

# A new species of the genus *Chiphragmalithus* from the Ypresian stage (early Eocene) in the northern part of the Caspian Depression (Russia)

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**Abstract** The formal description is provided for a new taxon, *Chiphragmalithus muzylevii* sp. nov., from the early Eocene beds penetrated by the Novouzensk №1 key borehole in the northern part of the Caspian Depression. This species is confined to a narrow stratigraphic range and, therefore, possesses good potential for high resolution biostratigraphy and for accurate dating of the Ypresian sedimentary masses in the Northern hemisphere.

**Keywords** nannofossils, new taxon, Lower Eocene, Ypresian stage, Caspian Depression, Russia, *Chiphragmalithus*

## 1. Introduction

Deposits of Ypresian age occur over wide areas of Crimea, North Caucasia, in the south of the Russian Platform, in the Caspian Depression and the Turan Plate (Figure 1). Their age is most accurately determined from foraminifer assemblages, calcareous nannofossils and dinoflagellates. The most complete data on calcareous nannoplankton complexes is presented in papers by Muzylev (1980, 1994), Musatov (1996), Vasil'eva & Musatov (2008, 2010, 2012), Shcherbinina *et al.* (2014), Bugrova *et al.* (2002) and King *et al.* (2013). The associations are generally characterized by good preservation and a large number of species. Over the major part of the territory, the deposits are represented by marine facies – clays of variable carbonate content, marls and limestones. According to Zachos *et al.* (2001), this interval corresponds to the Early Eocene Climatic Optimum (EECO), which provides good paleontologic grounding for age determination and position in the general stratigraphic scale.

Though the genus *Chiphragmalithus* Bramlette & Sullivan (1961) has been known for nearly 60 years, only six species have been described up to the present time: *Chiphragmalithus acanthodes* Bramlette & Sullivan 1961, *Chiphragmalithus calathus* Bramlette & Sullivan 1961, *Chiphragmalithus barbatus* Perch-Nielsen 1984, *Chiphragmalithus altinlii* Varol 1989, *Chiphragmalithus armatus* Perch-Nielsen 1971, *Chiphragmalithus vandenberghaei* Steurbaut 2011, and four of these - *Ch. acanthodes*, *Ch. calathus*, *Ch. barbatus* and *Ch. altinlii* – are probably synonymous.

Discovery of a new species, *Chiphragmalithus muzylevii* sp. nov., within a short stratigraphic interval will allow more accurate correlations of remote Ypresian sections.

## 2. Materials

The studied materials consist of samples selected from the Ypresian and lowest Lutetian beds penetrated by the Novouzensk №1 key borehole (50.4583°N, 48.0200°E)

in the northern part of the Caspian Depression within the 568–405m interval (Figures 1, 2). The lower part of the section (568–475m interval) is represented by a member of interbedded clays (greenish-gray, non-calcareous) and sandstones (glauconite-quartzose, clayey, noncalcareous). No calcareous nannofossils have been detected in this lower interval. The age has been determined from Vasilyeva's dinoflagellate assemblages (2008, 2010). Zones from D5a to the lowermost of the D7c on the Luterbacher scale have been identified there.

The upper part of the section in the 475–414m interval is represented by a member of interbedding clays (greenish light gray, calcareous) with interlayers of sandstones and siltstones (glauconite quartzose, calcareous, clayey). Interlayers of brown clays occur in the 436–428m interval, with substantial contents of brown organic matter in the form of small amorphous “drops”. A certain amount of pollen has been encountered, as well as small roundish grains (unicellular algae?), dinoflagellate fragments, and amorphous clots. Muzylev (1994) believes that accumulation of sediments with high organic matter content may be associated with anoxic environments in the near-bottom zone and may correspond to the “Ypresian sapropelite” level described by Muzylev (1980, 1994) from the sections in the North Caucasia, and by Steurbaut (2011) and King *et al.* (2013) from the sections in the Aktulagay Plateau (West Kazakhstan).

In the 420–411m interval, the carbonate content in the section increases and the section is represented by highly carbonate clays and marls (See Figure 2). Zones NP12 and NP13 of the standard Martini zonation (1971) or CP10 and CP11 of the Okada & Bukry zonation (1980) have been recognized with a reasonable level of confidence in that part of the section. According to dinoflagellates, the interval corresponds to the uppermost of the D7 zone and to the D8 zone.

A member of noncarbonated sandy clay and clayey siltstones occurs higher in the 411–405m interval; no

nannofossils have been found. The lowermost part of the D9 zone has been determined from dinoflagellates. The total thickness of the Ypresian beds is about 160m.

In the 405–400m interval, greenish light gray marls occur, highly sandy in the lower part of the interval, with large amounts of glauconite and rare phosphorite gravel grains. This part of the section corresponds to the uppermost of the NP14 zone or to the CP12b subzone. Those are overlain with low siltstone greenish marls grading into white marls (soft coccolith chalk) higher in the section. This part of the section corresponds to the base of the NP15 zone and to the base of the CP13a subzone.

Practically all the described species of the *Chiphragmalithus* genus have been encountered in the upper part of the Ypresian clay unit (420–411m interval). In addition, a further, very distinctive morphotype has been found and is described herein as *Chiphragmalithus muzylevii* sp. nov. The species was first encountered at the depth of 416m and was traced up to 411m.

### 3. Methods

The core samples analyzed for nannofossils were selected by the author at a sampling frequency of 1.0–0.2m. In the upper, fossiliferous part of the section, samples were selected at 0.2–0.05m intervals. For nannofossil examinations, temporary whole mounts were prepared by the method described by Bown & Young (1998), with certain modifications: small amounts of rock powder were scraped with a needle off a clean sample surface to the object plate; two or three drops of ethyl alcohol were added, the alcohol suspension was accurately distributed over the object plate surface with a wooden needle. The sizes of

the ready “smears” were 40–50x25mm if the sediment was of low nannofossil abundance, and 20–30x25mm in cases of marls and soft coccolith chalk. After the fairly quick volatilization of alcohol, some immersion liquid, Immersol 518N, was added and the slide was placed on the specimen stage of the light microscope, a Zeiss Axio Lab.A1. No coverslips were used. Examination was made with a x100 Plan-NEOFLUAR objective lens, and x10–15 ocular lenses. Nannofossils were examined and photographed in transmitted normal and polarized light with a Canon-1000D digital camera. The images were processed with AxioVision Rel.4.8 software product. The Electronic Calcareous Nannofossils: BugCam-NannoWare [Version 2002.12.1] (2002) electronic database was used for species determinations, as well as the accessible electronic database of nannoplankton images, inclusive of index species and holotypes, of the Nannotax3 website (2014). The biostratigraphic division of the section was based on the standard Paleogene NP calcareous nannofossil zonation of Martini (1971) and on the CP zonal scale of Okada & Bukry (1980)

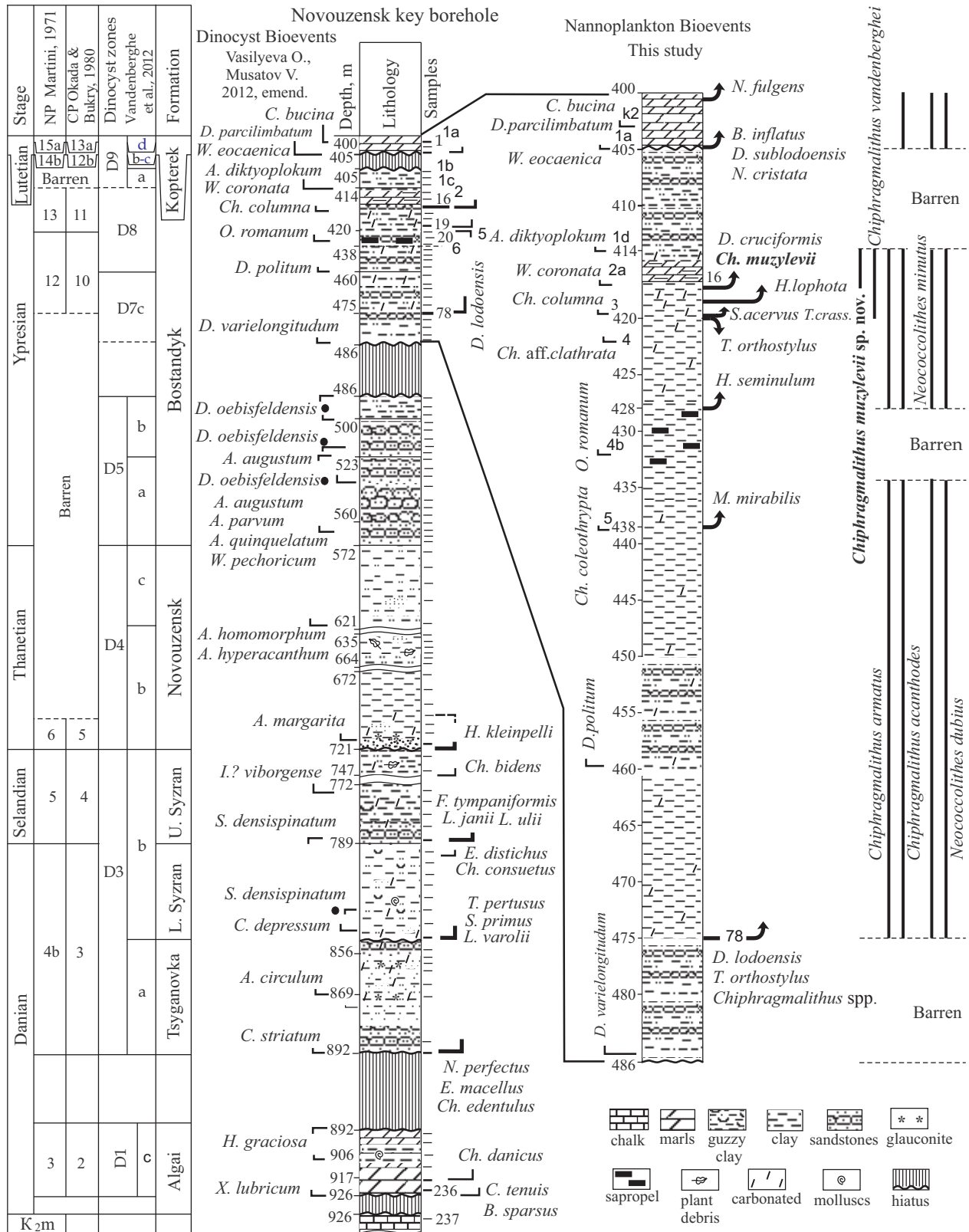
Taxonomy was adopted from Perch-Nielsen (1985) and Nannotax3. Only taxonomic references not included in these resources are provided herein. The author of the present paper keeps the examined samples and original photos.

### 4. Systematic palaeontology

To provide a better understanding for recognizing the new taxon, *Chiphragmalithus muzylevii* sp. nov., we briefly discuss the most characteristic features of species within the genera *Chiphragmalithus* Bramlette & Sullivan, 1961,



Figure 1: A) Regional and B) local site maps of Novouzensk №1 borehole



**Figure 2:** Litho- and biostratigraphy of the Paleogene in Novouzensk №1 borehole with overview of the stratigraphic ranges of described taxa

and *Neococcolithes* Sujkowski, 1931, the likely ancestor. The descriptions are based on the author's initial diagnoses of the species, with certain additions that might prove to be useful for examinations with standard light microscope.

Descriptions of the species *Ch. calathus*, *Ch. barbatus* and *Ch. altinlii* are presented in the author's version, with comments on the probable similarity among taxa. Core samples and photos are retained in the private collection by the author of the present paper.

#### Family **Zygodiscaceae** HAY & MOHLER, 1967

##### Genus *Neococcolithes* Sujkowski, 1931

Plano-elliptical muroliths, with H-shaped central structure and low framing wall. The wall is thin, low and composed of one layer of elements. Provides a fairly bright figure in cross-polarized light (XPL).

##### *Neococcolithes dubius* (Deflandre in Deflandre & Fert, 1954) Black, 1967

Pl. 1, figs 1–6

Of roundish-elliptical shape, medium to large size, with H-shaped central structure protruding slightly above the distal surface. The wall is thin and low. In favorable conditions it is prone to overgrowth and complete occlusion of the central area due to abnormal thickening of the cross-bars of the central structure. Provides a fairly bright figure in XPL. Length = 6.5–12.0  $\mu\text{m}$ , occasionally up to 14.0  $\mu\text{m}$ .

##### *Neococcolithes minutus* (Perch-Nielsen, 1967)

Perch-Nielsen, 1971

Pl. 1, figs 7–10

Narrow-elliptical with pointed ends, small or medium-sized. The H-shaped central structure does not generally rise above the wall, and is frequently skewed relative to the long axis. The wall is thin and low. Often produces slightly or moderately luminous figure in XPL. Length = 4.5–8.0  $\mu\text{m}$ .

##### Genus *Chiphragmalithus* Bramlette & Sullivan, 1961

The genus has been introduced to distinguish heterococcoliths of open, basket-like, truncated-conical shape, consisting of a relatively high wall built of two adjacent element cycles, with a cross-shaped or H-shaped central structure, formed of vertical septa which extend from the base of the coccolith to the distal surface. In plan-view, the genus presents a nearly regular circle or elliptical shape. The outer wall often expands flexuously in its upper part, producing regular or irregular spines.

**Type species:** *Chiphragmalithus calathus* Bramlette & Sullivan, 1961

##### *Chiphragmalithus calathus* Bramlette & Sullivan, 1961

Specimens range from circular or slightly quadrate to slightly elliptical in plan-view. The rim is thin, with height one-half to equal to the greatest diameter, flaring

somewhat distally, with the periphery commonly showing slight barbs that hook sinistrally in distal view. The central opening is transversely spanned by a X-shaped structure formed by septa, which are slightly higher than the rim and are conspicuous through the rim in side view. Length = 6.0–9.0  $\mu\text{m}$ .

**Remarks:** From the descriptions, the differences between *Ch. calathus* and *Ch. acanthodes* are quite small. The holotype photos presented in the paper by Bramlette & Sullivan (1961) show the species to be similar in both their aspects and structures.

##### *Chiphragmalithus barbatus* Perch-Nielsen, 1967

A species of *Chiphragmalithus* with a strongly developed "beard". Under the light microscope, the "beard" is clearly visible. It surrounds the polygonal coccoliths and is not seen in polarized light. The cross, which intersects the central opening, has the same attachment points as the "beard" does. It is seen under the electron microscope, that the "beard" consists of a broad ring, which surrounds the central opening, with the diameter equal to the width of the ring. The ring consists of an indeterminate number of inclined elements. Holotype dimensions = 8.0  $\mu\text{m}$ .

**Remarks:** The *Ch. barbatus* species is similar to *Ch. calathus* and *Ch. acanthodes*, both in aspect and in size. The earlier described "beard" along the coccolith edge may result from substantial overgrowth of the coccolith wall in favorable conditions (which is typical of the genus in question). The wide ring, or a "beard", clearly visible in the photo of the carbon replica under the transmission electron microscope is a plane projection of the coccolith conical wall. In this case, one may comprehend the author's description of the "beard" consisting of "an indeterminate number of inclined elements".

##### *Chiphragmalithus altinlii* Varol (1989)

A quadrate to sub-quadrate form in plan view, it has two septa in the central opening. In the proximal end, it has a distinct rim but this does not exceed the outer limit of the wall. The wall is ornamented by longitudinal ribs throughout its length whereas only its distal portion displays transverse ornamentation across the longitudinal ribs. The wall flares outward distally. The height of the form varies but is always greater than its diameter. Holotype dimensions: Height = 6.0  $\mu\text{m}$ ; Diameter = 6.0  $\mu\text{m}$ .

**Remarks.** The *Ch. altinlii* species is described as being square or subsquare. Judging from the holotype photos, it may also be described as rounded-square, sub-oval and polygonal (like *Ch. calathus*, *Ch. acanthodes* and *Ch. barbatus*). The wall is high, cone-shaped, ribbed – characteristic of all the species of the *Ch.* genus. The shape and the size are either slightly different or do not differ from those of *Ch. calathus* and *Ch. acanthodes*.

It is obvious this speculation on the probable synonymy of the species described as *Ch. acanthodes*,



*Ch. calathus*, *Ch. barbatus* and *Ch. altinli* requires further research to be substantiated.

*Chiphragmolithus acanthodes* Bramlette & Sullivan, 1961

Synonym (?): *Chiphragmolithus calathus* Bramlette & Sullivan, 1961

*Chiphragmolithus altinlii* Varol, 1989

*Chiphragmolithus barbatus* Perch-Nielsen, 1967

Pl. 1, figs 11–19

**Description:** Round or weakly elliptical and of medium size. The wall is thin or of medium thickness and of medium height; its height is roughly equal to one-half the maximum diameter. The rim slightly widens distally. The central area is occupied by an X-shaped structure that is slightly higher than the wall and increases in height from the wall towards the center. Typically, the four septa meet at the center, sometimes one pair are slightly displaced relative to each other. In favorable conditions this species has a tendency toward heavy overgrowth, and total occlusion of the central area can even occur due to intense overgrowth of the septa and the wall elements. Likely due to its high overgrowth potential, the species has been described as several different taxa. Length = 6.0–9.0  $\mu\text{m}$ .

**Remarks:** Nannofossil results from the Ypresian and the Lutetian beds penetrated by the Novouzensk key hole and from the section along the Kheu river (Northern Caucasias), show the second burst in the *Ch. acanthodes* species development is associated with the CP12b subzone. Substantially overgrown specimens generally occur there. Solitary specimens are also encountered in the basal part of the CP13a subzone.

*Chiphragmolithus armatus* Perch-Nielsen, 1971

Pl. 2, figs 1–9

Narrow-elliptical, with rounded ends and H-shaped central structure, slightly skewed relative to the long axis. The septa of the central structure are visibly higher than the wall and grow in height towards the central part. The ends of the septa are generally bifurcate and extend slightly beyond the wall limits producing small spines. The wall is of medium height, slightly widens from the coccolith base and has a serrate distal edge. Small spines are observed over the wall edge when examined under the light microscope. Produces a moderately luminous figure in XPL. Length = 8.0–12.0  $\mu\text{m}$ .

*Chiphragmolithus vandenberghiei* Steurbaut 2011

Pl. 2, figs 10–21

Wide-elliptical, large and massive. The H-shaped central structure is slightly skewed relative to the long axis, making a septum from the coccolith base that protrudes substantially above the wall. The ends of the septa bifurcate and go beyond the wall edge producing massive spines. The wall is thick, high, substantially widening from the

base, highly flexuous along the edge, and with smaller spines. Produces fairly bright figure in XPL.

**Note:** According to Steurbaut's definition (2011, p. 268), "The flaring wall, presenting a series of irregularly positioned ribs and spines, amalgamates with the protruding, also flaring and irregularly edged H-shaped central bridge". The results of the present study, however, show all the spines and ribs in the species described to be arranged quite regularly, with the largest ribs being the ends of the septa of the central H-shaped structure.

*Chiphragmolithus muzylevii* sp. nov.

Pl. 3, figs 1–22

**Derivation of name:** The species name has been derived from the surname of Muzylev Nikita Georgiyevich (Geology Institute at the Russian Academy of Sciences, Moscow) – a scientist involved in studying Paleogene calcareous nannofossils from the Caucasias, Crimea, Russian Platform and Central Asia. The species is dedicated to him.

**Diagnosis:** Large heterococcoliths, with elongated, sinuous, biconvex shape in plan-view, with spinose walls and an H-shaped septum in the center.

**Description:** The external wall is rather thick, composed of large, clearly visible elements of medium height, slightly widening from the base towards the distal part. Along one side of the coccolith 6–9 relatively large pointed spines occur. There are generally some minor tubercles on the opposite side of the coccolith. The coccolith has pointed ends, one of which bears a large beak-shaped spine; on the opposite end the spine is generally ill-defined or missing. The central part is partitioned by a large, thick, H-shaped septum, somewhat skewed relative to the coccolith axes. The septum ends reach the wall, bifurcate and extend beyond the contour as relatively large spines on one side of the coccolith. The septum projects rather high above the wall. Under XPL, the entire coccolith structure produces a moderately bright birefringence, the H-shaped central structure showing brighter luminescence than the wall.

**Differentiation:** The new species differs from *Ch. armatus* in having a higher wall, larger size, clearly defined elongated S-shape with pointed ends, and larger spines arranged only on one side of the coccolith. It differs from *Ch. vandenberghiei* in the elongated S-shape, presence of smaller spines on only one wall, absence of large ribs, the H-shaped structure, and the framing walls are lower. It differs from *Ch. acanthodes* in the larger size, oval S-shaped coccolith and H-shaped septum.

**Dimensions:** L = 10.0–14.0  $\mu\text{m}$ ; W = 6.0–9.0  $\mu\text{m}$ .

**Holotype:** Pl. 3, figs 1–8. Holotype photos are retained by the author of the present paper. The Novouzensk № 1 key hole, interval 411–420m, sample 15.

**Holotype size:** L = 14.0  $\mu\text{m}$ ; W = 9.0  $\mu\text{m}$

**Paratype:** Pl. 3, figs 9–15. The Novouzensk № 1 key hole, interval 411–420m, sample 15.

**Type Level:** the uppermost of the Ypresian stage, Bostandyk series (upper part), above the sapropel layer level.

**Type locality:** The northern part of the Caspian Depression, the south of the Saratov Region (50.4583°N, 48.0200°E), the Novouzensk № 1 key hole.

**Occurrence:** the first occurrence is recorded in the upper part of the NP13 and CP11 zones and has not yet been detected in younger deposits.

## 5. Biostratigraphic significance

The species described above has not been encountered, yet, anywhere but in the uppermost of the Ypresian from the Novouzensk № 1 key hole in the Caspian Depression. The species occurrence is recorded after *Tribrachiatus orthostylus* has disappeared from the assemblage almost completely, which allows reliable assignment of this part of the section to the NP13 zone (CP11). Similarly, Steurbaut (2011) noted that *Ch. vandenberghiei* occurs in the upper part of the NP13 zone and in the base of the NP14 zone. The new species, *Ch. muzylevii*, is encountered together with *Ch. vandenberghiei*, but there is still no *Discoaster sublodoensis* in the assemblage. The first occurrence of *H. seminulum* is recorded somewhat below the first occurrence of *Ch. muzylevii* sp. nov. In addition, *Ch. muzylevii* appears above the rocks with high organic contents that may be compared to the Ypresian sapropels described by Muzylev (1980, 1994), King *et al.* (2013) and Steurbaut (2011). The species has not been detected in the overlying marls assigned to the NP14b and NP15 subzones. No nannofossil assemblage of the NP14a subzone has been detected. That part of the section is probably missing due to erosion during the Pre-Lutetian regressive cycle. Thus, the age range of the species is tentatively determined as the uppermost portion of the NP13 and CP11 zones.

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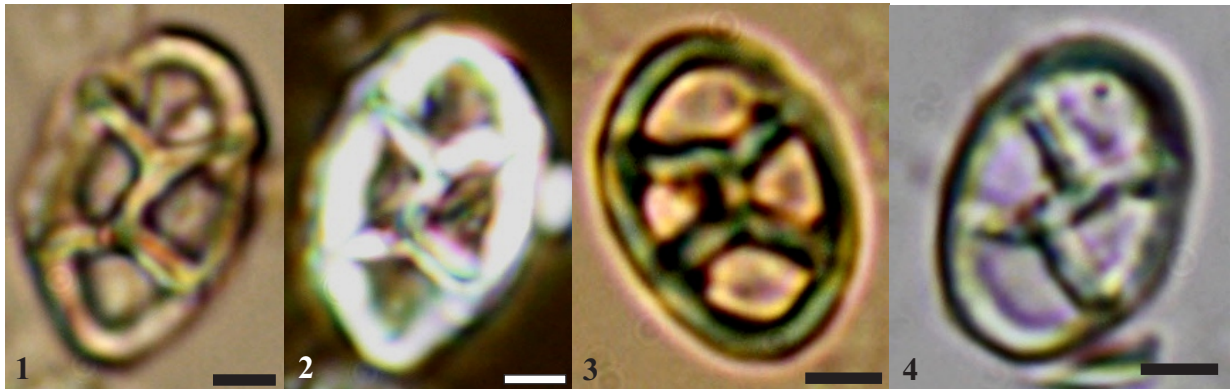
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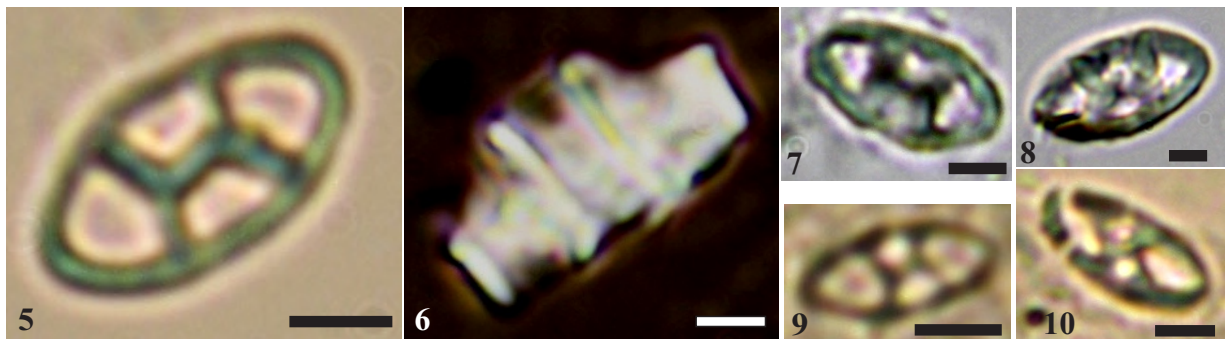
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**Plate 1**  
**Scale-bars = 2 $\mu$ m**

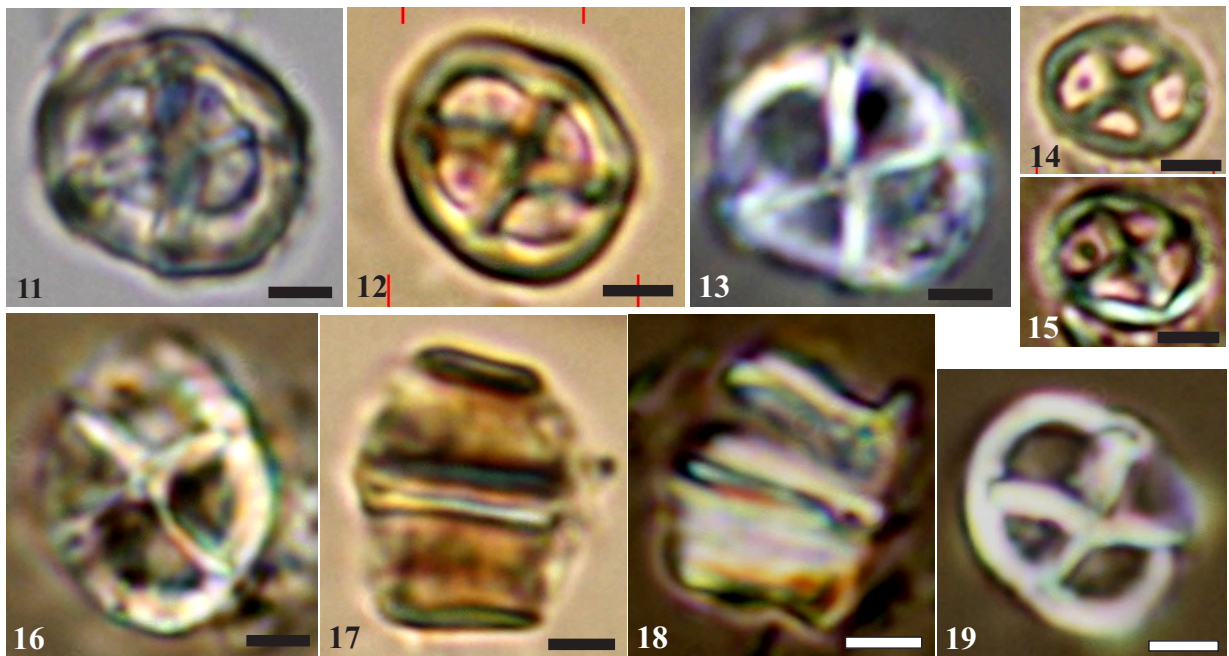


*Neococcolithes dubius*



*Neococcolithes dubius*

*Neococcolithes minutus*

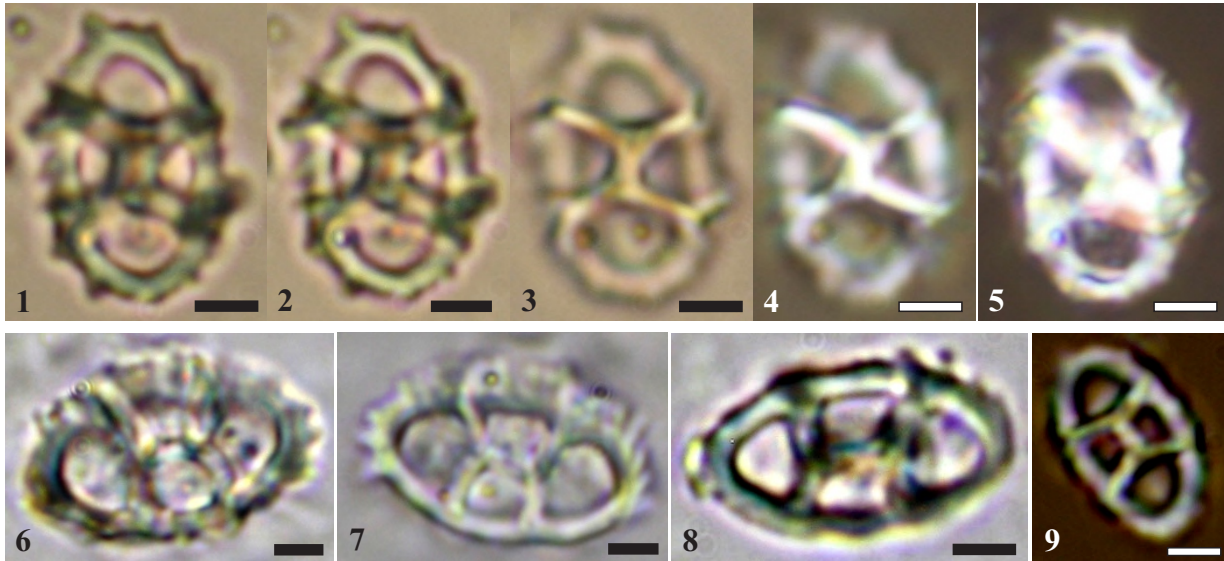


*Chiphragmalithus acanthodes*

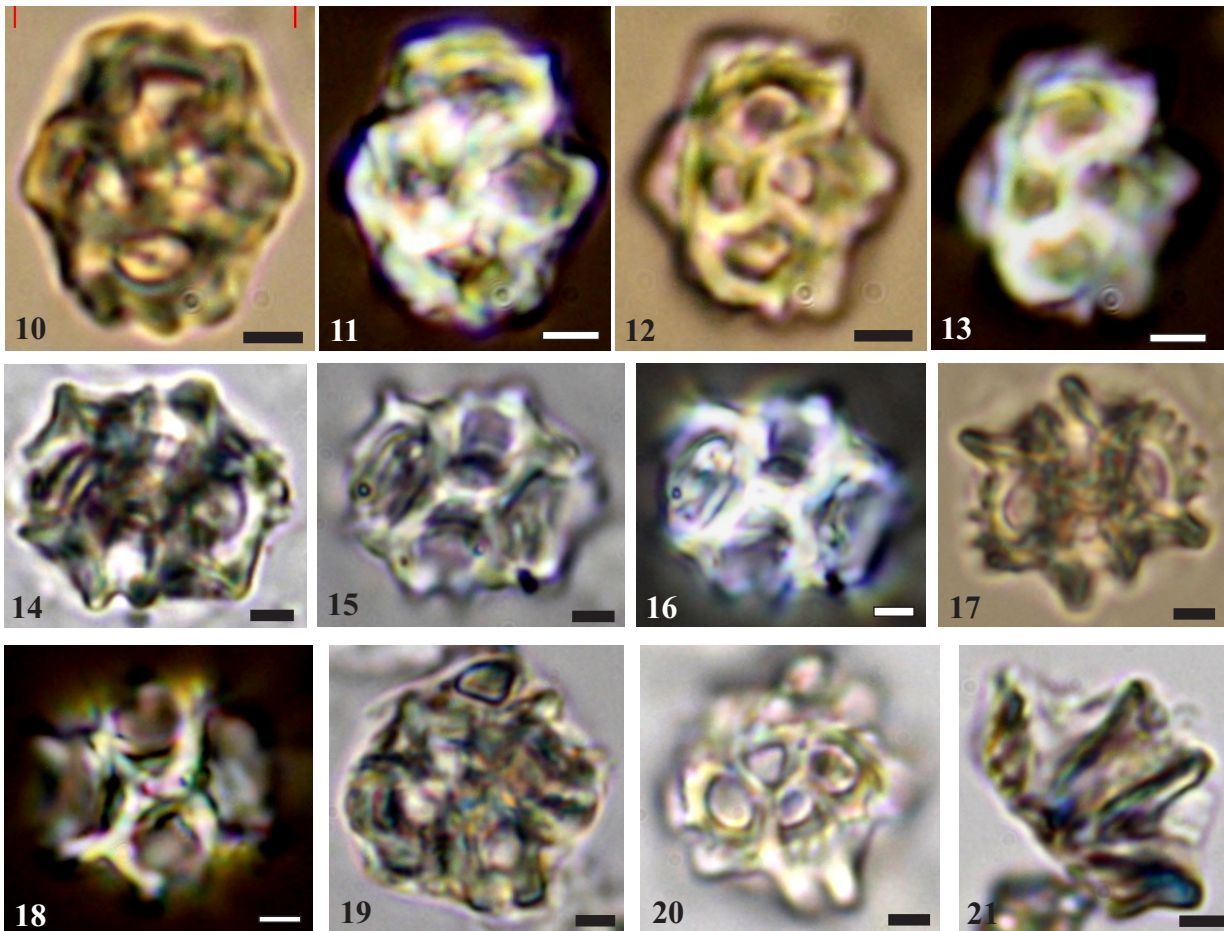
**Plate 1:** 1–2: sample 77, 460–475m; 3, 5, 6: sample 15, 414–420m; 4: sample 2, 400–405m; 7, 8: sample 2, 400–405m; 9, 10, sample 77, 460–475m; 11–17, 19: sample 77, 460–475m; 18: sample 40, 432–438m; Phase contrast (PC) = 1–3, 5, 7–12, 14, 17; Cross-polarized light (XPL): 2, 6, 13, 15–16, 18–19; Side view = 17–18



**Plate 2**  
**Scale-bars = 2µm**



*Chiphragmalithus armatus*



*Chiphragmalithus vandenberghiei*

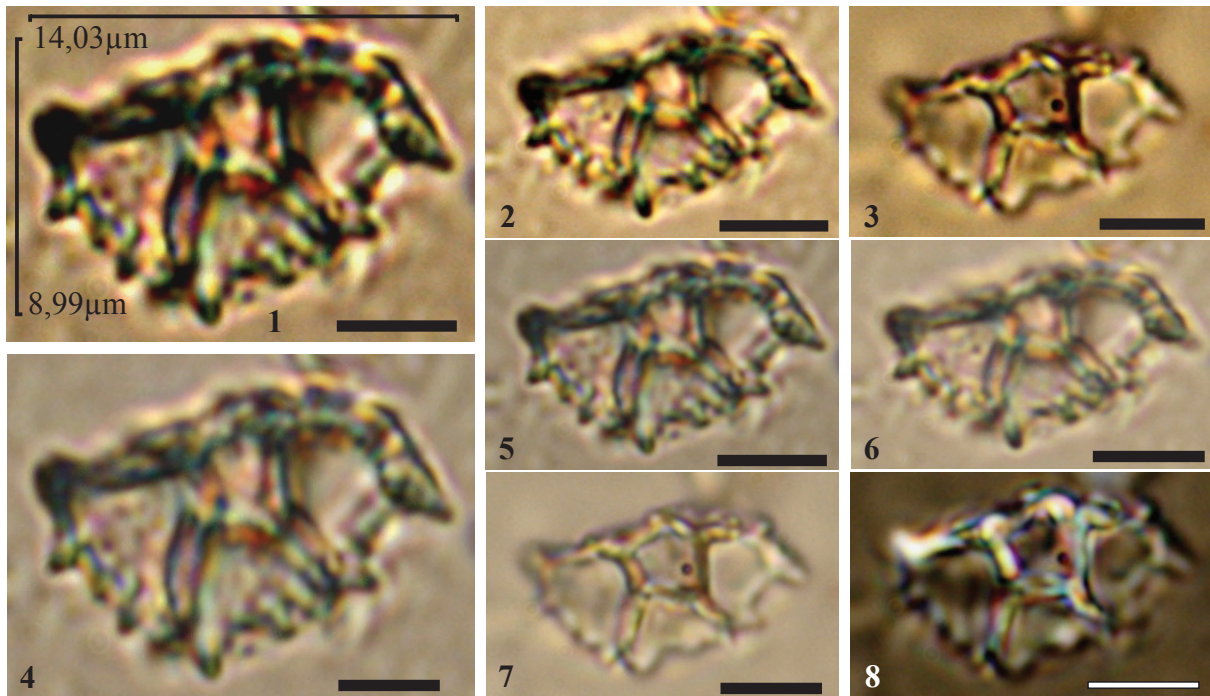
**Plate 2:** 1–5: sample 17, 414–420m; 6–9: sample 15, 414–420m; 10–21 sample 15, 414–420m; PC = 1–3, 6–8, 10, 12, 14, 17, 19–21; XPL = 4–5, 9, 11, 13, 15–16, 18; Side view = 21



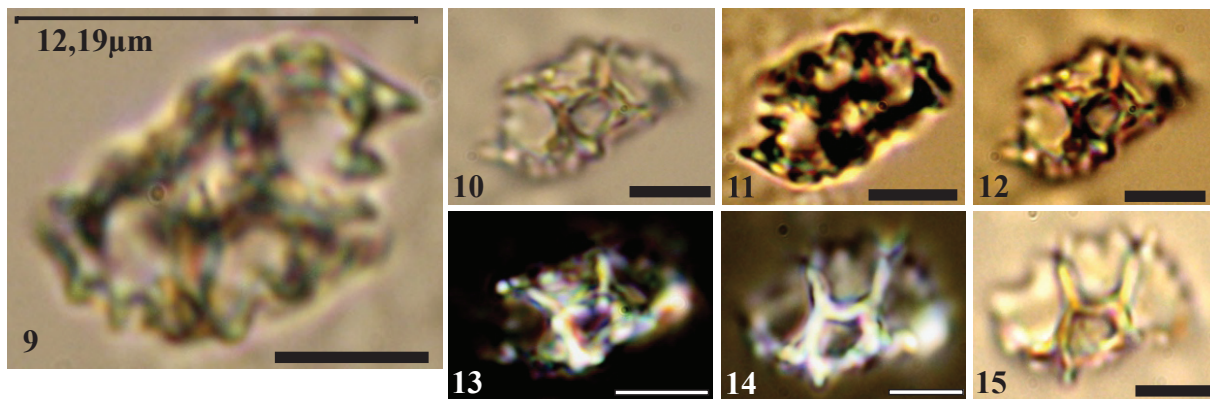
### Plate 3

*Chifragmalithus muzylevii* sp.nov.cc

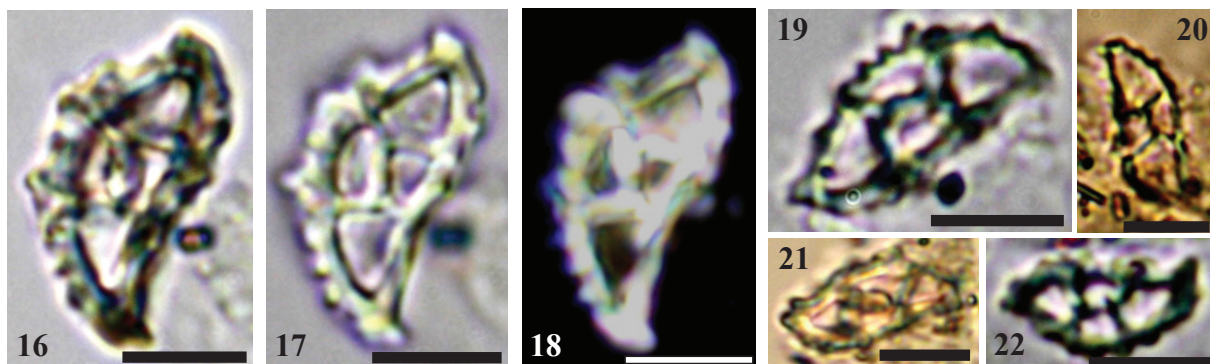
Scale-bars = 5  $\mu$ m



*Holotype*



*Paratype*



*Variability*

**Plate 3:** 1- **Holotype:** 1-8, Sample 15, 414-420m; **Paratype** 9-15; Intra-species variability 16-22; PC = 1-7, 9-12, 15-17, 19-2; XPL = 8, 13-14, 18