cubiformis Forchheimer (Pl.5, Fig.8)
Micula decussata Vekshina (Pl.5, Fig.9)
Micula murus (Martini) Bukry (Pl.5, Fig.10)
Micula staurophora (Gardet) Stradner (Pl.5, Fig.11)
Micula premolisilvae Lees and Bown (Pl.5, Fig.12)
Micula praemurus (Bukry) Stradner and Steinmetz (Pl.6, Fig.1)
Micula sp. (Pl.6, Fig.2)
Genus *Quadrum* Manivit et al.
Quadrum gartneri Manivit et al. (Pl.6, Fig.3)
Quadrum gothicum (Deflander)Manivit et al. (Pl.6, Fig.4)
Quadrum trifidum (Stradner In Stradner and Papp) Prins and Perch-Nielsen in Manivit et al. (Pl.6, Fig.5)
Genus *Ceratolithoides* Bramlette and Martini
Ceratolithoides aculeus (Stradner) Prins and Sissingh in Sissingh (Pl.6, Fig.6)
Ceratolithoides brevicorniculans Burnett (Pl.6, Fig.7)
Ceratolithoides longissimus Burnett (Pl.6, Fig.8)
Ceratolithoides prominens Burnett (Pl.6, Fig.9)
Ceratolithoides sesquipedalis Burnett (Pl.6, Fig.10)
Ceratolithoides ultimus Burnett (Pl.6, Fig.11)
Ceratolithoides cf.*ultimus* Burnett (Pl.6, Fig.12)

Plate 1

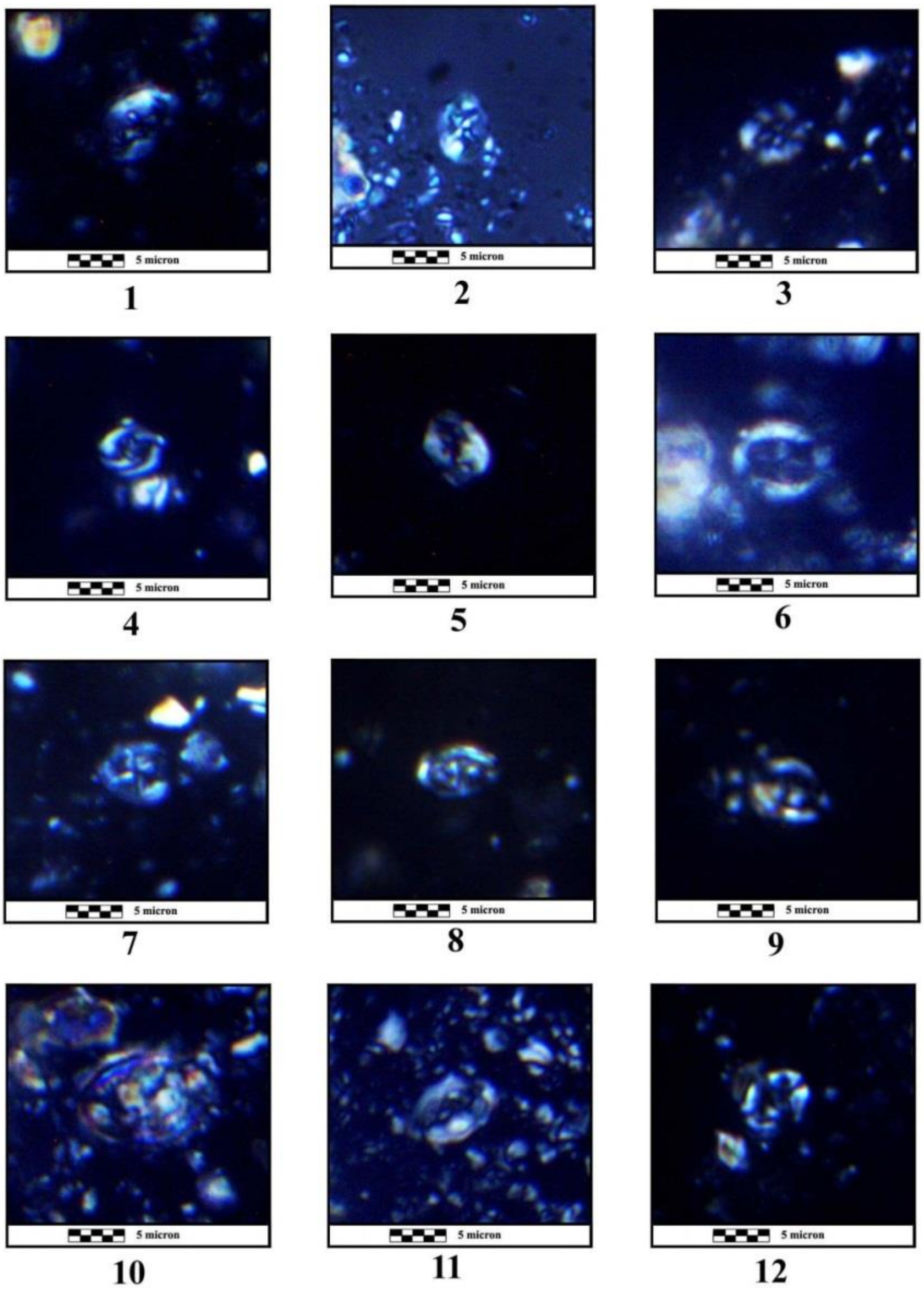


Plate (1): Cross-polarized light microscope photos of significant calcareous nannofossil taxa fromTanjero Formation. (1)*Bukyrlithus ambiguus* Black; (2)*Chiastozygus platyrhethum* Hill; (3)*Chiastozygus* sp.; (4)*Glaukolithus diplogammus* Deflander and Fert; (5)*Reinhardtitus levis* Prins and Sissingh in Sissingh; (6)*staurolithites flavus* Burnett; (7)*staurolithites imbricatus* (Gartner) Burnett; (8)*staurolithites laffittei* Caratini; (9)*Tranolithus phacelosus* Stover; (10)*Zeugrhabdotus embergeri* (Noël) Perch-Nielsen; *(11)Neocrepidolithus watkinsii* Pospichal and Wise; (12)*Eiffellithus eximius* (Stover) Perch-Nielsen.

Plate 2

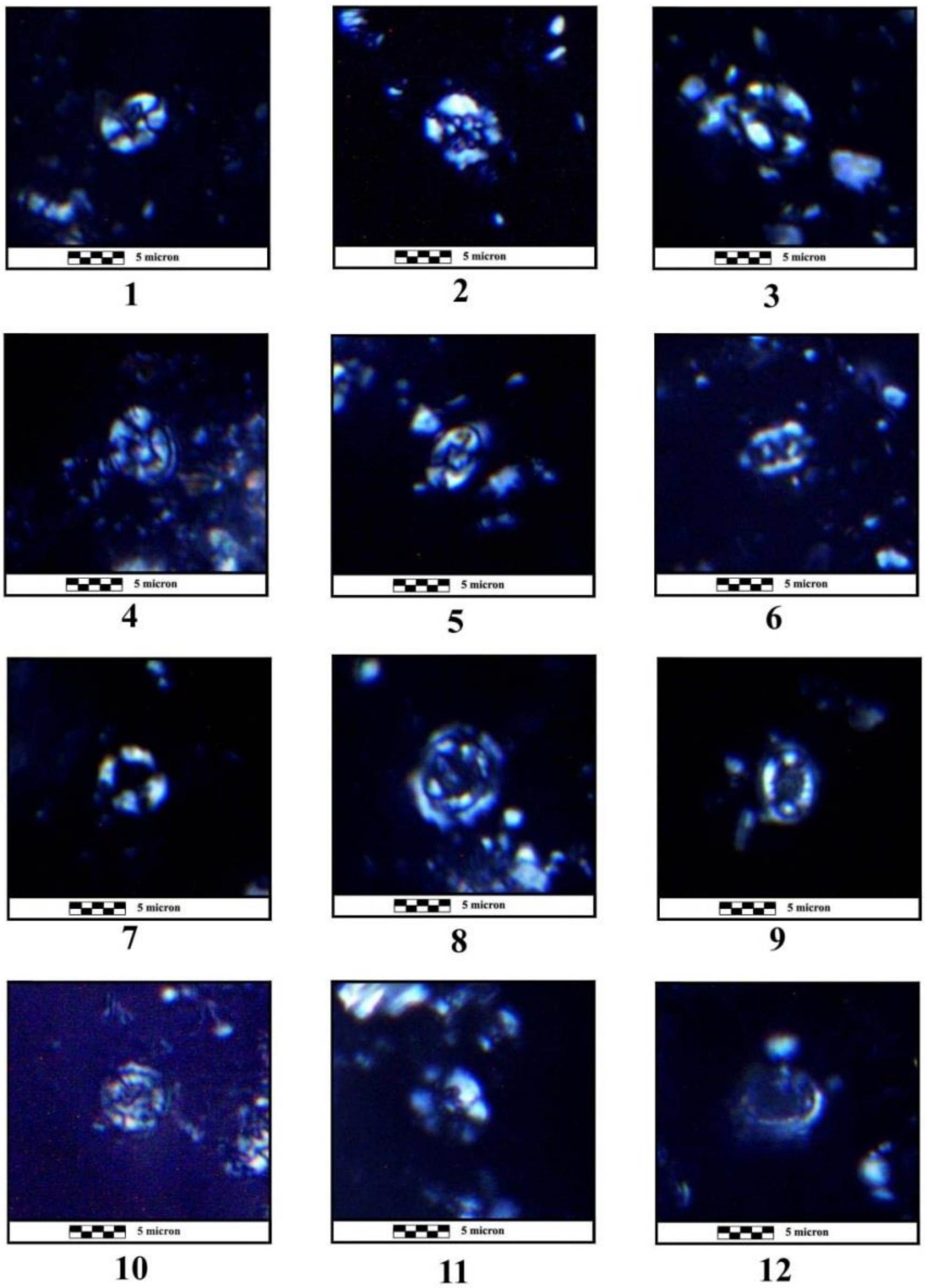
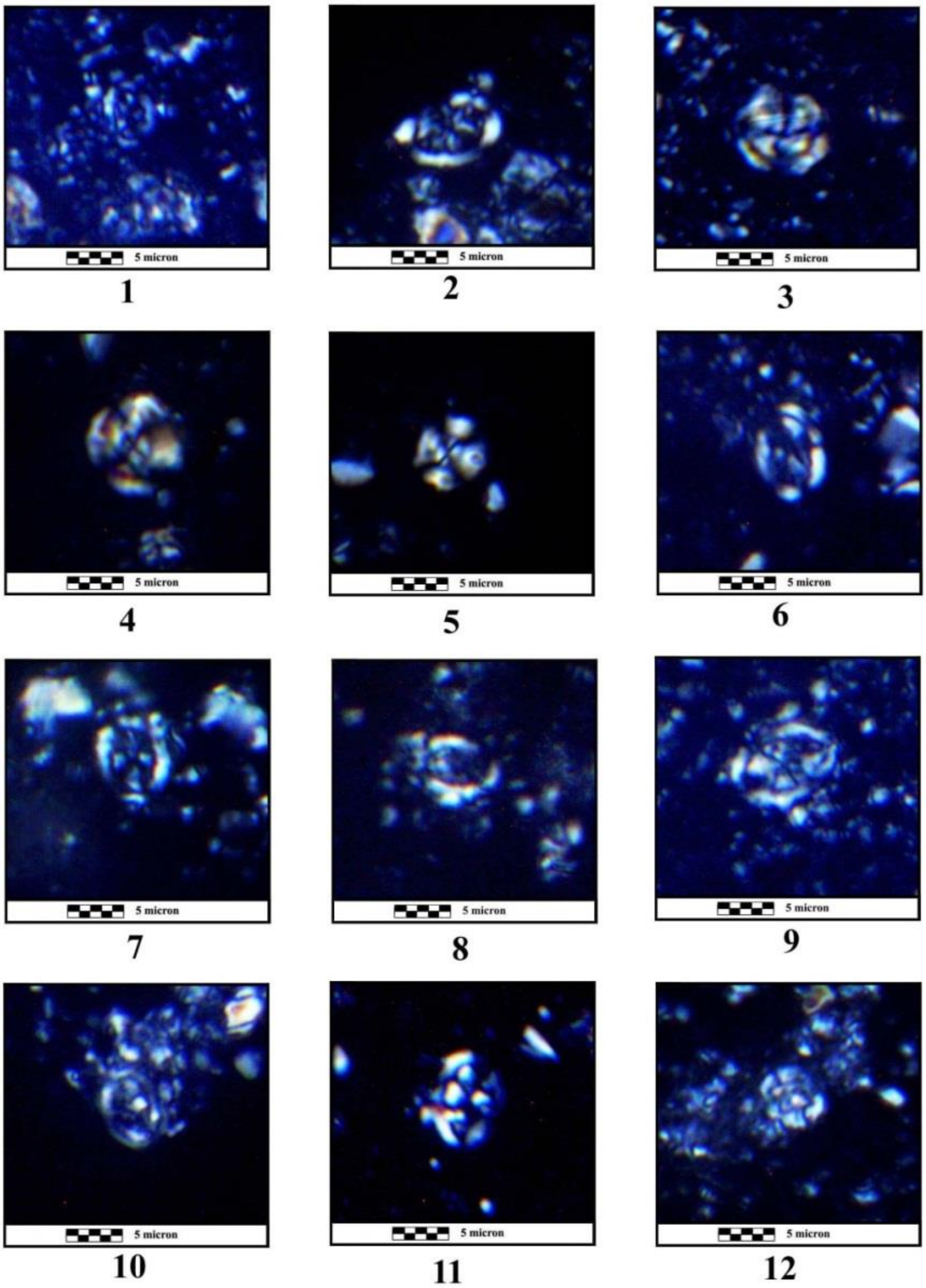


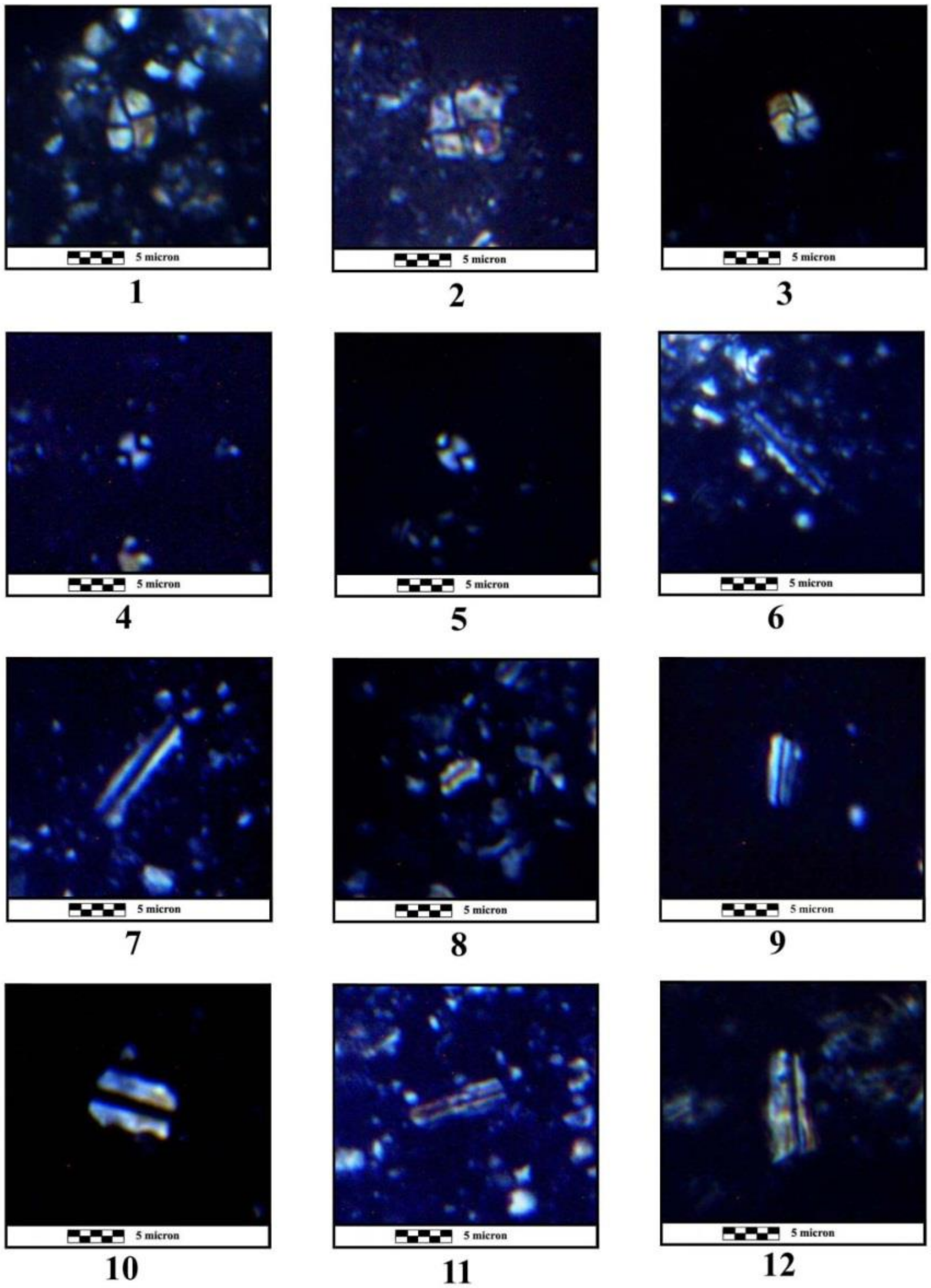
Plate (2): Cross-polarized light microscope photos of significant calcareous nannofossil taxa fromTanjero Formation. (1)*Eiffellithus gorkae* Reinhardt; (2)*Eiffellithus parallelus* Perch-Nielsen; (3)*Eiffellithus turriseiffeli* (Deflander and Fert) Reinhardt; (4)*Eiffilithus* cf. *parvus* Watkins and Bergen; (5)*Eiffilithus* sp.; (6)*Rhagodiscus* splendens (Deflandre) Verbeek; (7)*Cribrocorona gallica* (Stradner) Perch- Nielsen; (8)*Cribrosphaerella dania* Perch-Nielsen; (9)*Cribrosphaerella ehrenbergii* (Arkhangelsky) Deflandre; (10)*Cribrosphaerella romanica* Reinhardt; (11)*Nephrolithus frecuens* Górka; (12)*Nephrolithus* sp.

Plate 3



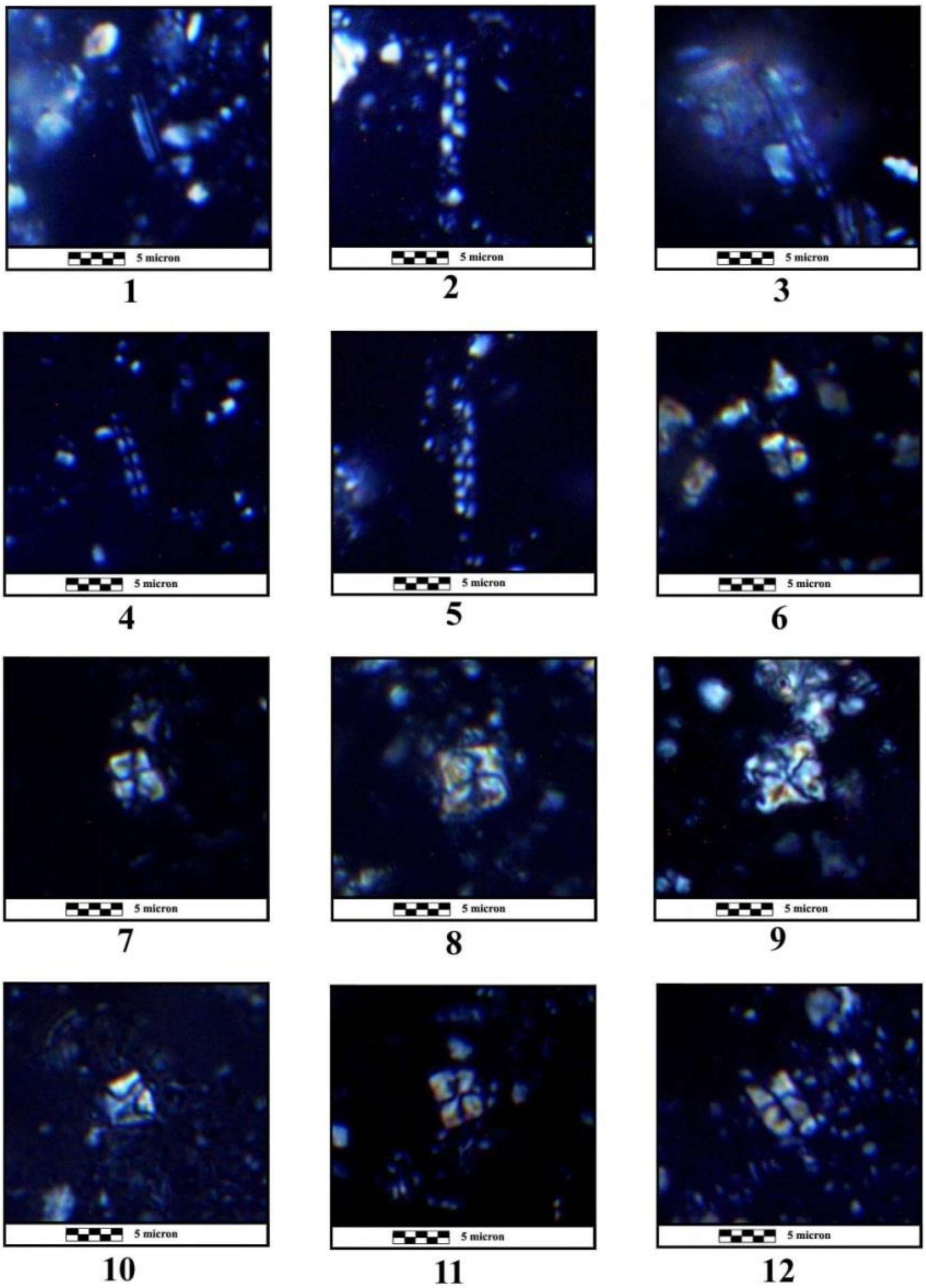
Explanations Plate (3): Cross-polarized light microscope photos of significant calcareous nannofossil taxa from Tanjero Formation. (1)*Prediscosphaera* cf.*grandis* Perch-Nielsen; (2)*Retecapsa crenulata* (Bramlette and Martini) Grün in Grün and Allemann; (3)*Cyclgelosphaera margerelii* Noël; (4)*Watznaueria barnesae* (Black and Barnes) Perch-Nielsen; (5)*Watznauria biporta* Bukry; (6)*Arkhangelskiella cymbiformis* Vekshina; (7)*Arkhangelskiella maastrichtiensis* Burnett; (8)*Arkhangelskiella* sp.; (9)*Broinsonia parca* (Stradner)Bukry, 1969; (10)*Broinsonia* sp.; *(11)Gartnerago segmentatum* (Stover) Thierstein; *(12)Gartnerago* sp.

Plate 4



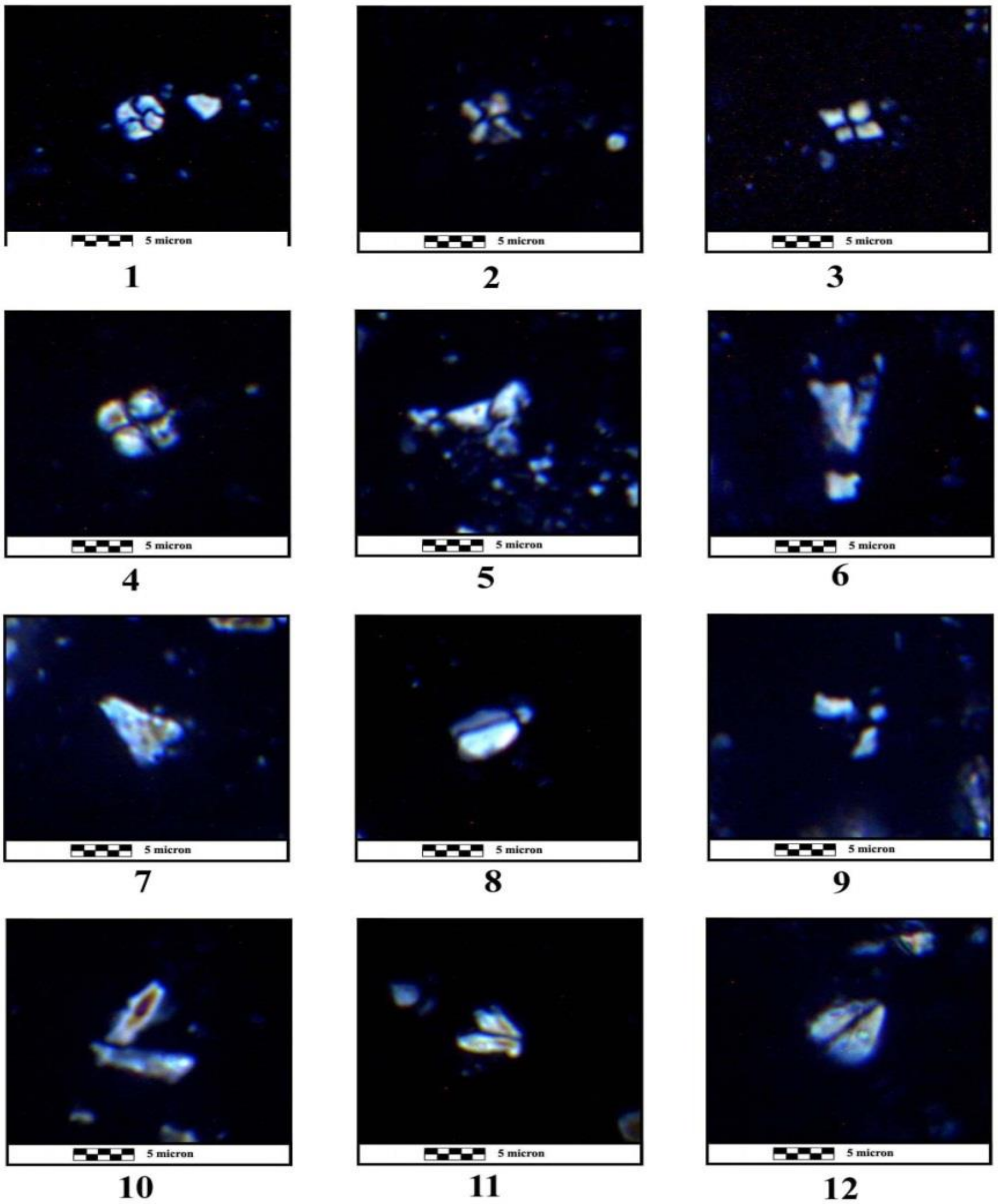
Explanations Plate (4): Cross-polarized light microscope photos of significant calcareous nannofossil taxa from Tanjero Formation. (1)*Calculites obscurus*(Deflander) Prins and Sissingh in Sissingh; (2)*Calculites ovalis* (Stradner) Prins and Sissingh in Sissingh; (3)*Calculites* sp.; (4)*Russellia bukryi* Risatti; (5)*Russellia laswellii* Risatti; (6)*Lithraphidites acutus* Verbeek and Manivit in Manivit et al.; (7)*Lithraphidites carniolensis* Deflandre; (8)*Lithraphidites grossopectinatus*, Bukry; (9)*Lithraphidites praequadratus* Roth; (10)*Lithraphidites* cf. *praequadratus* Roth; (11)*Lithraphidites quadratus* Bramlette and Martini; (12)*Lithraphidites cf. quadratus* Bramlette and Martini.

Plate 5



Explanations Plate (5): Cross-polarized light microscope photos of significant calcareous nannofossil taxa from Tanjero Formation. (1)*Lithraphidites* sp.; (2)*Microrhadulus decuratus* Deflandre; (3)*Microrhadulus stradneri* Bramlette and Martini; (4)*Microrhabdulus undosus* Perch-Nielsen; (5)*Microrhadulus* sp.; (6)*Micula adumbrata* Burnett; (7)*Micula clypeata* Lees and Bown; (8)*Micula cubiformis* Forchheimer; (9)*Micula decussata* Vekshina; (10)*Micula murus* (Martini) Bukry; (11)*Micula staurophora* (Gardet) Stradner,; (12)*Micula premolisilvae* Lees and Bown.

Plate 6



Explanations Plate (6): Cross-polarized light microscope photos of significant calcareous nannofossil taxa from Tanjero Formation. (1)*Micula praemurus* (Bukry) Stradner and Steinmetz; (2)*Micula* sp. ; (3)*Quadrum gartneri* Manivit et al.; (4)*Quadrum gothicum* (Deflander)Manivit et al.; (5)*Quadrum trifidum* (Stradner In Stradner and Papp) Prins and Perch-Nielsen in Manivit et al.; (6)*Ceratolithoides aculeus* (Stradner) Prins and Sissingh in Sissingh; (7)*Ceratolithoides brevicorniculans* Burnett; (8)*Ceratolithoides longissimus* Burnett; (9)*Ceratolithoides prominens* Burnett; (10)*Ceratolithoides sesquipedalis* Burnett; (11)*Ceratolithoides ultimus* Burnett; (12)*Ceratolithoides* cf.*ultimus* Burnett.

2 - Nannobiostratigraphy

Depending on the stratigraphic distribution of the recorded species, three Biozones were identified [4] (Figs. 5, 6, 7).

Tranolithus phacelosus Interval Biozone (CC 23))1

Definition: Interval biozone of Tranolithus *phacelosus* Stover.

Boundaries: The biozone was determined by the last occurrence of *Eiffilithus eximus* (Stover) Perch-Nielsen to the last occurrence of *Tranolithus phacelosus* Stover.

Correlation and Discussion: This biozone is correlated with CC23 (*Tranolithus phacelosus* biozone) that was studied by [8] and aged as late Campanian - early Maasterchtian. Also, it is correlated with

UC16 and UC17 biozones studied by [9, 10] and aged as Campanian. Therefore, the present study suggests that this *Reinhardtites* biozone belongs to the Campanian age.

2) *Reinhardtites levis* Interval Biozone (CC24)

Definition: Interval biozone of *levis* Prins and Sissingh, in Sissingh.

Boundaries: The biozone was determined by the last occurrence of *Tranolithus phacelosus* Stover to the Last occurrence of *Reinhardtites levis Prins* and Sissingh, in Sissngh.

Correlation and Discussion: This biozone is correlated with CC24 (*Reinhardtites levis* biozone) which was studied by [8] and assigned to the age of the late Campnian - early Maastrichtian. It is also correlated with UC18 biozone which was studied by [9, 10] which aged as the Maastrichtian. Therefore, the present study suggests that this biozone belongs to the Maastrichtian age.

3) *Arkhangelskiella cymbiformis* Interval Biozone (CC25)

Definition: Interval biozone of *Arkhangelskiella cymbiformis* Vekshina.

Boundaries: The biozone was determined by the last occurrence of Reinhardtites *levis* Prins and Sissingh to the first occurrence of *Nephrolithus frequens* Górka.

Correlation and Discussion: This biozone is correlated with (CC25) (*Arkhangelskiella cymbiformis* Biozone) [8] which is divided into three subdivisions (CC25a, CC25b, CC25c) by the first appearance of the species *Arkhangelskiella cymbiformis* and the first appearance of the species *Lithraphidites quadratus* at the Maastrichtian age. It is also correlated with UC19 biozone which was studied by [9, 10] and aged as the Late Maastrichtian. Therefore, the present study suggests that this biozone belongs to the Maastrichtian age [11]..

4) *Nephrolithus frequens* Rang Biozone (CC26)

Definition: Rang biozone of *Nephrolithus frequens* Górka (1957).

Boundaries: The biozone is determined by the first occurrence to the last occurrence of *Nephrolithus frequens* Górka. This biozone has a thickness of 50 m.

Correlation and Discussion : This biozone is correlated with *Nephrolithus frequens* biozones (CC26) described by [8] and UC20 described by [9] and [10], all belonging to the Late Maastrichtian. Therefore, the present study suggests that this biozone belongs to the Maastrichtian age..

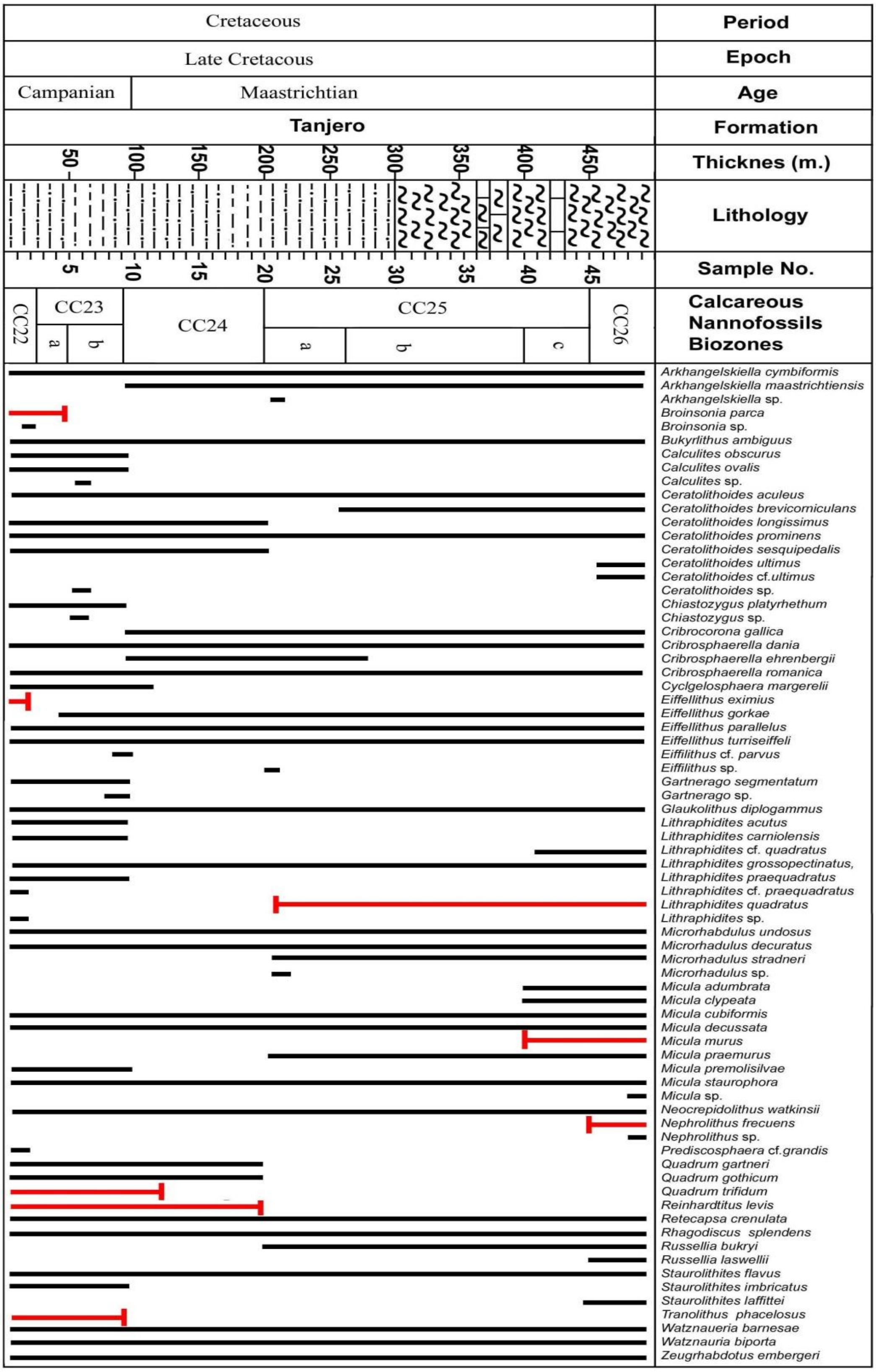


Figure 2- Biostratigraphic range chart of Tanjero Formation in Azmer anticline, Northern Iraq.

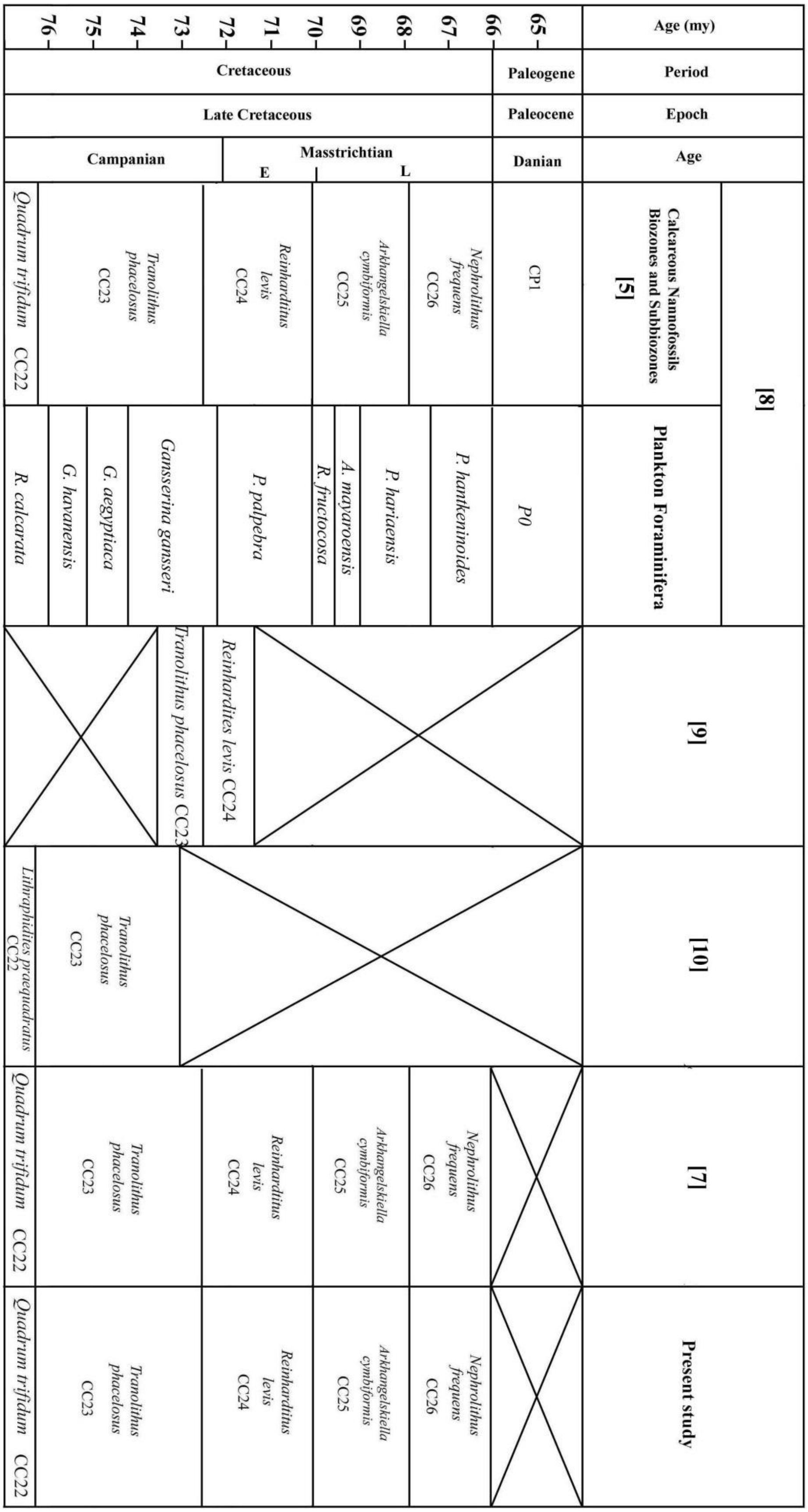


Figure 3-Iraqi correlation chart of Tanjero Formation in Azmer anticline, Northern Iraq.

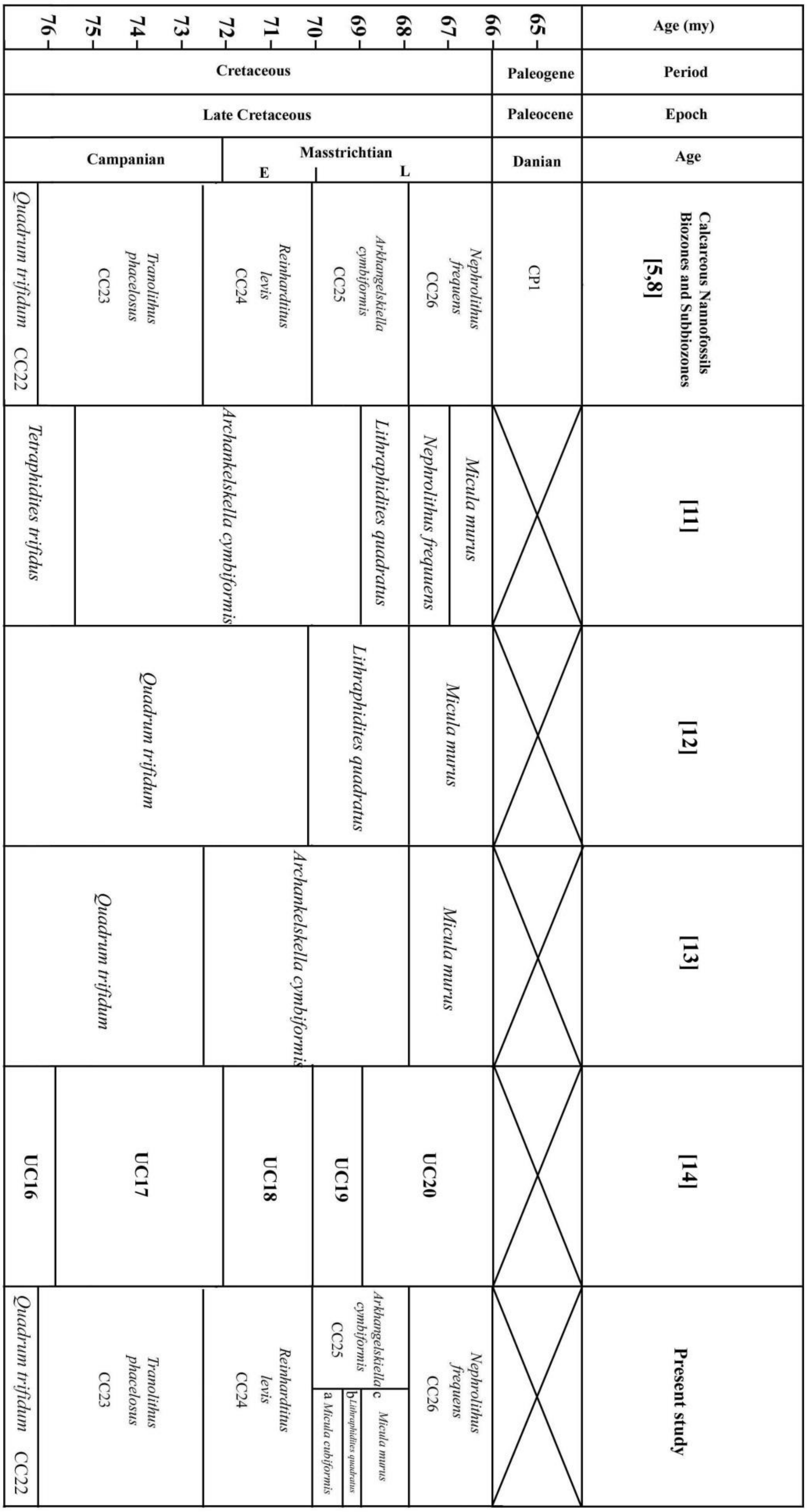


Figure 4- Regional correlation chart of Tanjero Formation in Azmer anticline, Northern Iraq.

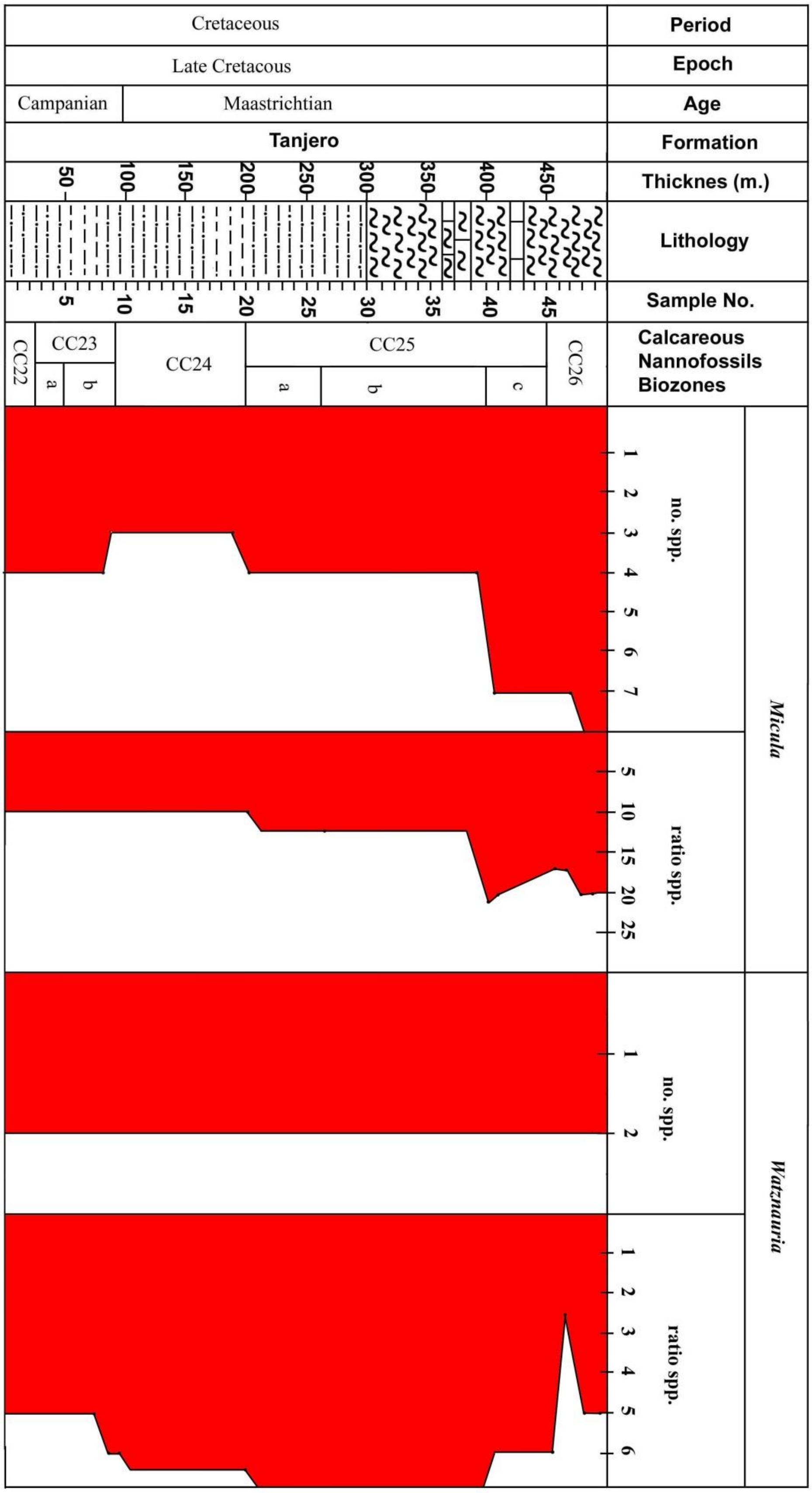


Figure 5- Distribution chart for *Micula and Watznauria* through the Tanjero Formation in Azmer anticline, .Northern Iraq.

3 - Response of calcareous nannofossils Paleoclimatology

The end of the Cretaceous age was associated with a global warming event as described in the geological record. Based on the calcareous nannofossils from forty nine samples from Tanjero Formation in Azmer anticline, Northern Iraq, seventy two species were identified and can be marked by higher speciation for the calcareous nannofossils. The occurrence of *Micula and Watznauria* is closely related to the global warming during the end of the Cretaceous (Fig.5) [18, 19, 20].

Conclusions

On the basis of the stratigraphic ranges of the recorded calcareous nannfossils, we determined four biozones that are arranged, from the oldest to the youngest, in an ascending pattern as follows:

4 - *Nephrolithus frequens* Rang Biozone (CC26) Part
3 - *Arkhangelskilla cymbiformis* Interval Biozone (CC25)
2 - *Rienhardtites lives* Interval Biozone (CC24)
1 - *Tranolithus phacelosus* Interval Biozone (CC23) Part

This study is correlated with a previous study performed by Al- Maamari and Al-Badrani (2019), that deals with Shiranish Formation which is distributed at the central, low, and high folded zones of Iraq, compared with Tanjero Formation which is distributed at the imbricated zone of Iraq.

These biozones are correlated with other calcareous nannofossil biozones from both local and regional sections, leading to conclude that they belong to the age of Late Campanian- Maastrichtian.

Acknowledgements

The authors are very grateful to the University of Mosul/College of Science for the provision of their which helped to improve the quality of this work.

References

1. Bellen, R.C., Dunnington, H.V., Wetzel, R. and Morton, D.M. 1959. *Lexique stratigraphique international*, V.III: Asie , Fascicule 10 a, Iraq. 333 p.

2. Al- Sheikhly S.S. and Kamil A.I. 2016.Ostracoda as a paleoecological indicators for the Maastrichtian – Upper Eocene succession in North and Western Iraq. *Iraqi Journal of Science*,57(2B): 1227-1237.

3. Ahmed, M.J., Tamar-Agha, M.U. and Alwan, T.A. 2017. The Sedimentology and Facies Analysis of the Cretaceous Oceanic Red Beds (CORBs) in the Shiranish Formation, Northern of Iraq. *Iraqi Journal of Science*,58(3A): 1220-1234.

4. Al-Mashaikie, S.Z. and Mohammed, Y.A. 2017. Facies Analysis of The Siliciclastic-calciturbidites, Gercus Formation In Dokan Area, Ne-Iraq; New Insight On Deposition Enviroment And Basin Evolution. *Iraqi Journal of Science*, 58(1C): 462-481.

5. Jaff, R. B.N., Williams, M., Wilkinson, I.P., Lawa, L., Lee, S. and Zalasiewicz, J. 2014. *A refined foraminiferal biostratigraphy for the Late Campanian – Early Maastrichtian succession of northeast Iraq*. GeoArabia, 2014, v. 19, no. 1, p. 161-180

6. Armstrong, H. and Brasier M. 2005.*Microfossils*. Black well publishing. 296p.

7. Murphy, A.M. and Salvador, A. 1999. *International Subcommission on Stratigraphic Classification of IUGS International Commission on Stratigraphy*,22, 4, 255-272.

8. Sissigh, W. 1977. *Biostratigraphy of Cretaceous calcareous nannoplankton*. Geol. Mjnb.,56, 37-65.

9. Burnett, J.A. 1998. *Upper Cretaceous. In: Bown, P.R. (Ed.), Calcareous Nannofossil Biostratigraphy*. British Micropalaeontological Society Publications Series. Chapman and Hall, London, 132-199.

10. Al-Maamari, A.M. and Al-Badrani 2019. *Calcareous Nannofossils Biostratigraphy of Shiranish Formation (K-306) well, Northern Iraq*. Iraqi National Journal of Earth Sciences 19,2,1-10.

11. Gradstein, F.M., Ogg, J.G., Schmitz, M.D. and Ogg, G.M. 2012. *The geologic time scale*. The Boulevard, Langford lane, Kidlington, Oxford OX5 1GB, UK,2,437-1144.

12. Al-Badrani, O. A., and Al-Assaf, E. N. 2011. *Nannobiostratigraphy of Shiranish Formation in Balad Well No. 8, Northern Baghdad, Iraq*. Iraqi National Journal of Earth Sciences, vol. 11, no. 2, pp. 65-80.

13. Al-Badrani, O. A. 2012. *Nannobiostratiraphy of the Lower part of Shiranish Formation, Sinjar Anticline, NW Iraq*. Iraqi National Journal of Earth Sciences, vol. 12, no. 1, pp. 1-16.
14. Perch-Nielsen, K. 1985. *Mesozoic calcareous nannofossils*. In: Bolli, H. M., Saunders, J. B. and Perch-Nielsen, K.,(eds.), *Plankton stratigraphy*. Cambridge University Press, Cambridge, pp. 329-426.
15. Verbeek, J. W. 1977. *Calcareous nannoplankton biostratigraphy of Middle and Upper Cretaceous deposites in Tunisia, Southern Spain and France*. Utrecht Micropaleontology Bull., vol. 16, pp. 1-157.
16. Stradner, H. and Steinmetz, J. 1984. *Cretaceous calcareous nannofossils from the Angola Basin, Deep Sea Drilling Project Site 530*. Initial Reports of the Deep Sea Drilling Project, vol. 75, pp. 565-649.
17. Bown, P. R. and Cooper, M. K. E. 1998. *Jurassic*. In: Bown, P.R. (Editor), *Calcareous nannofossil biostratigraphy*. British Micropalaeontological Society Publication Series. Chapman and Hall, pp. 34-85.
18. Brasier, M.D.1980. *Microfossils*, George Allen and Unwin. London Publish Company. 193p.
19. Brasier, M.D., and Armstrong, H.A.1980. *Microfossils*, Black well publishing. 296p.
20. Haq, B.U. and Boersma, A. 1998. *Introduction to Marine Micropaleontology*. Elsevier, Amsterdam.