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Biostratigraphic study on calcareous nannofossils in South Gorgan, North of Iran

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Abstract

A calcareous nannofossils biostratigraphic study has been carried out on the chalky limestones located in South Gorgan, north of Iran. The study is aimed at determining the age and nannofossil biozonations of the well. The samples were prepared using smear slide technique. Thirty seven calcareous nannofossils species were identified and used to make biostratigraphic zonations and dating of the strata. The distribution of the calcareous nannofossils enabled the establishment of five zones: *Quadrum trifidum* (CC22), *Tranolithus phacelosus* (CC23), *Reinhardtites levis* (CC24), *Arkhangelskiella cymbiformis* (CC25) and *Nephrolithus frequens* (CC26) belonging to late Late Campanian – late Late Maastrichtian following standard zonation schemes of previous workers. The zones were based on the first and last occurrences of marker species.

Keywords: *Biostratigraphy, biozonation, nannofossils, Campanian, Maastrichtian, South Gorgan*

1. Introduction

This study focuses on the nannofossils biostratigraphy of chalky limestones, located in South Gorgan, north of Iran. The aim of the study is to present biostratigraphic information from the nannofossils recovered from the strata penetrated. Calcareous nannofossils are tiny (less than 30 microns) marine phytoplanktons. Calcareous nannofossils are one of the major primary producers and one of the most important groups of microplankton contributing to the phytoplankton community in the oceans. Generally, the calcareous nannofossils dominate in the stratified waters of the tropical and subtropical regions (Brand 1994). However, there have been many reports on their abundant occurrences within the mixed layer (Kleijne 1993; Giraudeau et al. 1993). These calcareous nannofossils convert dissolved carbon dioxide in the ocean into calcium carbonate (CaCO3). The pathway from the production of this mineral at the sea surface to its deposition on the sea floor is an important process and is an essential variable in the global carbon cycle (Broerse et al. 2000; Ziveri 2000).

The Alborz ranges is a part of the Alps-Himalaya fold-thrust belt, and extends for about 2000 km in north of Iran. On the northern slope of eastern Alborz, a succession of Middle Jurassic to Upper Cretaceous rocks is distinguished, which was named "northern facies" (Ghasemi 1980). Lithologically, these deposits are very similar to time-equivalent sediments in the Kopet-Dagh fold belt in the northeast of Iran.

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A part of this succession is exposed at Sefidchah, where it overlies the Gorgan metamorphic complex unconformable and consists of chalky limestone and marl. In the present study, the lowermost sediments were studied at two locations: Sefidchah and Arzak village (Fig 1). Some foraminifera have been reported from this area, but there are no reports on the calcareous nannofossils. This work aim to identify: the calcareous nannofossils encountered, to establish the nannofossil zones in the analyzed strata and to determine their age.

2. Location and lithology

The materials used in this study were obtained from the Sefidchah and Arzak village sections in the South Gorgan, North Iran. The both of studied sections are composed of chalky limestones with a thickness of 16 m and 8 m in Sefidchah and Arzak village respectively (Fig 3) and underlaid by Gorgan schists disconformable (Fig 2).

3. Methods

Examined samples for calcareous nannofossils were subjected to smear-slide preparation. Smear slides for light microscope analyses were prepared according to standard techniques. For this, the surface of each sample was scraped with a razor blade until a fresh surface was obtained, and then a small amount of sediment was scraped into a glass cover slip and diluted with distilled water. The suspension was smeared with a flat-sided toothpick along the surface of the cover slip and then dried on a hot-plate. Between preparations, the razor used in the preparation was washed in distilled water.

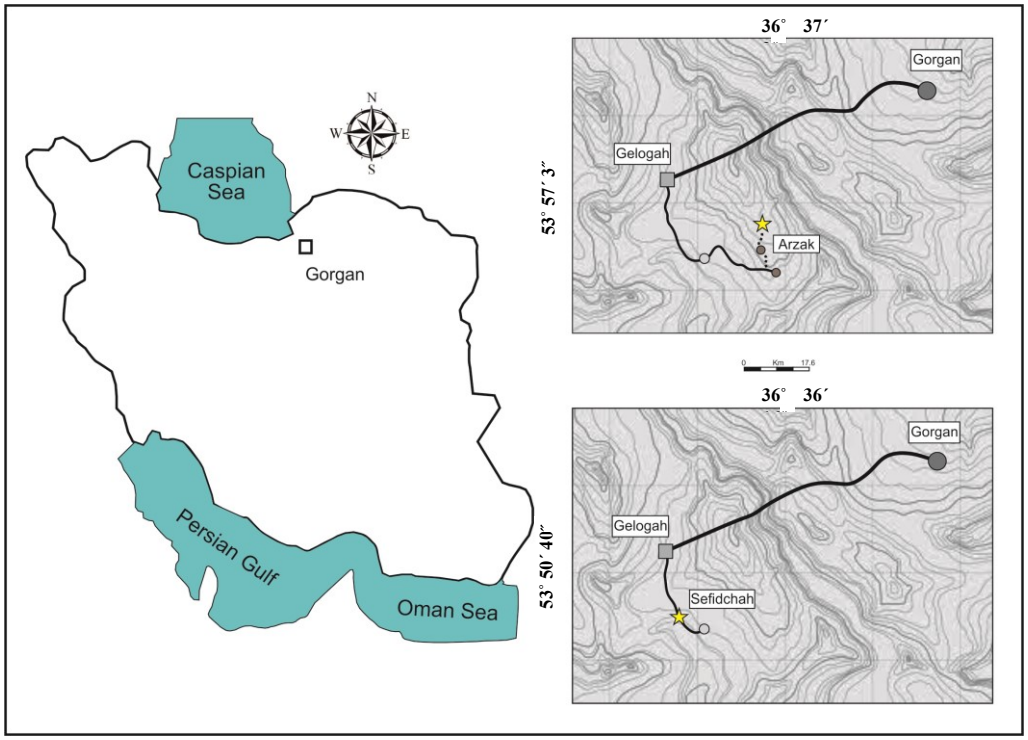

Fig 1. The location map of studied sections, South Gorgan.

The counter and the hot plate used in making the smearslide were wiped with 10% HCl between sample preparations. This was done to reduce the chance of contamination. In the current study, a number of 20 samples was studied by polarized microscope and photographed by the digital camera.

4. Results

Calcareous nannofossils recovery from this study is fairly abundant and moderately preserved (Pl 1). Twenty samples from these sections have been studied for their calcareous nannofossil content. A total of 37 nannofossils species belonging to 20 genera were recognized.

Fig 2. Boundary between the chalky limestones and Gorgan schists in study area

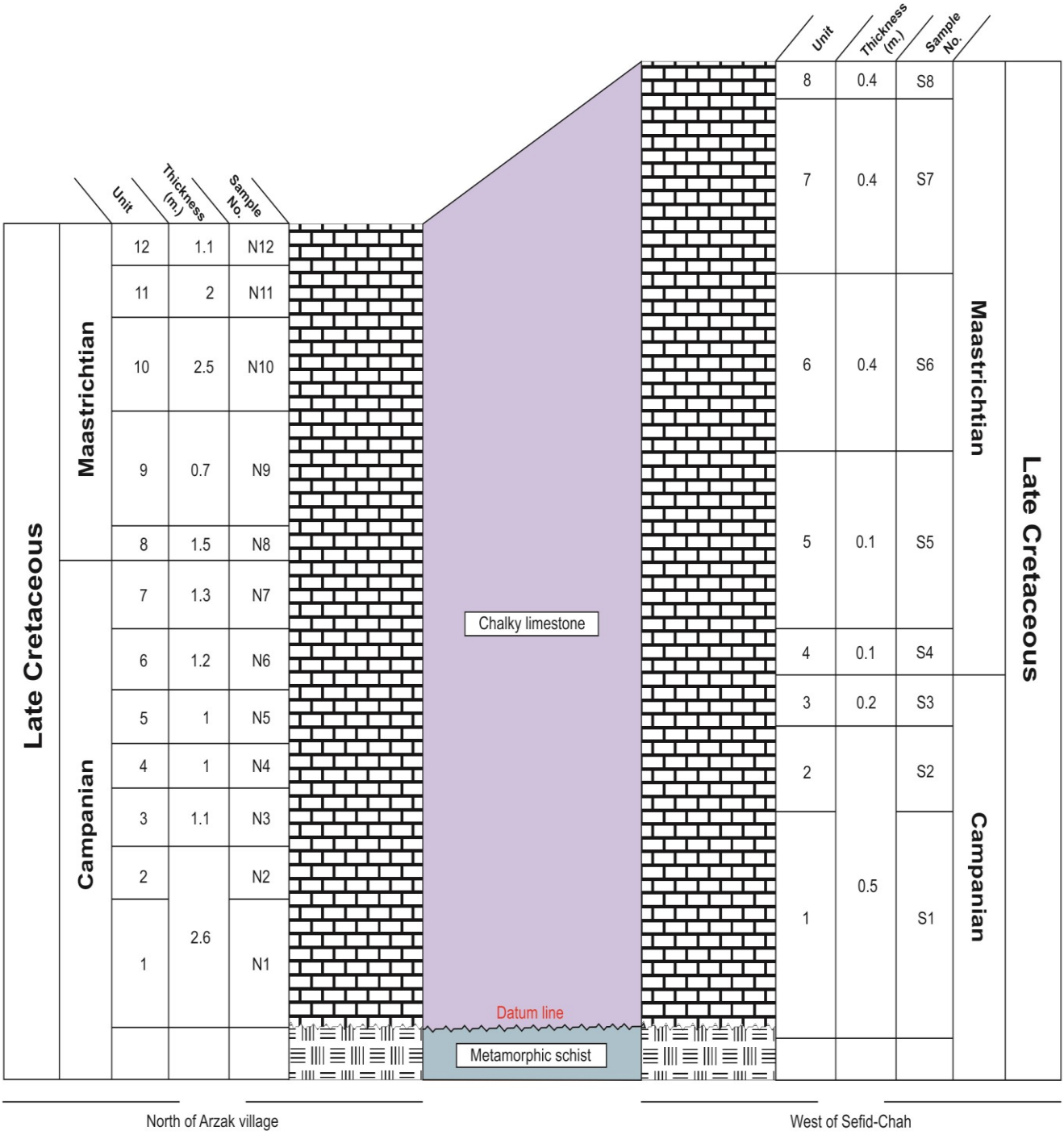

Fig 3. Stratigraphic column of the studied sections

Five major zones were distinguished for the sequences, based on the first and last occurrence of marker species. The zones include *Quadrum trifidum* (CC22), *Tranolithus phacelosus* (CC23), *Reinhardtites levis* (CC24), *Arkhangelskiella cymbiformis* (CC25) and *Nephrolithus frequens* (CC26). The zones have been assigned to late Late Campanian-late Late Maastrichtian following the standard zonations (Sissingh 1977; Perch -Nielsen 1979).

5. Biostratigraphy

Some foraminifera have been reported from both studied areas, but there are no reports on the calcareous nannofossils. Biostratigraphy of Sefidchah and Arzak village sections has been studied on the base of calcareous nannofossil. As a result, the age of both sections is determined as late Late Campanian–late Late Maastrichtian. In the present study, the nannofossils of the chalky limestones of two studied sections have been

identified. According to the first and last occurrence of marker species, five calcareous nannofossil biozones are proposed for the both stratigraphic sections which equivalent with CC22–CC26 of Sissingh (1977) and Perch-Nielsen (1979a, 1983) (Fig 4). The proposed biozones from base to top include: *Quadrum trifidum*, *Tranolithus phacelosus*, *Reinhardtites levis*, *Arkhangelskiella cymbiformis* and *Nephrolithus frequens* zones. The ranges of key marker species are shown in figures 5 and 6.

***Quadrum trifidum* Zone (CC22)**
Definition: Interval from the FO of *Quadrum trifidum* to the LO of *Reinhardtites anthophorus*.
Stage: late Late Campanian.
Remarks: Whereas all authors agree on *Q. trifidum* at the base of their *Q. trifidum* Zone, they use other markers for its top: the LO of *Q. trifidum* (Bukry and Bramlette 1970; Martini 1976; Roth 1978; Doeven 1983). The FO of *Lithraphidites praequadratus* (Roth 1978); the FO of *Lithraphidites quadratus* (Verbeek 1976). Whereas *Q. trifidum* is not found in high northern latitudes, *R. anthophorus* is a reliable marker species in the North Sea area and can be found also in rather poorly preserved assemblages. *Q. trifidum* is observed in the lower part of both studied sections which is correlatable with CC22.

According to this fact, the lower part of both sections is determined as late Late Campanian. *R. anthophorus* is present in the Sefidchah section but due to the absence of the mentioned species in the Arzak village, we used the LO of *Eiffellithus eximius* according to the Perch-Nielsen (1979 and 1983).

***Tranolithus phacelosus* Zone (CC23)**
Definition: Interval from the LO of *R. anthophorus* to the LO of *Tranolithus phacelosus*.
Stage: Latest Campanian to Early Maastrichtian.
Remarks: The *T. phacelosus* Zone corresponds to the upper part of the *Q. trifidum* Zone of many authors. According to Doeven (1983), *T. phacelosus* disappears slightly before *Q. trifidum*. *T. phacelosus* is useful in low as well as in high latitudes. *R. anthophorus* and *T. phacelosus* are observed in the Sefidchah section but *R. anthophorus* is absent in the Arzak village section.

***Reinhardtites levis* Zone (CC24)**
Definition: Interval from the LO of *T. phacelosus* to the LO of *Reinhardtites levis*.
Stage: Early Maastrichtian.
Remarks: Sissingh (1977) remarked, that " the LO of *R. levis* virtually coincides with a distinct and interregional increase in number of large *Arkhangelskiella* representatives".

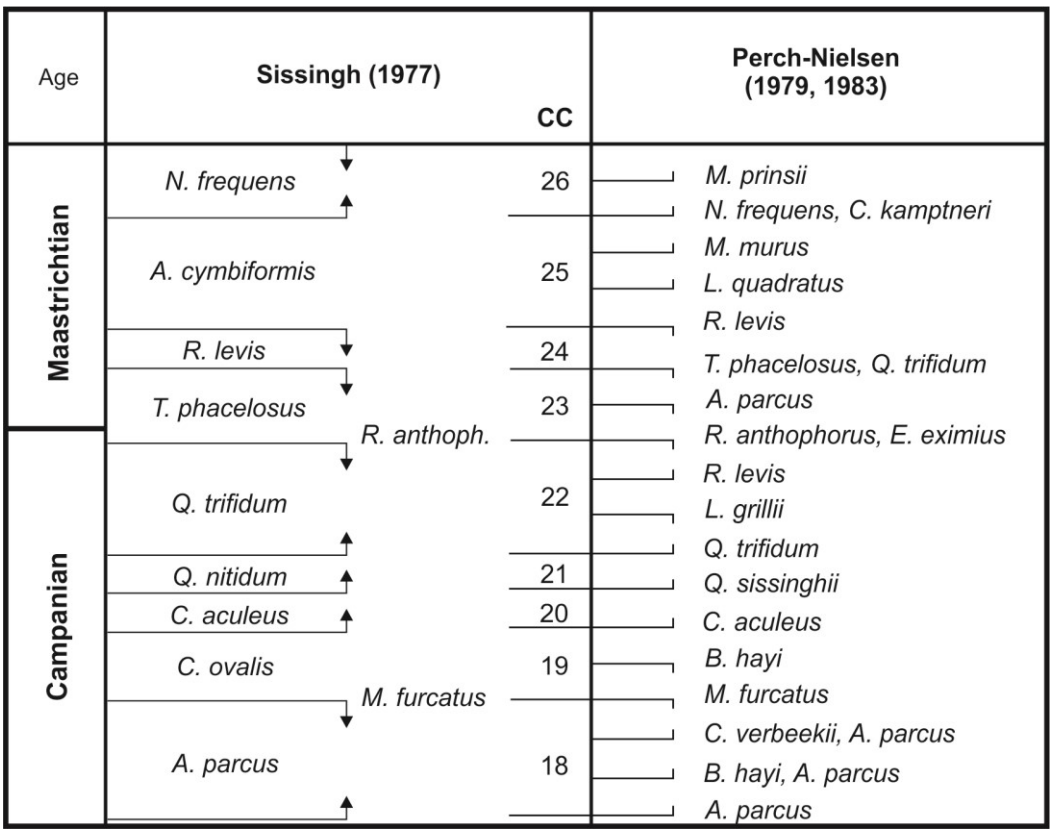

Fig 4. Campanian-Maastrichtian calcareous nannofossil biozones (Sindilar, 2011)

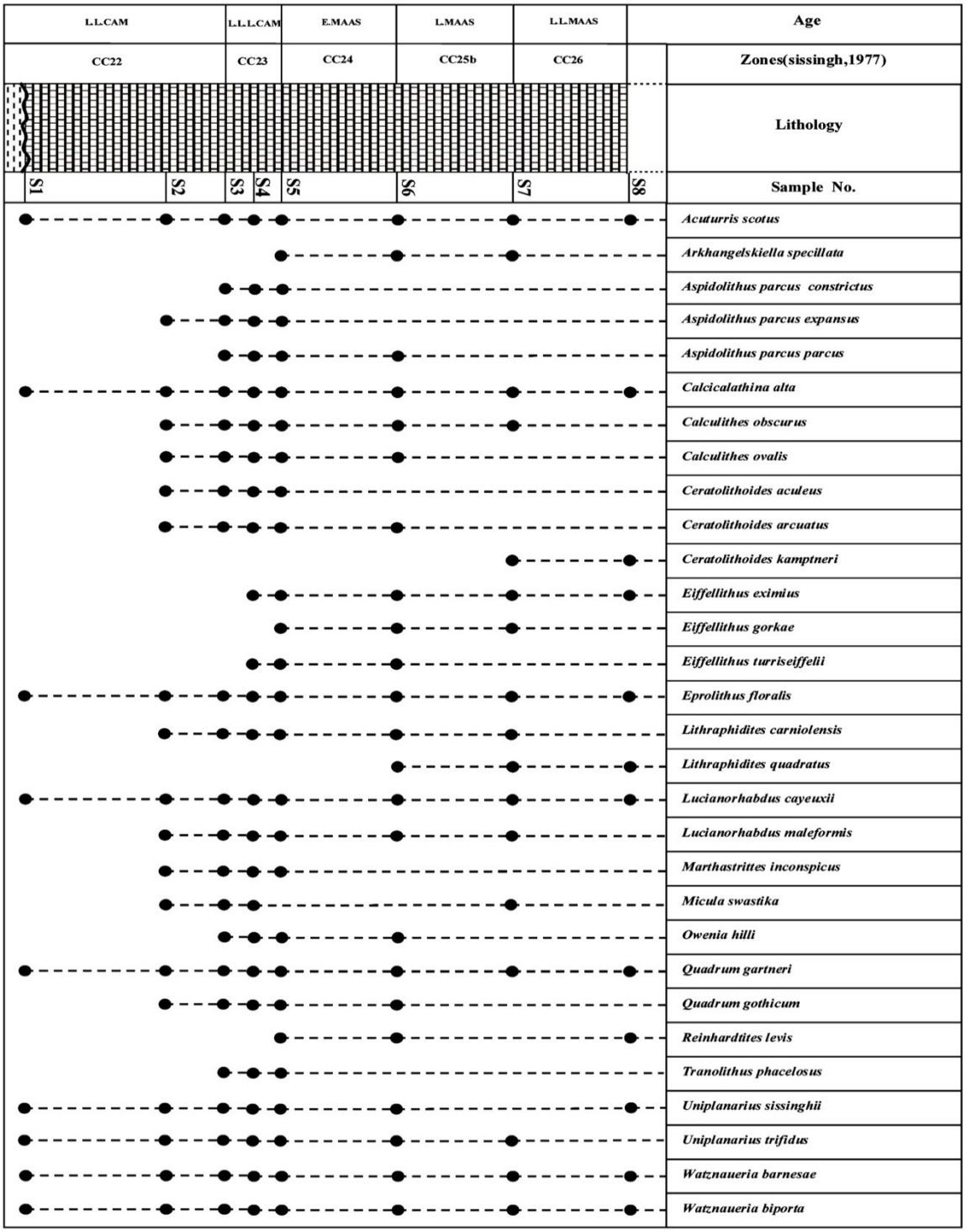

Fig 5. Stratigraphical distribution of observed species in the Arzak village section

This zone is recognizable in low and high latitudes. *T. phacelosus* and *R. levis* are observed in both sections.

***Arkhangelskiella cymbiformis* Zone (CC25)**

Definition: Interval from the LO of *R. levis* to the LO of *Nephrolithus frequens*.

Stage: Late Maastrichtian.

Remarks: There are several definitions attached to the name *A. cymbiformis* Zone. Perch-Nielsen (1972) defined it from the LO of *R. anthophorus* to the FO of *M. murus* or *N. ferequens*. This upper boundary provides a marker for low latitudes (*M. murus*) and one

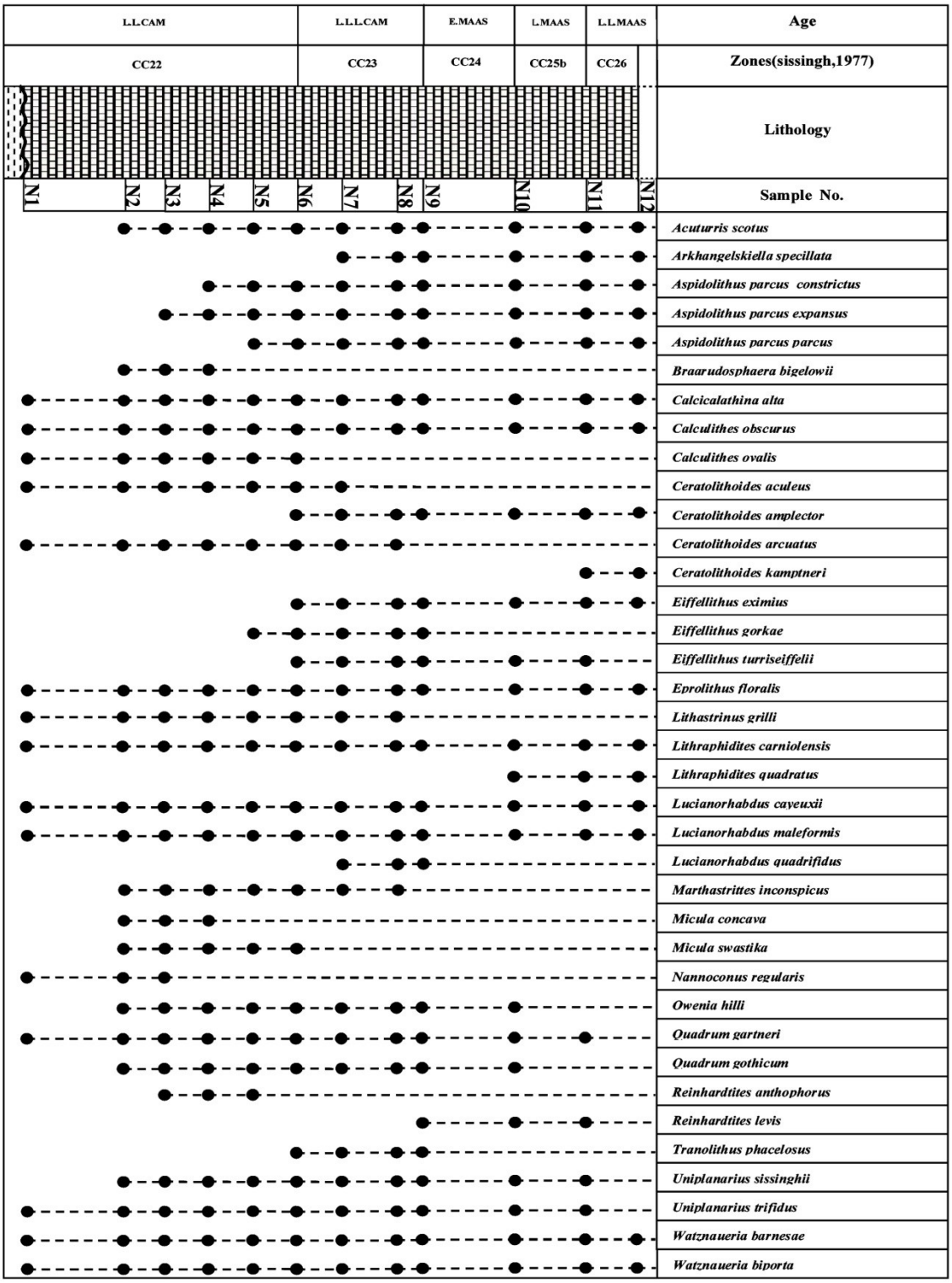

Fig 6. Stratigraphical distribution of observed species in the Sefidchah section

for high latitudes (*N. frequens*). Martini (1976) defined it from the LO of *Q. trifidum* to the FO of *Lithraphidites quadratus*, the way it is also used by Doeven (1983). Sissingh (1977) suggested a subdivision CC25 by the FO of *Arkhangelskiella cymbiformis* and the FO of *Lithraphidites quadratus*. Sissingh's concept of *A. cymbiformis* is more restricted than the species concept of most other authors, who plot the FO of *A. cymbiformis* at about the base of CC22 in the Late Campanian. The FO of *L. quadratus* is a good marker event in low latitudes, but usually cannot be recognized in high northern latitudes. It was used by several authors

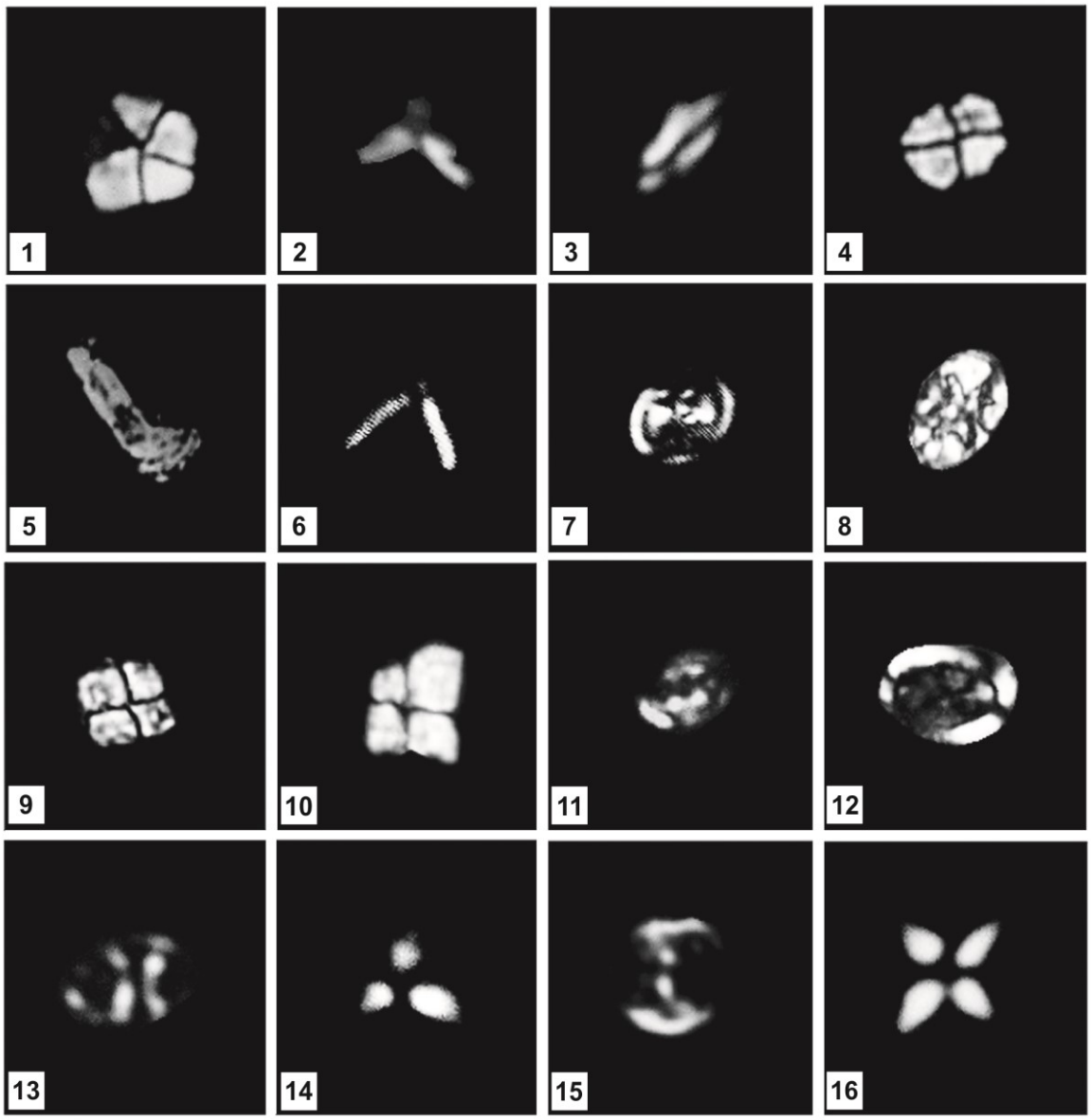

Plate 1. 1. *Braarudosphaera bigelowii* (Gran & Braarud 1935) Deflandre, 1947, 2. *Ceratolithoides kamptneri* Bramlette & Martini, 1964, 3. *Lithraphidites quadratus* Bramlette & Martini, 1964, 4. *Calculites ovalis* (Stradner, 1963), Prins & Sissingh in Sissingh, 1977, 5. *Lucianorhabdus quadrifidus* Forchheimer, 1972, 6. *Ceratolithoides kamptneri* Bramlette & Martini, 1964, 7. *Reinhardtites levis* Prins & Sissingh in Sissingh, 1977, 8. *Eiffellithus gorkae* Reinhardt, 1965, 9, 10. *Quadrum gothicum* Deflandre, 1959. (Hattner & Wise, 1980), 11. *Tranolithus phacelosus* Stover, 1966, 12. *Arkhangelskiella specillata* Vekshina, 1959, 13. *Tranolithus phacelosus* Stover, 1966, 14. *Quadrum trifidum* (Stradner) Prins & Perch-Nielsen 1977 15. *Reinhardtites anthophorus* (Deflandre, 1959), Perch-Nielsen, 1968, 16. *Quadrum sissinghii* Perch-Nielsen (1986). (All figures light micrographs magnified x1250).

as the base of a *L. quadratus* Zone. *L. quadratus* is present in both sections (According to Perch-Nielsen (1979, 1985) which can be correlated with CC25b. Because of the absence of *N. frequens*, we have used *Ceratolithoides kamptneri*. This species is observed in both sections. This biozone is defined based on the LO of *R. levis* to FO *C. kamptneri.*

***Nephrolithus frequens* Zone (CC26)**

Definition: Interval from the FO to Lo of *N. frequens*.

Remarks: This zone definition is well correspond in high latitudes, where *N. ferequens* is relatively common. In low latitudes, *N. ferequens* is very rare and here the FO of *M. murus* and the subsequent FO of *Micula prinsii* can be used to subdivide the interval between the FO of *L. quadratus* (base CC25c) and the top of the Maastrichtian. Because of the absence of *N. frequens*, we have used *C. kamptneri*. This species is observed in both sections. The biozone is defined based on the FO

to LO of *C. kamptneri* (According to Perch-Nielsen (1979, 1985)).

6. Conclusion

In the current study, Calcareous nannofossil assemblages are fairly abundant and moderately preserved. According to present study, 20 genera, and 37 species were identified. As a result of biostratigraphic studies, five biozones are suggested which are equivalent to CC22–CC26 of Sissingh (1977) and Perch-Nielsen (1979, 1983). Based on the first and last occurrence of the calcareous nannofossils, the age of chalky limestones of Sefidchah and Arzak village sections is late Late Campanian to late Late Maastrichtian.

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