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Several New Species of Middle and Upper Eocene Nannoplankton related with Micrantholithus parisiensis Bouché

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난노化石 미크란도리두스屬의 新種(中期 및 後期에오世)記載

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ABSTRACT

6 new species of *Micrantholithus* Deflandre and 1 new subspecies of *Micrantholithus parisiensis* Bouché, which are more or less closely related each other and of Middle to Upper Eocene age, are described.

INTRODUCTION

Pentaliths which constitute the subfamily Braarudosphaerinae are very simple nannoplanktons, while highly varied in morphology. In this particular group I have been much interested, and a concentrated observation has been made with every material, preparation and sample, available at the laboratory of nannoplankton in the Geological Survey of Austria, during several months of my stay there as a guest geologist. In doing so I found several undescribed pentaliths of Middle to Upper Eocene age, which are more or less closely related each other and with *Micrantholithus parisiensis* Bouché. 6 new species of *Micrantholithus* Deflandre and 1 new subspecies of *Micranthloithus parisiensis* Bouché are described here.

SYSTEMATIC DESCRIPTION

Family **Coccolithidae** Lohman 1902

Subfamily **Braarudosphaerinae** Deflandre 1966

Genus **Micrantholithus** Deflandre 1954

"Pentalithes étoilés dont les cinq pièces triangulaires (et non trapézoïdales comme chez Braarudosphaera) sont facilement séparables." (G. Deflandre and C. Fert, 1954, P. 52)

Each of the five crystal pieces (sectors) of the pentalith are fundamentally triangular in shape. Star-like pentaliths show single engulfing in various degree at the margin of the basically triangular sector (*M. vesper*, *M. aequalis*, *M. pinguis*, *M. fornicatus*, *M. obtusus* etc.). Another type of modification of the margin is shown in such form as *M. bramletti*. In general, this genus is characterized by symmetrical sectors. Such exception as *M. inaequalis*, which has inequal arms thus shows asymmetry in each sector, is probably the result of secondary modification in evolution. Another group of Micrantholithus shows compli-

cated ornamentations on the surfaces of pentaliths, such as elevations along sutures (sutural thickenings), concavity or hole in each sector (sectoral concavity or sectoral hole), and serration at the margin (marginal serration). The simplest species of this group is *M. flos*, type species of this genus, which has merely simple sutural thickenings. Those species described below belong to this group and show very complicated surface ornamentations which are mostly asymmetrical. Thus, symmentry is not an unfailing attribute of the morphologic details of the sectors of this genus. Relatively large pentaliths, especially star-like larger ones, are easily separable into isolated sectors, while smaller and rounded species are usually found as complete pentaliths. The "coccosphere" of this genus remains unknown.

Type species: *Micrantholithus flos* Deflandre

Micrantholithus parisiensis Bouché

Plate 1, figures 17–20; plate 2, figures 1–7, 13–20

Micrantholithus parisiensis Bouché, 1962, Revue de Micropaleontologie, vol. 5, no. 2, p. 86, pl. 2, figs. 13–21, 23–26; text-figs. 9–11.

"*Diagnose:* pentalithe dont chaque secteur est pourvu d'épaississements latéraux relativement étroits. Ces épaississements ont tendance à se développer inégalement l'un par rapport à l'autre, de telle sorte que deux bandes fortement épaissies sont rarement contiguës mais alternent avec des bandes peu marquées. A leur extrémité libre les bandes épaissies ont tendance à se recourber vers l'intérieur du secteur. Entre les épaississements latéraux et la région marginale se trouve une zone amincie en forme de dépression conique qui va en s'élargissant d'une face à l'autre." (Pierre M. Bouché, 1962, p. 86)

Remarks: Each sector of the pentalith has a pair of sutural thickenings (épaississements latéraux) which are inequal each other in width and, in most specimens, in length and shape too, making a sector asymmetrical in morphologic details. A sutural thickening has either a stumpy end or a perpendicular branch, with which it surrounds a concavity which lies near to the center of the sector. The pentaliths have round to pentagonal outlines with naively and shallowly serrate margins. The approximate mid-point of the margin in each sector is rather saliently notched. Diameter 6–13 microns.

Distribution: Quite abundant in the Lutetian of the Paris basin, according to my observation with the original preparations by P. M. Bouché. Abundant in the Ledian (stratotype) of Steenberg, Belgium. Apparently declines afterward: Common in the Upper(?) Eocene of Kutch, Western India. But rare in the Bartonian (Barton Clay), England. Apparently the development of this species is confined in the Middle and Upper Eocene. Typical specimens, however, do not occur in the upper part of the Upper Eocene and the basal part of the Middle Eocene. With reference to number of the individuals also, the major development took place from the Middle Middle Eocene to the Lower Upper Eocene.

Micrantholithus parisiensis parisiensis Bouché

Plate 1, figures 17–18; plate 2, figures 2–7

Micrantholithus parisiensis parisiensis Bouché, 1962, Revue de Micropaleontologie, vol. 5, no. 2, p. 86; pl. 2, figs. 8, 13–16, 18, 23; text-figs. 9, 10.

Remarks: Smaller *Micrantholithus parisiensis* (6–8 microns in diameter) with asymmetrical sutural thickenings. The most characteristic morphologic

feature of this subspecies is shown in plate 2, no. 2, namely the svastica-like arrangement of sutural thickenings. In the various specimens, the morphology of the sutural thickenings is highly variable.

Distribution: Common in the Upper Lutetian of the Paris Basin and the Lutetian (Middle Eocene) of Guyabal, Mexico. Abundant in the Ledian of Steenberg, Belgium. Rare in the Upper(?) Eocene of Kutch, Western India. Extremely rare in the Barton Clay (Bartonian stratotype), England.

Micrantholithus parisiensis major Bouché
Plate 1, figures 19–20

Micrantholithus parisiensis major Bouché, 1962, Revue de Micropaleontologie, vol. 5, no. 2, p. 86; pl. 3, figs. 17, 19, 20, 21, 25; text-fig. 11.

Remarks: Larger *Micrantholithus parisiensis* (9–13 microns in diameter) with asymmetrical sutural thickenings. The marginal teeth are rather numerous(4 to several in a sector) than in *Micrantholithus parisiensis parisiensis*(4 or so). Also ,highly varied in morphology. Plate 1, figures 19 and 20 show two sides of the typical pentaliths, though of different specimens. Relying upon the explanation of the text-figures in the original paper, the above-mentioned figures should be analogized to represent respectively the upper and the lower sides of the pentaliths.

Distribution: Common in the Lower Lutetian of the Paris Basin and the Lutetian of Guyabal, Mexico. Abundant in the Ledian of Steenberg, Belgium. Apparently disappear after the Ledian time, so far as this study shows.

Micrantholithus parisiensis primordis n. subsp.
Plate 2, figures 15, 18–19

Pemma papillatum Martini—Stradner, 1961, Tertiäre Discoasteriden aus Österreich und deren Stratigraphische Bedeutung; Jahrbuch der Geologischen Bundesanstalt Sonderband 7, Tafel 38, Figur 3.

Description: *Micrantholithus parisiensis* of which a pair of sutural thickenings in each sector are of same length and symmetrical. The frail fringe of the pentalith has typically four teeth. The sectoral concavity is trapezoidal in shape. Diameter 7–8 microns.

Remarks: The sutural thickenings in a sector, however, are not perfectly alike in width, thus fail to show exact symmetry. Even though, they are in contrast to those of other two subspecies, which are characterized by salient asymmetry. The teeth-bearing fringe may be compared to the nipples of *Pemma papillatum*. The trapezoidal shape of the concavity of this subspecies and the hole of *Pemma papillatum* may be a clue of their close relationship. This subspecies is being described in the basal part of the Middle Eocene. Therefore it represents the earliest ever known stage of the evolution of *Micrantholithus parisiensis*: Hence the name "primordis."

Holotype: KUDG–2007 (pl. 2, fig. 19), from the Lower Middle Eocene of Aragon, Mexico.

Distribution: Rare in the Lower Middle Eocene of Aragon, Mexico.

Micrantholithus complicatus n. sp.
Plate 1, figures 7–8

Description: Round, large sized (10–14 microns) pentaliths with highly complicated sutural thickenings and exceptionally numerous marginal teeth (5 to 8 teeth in each sector). Each sutural thickening has two branches. A heart-shaped hole in each sector is surrounded by the inner branch of the sutural thickenings. Each sector shows almost exact symmetry, having symmetrical sutural thickenings. There are conspicuously large sutural notches at the ends of the sutures, thus, sutures

never reach to the margin of the pentalith. Diameter 10–14 microns, but mostly 12–13 microns.

Remarks: This species has common morphologic elements with *Micrantholithus parisiensis*, showing their close relationship. And the former replaces the latter in the course of evolution. Its uniqueness, howevr, lies in its highly complicated sutural thickenings (hence the name "complicatus"). Symmetry of the sutural thickenings in each sector is common characteristics of this species and *Micrantholithus parisiensis primordis* n. subsp. This fact indicates their intimate relationship. *Micrantholithus* aff. *M. complicatus* n. sp. (pl. 2, fig. 13) is a distinct variety, and it represents the stage of the beginning of double branching in the sutural thickenings and multiple serration in the margin. This variety is morphologically and chronologically intermediate between *M. parisiensis primordis* n. subsp. and *M. complicatus* n. sp. It is quite convincing that *M. complicatus* n. sp. derived from *M. parisiensis primordis* n. subsp., passed through the stage of *M.* aff. *M. complicatus* n. sp.

Holotype: KUDG-2003(pl. 1, figs. 7, 8), from the Barton Clay (Bartonian stratotype), White Clay Bay, Isle of Wight, England.

Distribution: Abundant in the Barton Clay, England. Resembling specimens, *Micrantholithus* aff .*M. complicatus* n. sp. (pl. 2, fig. 13), are very rare in the Middle Eocene of Guyabal, Mexico.

Micrantholithus serratus n. sp.
Plate 1, figures 5–6

Description: Round to sub-pentagonal small pentaliths, each sector of which has four, relatively sharp and equal teeth at the margin. Each sector has single sutural thickening along one suture of the sector. Thus, sutural thickenings of a pentalith, altogether, have somewhat svastica-like arrangement. They may reach the margin, making the pentalith sub-pentagonal, but typically, they do not reach it as in the type specimen, making the pentalith round-shaped. Each sector has a hole in the center. Diameter 6–10 microns, but mostly 7–9 microns.

Remarks: The particularly regular and neat serration, that characterizes the species, is the source of the name "serratus". This species has same kind and arrangement of morphologic elements with *Micrantholithus parisiensis*. The characteristic arrangement of the sutural thickenings already appear in some Ledian *Micrantholithus parisiensis parisiensis*. The flourishing of this species in the Bartonian time is coincident with the diminishing of *M. parisiensis parisiensis*. Therefore, I believe that this species diverged off from *M. parisiensis parisiensis*, probably during the early part of Late Eocene time.

Holotype: KUDG-2002 (pl. 1, fig. 6), from the Barton Clay (Bartonian stratotype), Whight Clay Bay, Isle of Wight, England.

Distribution: Quite common in the Barton Clay, England, and the Upper(?) Eocene of Kutch, Western India.

Micrantholithus n. sp. A
Plate 1, figures 9–10

Description: Approximately quadrilateral pentaliths retaining the traces of every morphologic elements of *Micrantholithus parisiensis*. Among five sectors of a pentalith, neighbouring three are triangular and the others are more or less trapezoidal in shape, together forming a pentalith roughly quadrilateral. Length 8–10 microns.

Remarks: This species is an aberrant form of *Micrantholithus parisiensis*, occurring in the latest stage of its phylogenic development. The morpho-

logic elements of *Micrantholithus parisiensis*, such as sutural thickenings, sectoral concavity and marginal serration, are retained but considerably irregularized, apparently due to the morphogenic deformation through which the pentalith became quadrilateral.

Holotype: KUDG-2004 (pl. 1, figs. 9, 10), from the Barton Clay (Bartonian stratotype), White Clay Bay, Isle of Wight, England.

Distribution: Rare in the Barton Clay, England.

Micrantholithus n. sp. B
Plate 2, figure 12

Description: Svastica-like pentalith composed of five J-shaped pieces. Dimension 7 microns.

Remarks: Each sector is virtually equivalent to such a sutural thickening as developed mainly along one suture line of a sector of certain *Micrantholithus parisiensis parisiensis*. This species thus is assumed to be more or less intimately related with *M. parisiensis*.

Holotype: KUDG-2006 (pl. 2, fig. 12), from the Middle Eocene of Guyabal, Mexico.

Dsitribution: Extremely rare in the Middle Eocene of Guyabal, Mexico.

Micrantholithus stradneri n. sp.
Plate 1, figures 1–4

Description: Pentaliths each sector of which has W-shaped margin due to a pair of right-angled notches. In each sector is a hole of trapezoidal shape. The mid-promontory of the margin of a sector is typically sharp to more or less rounded, but in many specimens it is slightly divided by a tiny notch. Overall diameter 8–9 microns.

Remarks: The shape of any sector is suggestive of the possible origin of this species: Cohesion of a pair of symmetrical sutural thickeinngs (devoid of the other part) such as those in *Micrantholithus parisiensis primordis* n. subsp. This species thus is assumed to be more or less closely related with *Micrantholithus parisiensis*. The name "stradneri" is given in honor of Dr. H. Stradner, the nannoplankton specialist at the Geological Survey of Autsria.

Holotype: KUDG-2003 (pl. 1, fig. 3), from the Barton Clay (Bartonian stratotype), Whight Clay Bay, Isle of Wight, England.

Distribution: Fairly common in the Barton Clay, England, and the Upper(?) Eocene of Kutch, Western India.

Micrantholithus floridus n. sp.
Plate 2, figures 9–11

Description: Flower-like pentaliths, each sector of which has an arched margin often with a shallow mid-notch. In each sector is a sub-central hole. Every two neighbouring sectors are obtusely divided by a sutural notch in the margin. Diameter 7–10 microns, but mostly 8–9 microns.

Remarks: Sutural thickenings or any other surface thickenings have not been recognized. The only relief feature seen on the surface is the hole in each sector. These remarks lead to the idea that this species may be classified to the genus *Pemma*. It seems to me, however, that the status of the genus *Pemma* is far from being really established. The hole in the sector, which was the only proposed positive criterion of *Pemma* distinguishing from *Micrantholithus*, has been now known to be the common element of both genera. The main difference of this species from *Micrantholithus parisiensis* is absence of sutural thickenings. Two species seem more related each other than with any other species. The name "floridus" denotes the flower-like outline of the pentalith.

Holotype: KUDG-2005 (pl. 2, fig. 10), from

the Middle Eocene of Guyabal, Mexico.

Distribution: Rare in the Middle Eocene of Guyabal, Mexico.

ACKNOWLEDGMENTS

This paper is a part of the result of the study entitled "the evolution of *Micrantholithus parisiensis* Bouché and related species," which will be published later. This study was conducted at the laboratory of nannoplankton in the Geological Survey of Austria, as a part of technical training at the Training Center for Geology in Vienna sponsored by UNESCO and Austrian Government. The writer wishes to express his thanks to Director Professor H. Küpper of the Geological Survey of Austria, who arranged for him an opportunity to sit at the Dr. H. Stradner's laboratory. His most grateful thanks are due to Dr. H. Stradner, who virtually opened his all reserves of samples and preparations, whether were described or new, for this study which was done under his most friendly technical guidance.

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요 약

난노化石 *Micrantholithus*屬의 6개 新種 및 *Micrantholithus parisiensis* Bouché의 1개 新亞種을 발표한다.

미세한 방해석 결정들로 구성된 난노浮游類화석은 알려진 가장 작은 화석류인데 근래 그 생물층서학상의 가치가 크게 인정되어 각광을 받고 있다. 난노화석이 생물진화의 기초적 양상을 가장 잘 보여 줄 가능성이 있음에 착안한 필자는 오오스트리아 지질조사소 난노화석 연구실에서 난노부유류 중 매우 간단한 기본 구조를 가졌으면서도 매우 다양한 형태를 보이는 五片石 (pentalith-다섯개의 방해석 결정들로 구성됨)類만을 수개월간 집중 관찰 하였다. 그 연구실에 보관되어 있는 세계 각지로부터의 여러 지질시대를 대표하는 모든 표품과 박편들을 가지고 고배율 (×1,000)의 광학현미경 하에서 그 類의 통계적연구를 하던 가운데 일련의 신종들이 발견되었기로 이번은 우선 그들의 계통만을 기재하였다. 그 크기가 6내지 14미크론의 범위 안에 있는 이들은 *Micrantholithus parisiensis* Bouché와 그리고 그들 서로 밀접한 유연관계를 가지며, 중기 내지 후기 에오(Eocene)세에 생존한 것들이다.

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EXPLANATION OF PLATE 1

Micrantholithus parisiensis **Bouché and related species(1)**
Magnification × 3,500

Figs. 1–4– *M. stradneri* n. sp. (3– Holotype, KUDG–2003–a): 1,4– anoptral contrast; 2,3– crossed nicols.

Figs. 5–6– *M. serratus* n. sp. (6– Holotype, KUDG–2002): anoptral contrast; views of different sides of different specimens.

Figs. 7–8– *M. complicatus* n. sp., Holotype, KUDG–2003–b; views of same side of same specimen; 7– anoptral contrast, 8– phase contrast.

Figs. 9–10– *Micrantholithus* n. sp. A, Holotype, KUDG–2004; views of same side of same specimen; 9– anoptral contrast, 10– phase contrast.

Fig. 11– *M. flos* Deflandre; anoptral contrast.

Figs. 1–11– Samples from Barton Clay, England, the stratotype of the Bartonian Stage (Upper Eocene).

Fig. 12– *M. ornatus* Sullivan; anoptral contrast.

Figs. 13–14– *M.* aff. *M. stradneri* n. sp.; 13– anoptral contrast, 14– crossed nicols.

Figs. 15–16– *M.* aff. *M. serratus* n. sp.; anoptral contrast.

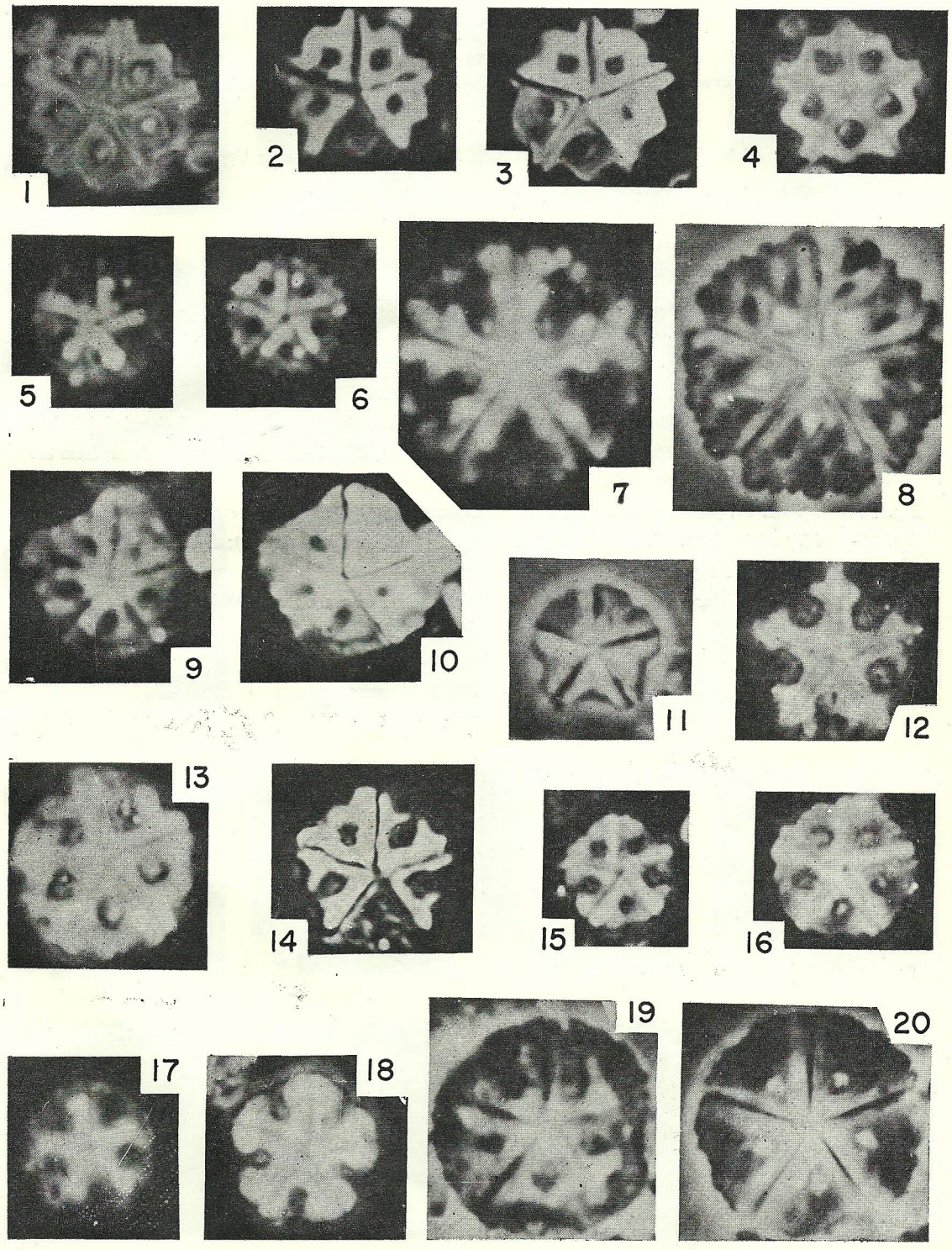
Figs. 12–16– Samples from the Upper(?) Eocene of Kutch, Western India.

Fig. 17– *M. parisiensis parisiensis* Bouché; anoptral contrast.

Fig. 18– *M. bulbosus* Bouché; anoptral contrast.

Figs. 19–20– *M. parisiensis major* Bouché; anoptral contrast; views of different sides of different specimens.

Figs. 17–20– Samples from the Ledian (Lower Upper Eocene) of Steenberg, Belgium.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EXPLANATION OF PLATE 2

***Micrantholithus parisiensis* Bouché and related species(2)**

Magnification × 3,500

Fig. 1- *M. parisiensis* Bouché; anoptral contrast; from the Ledian (Lower Upper Eocene), Steenberg, Belgium.

Figs. 2-6- *M. parisiensis parisiensis* Bouché; anoptral contrast.

Fig. 7- *M.* aff. *M. bulbosus* Bouché; anoptral contrast.

Fig. 8- *M. bulbosus* Bouché; anoptral contrast.

Figs. 2-8- Specimens from P.M. Bouché's preparation, Po-5367, Lutetian, Paris Basin.

Figs. 9-11- *M. floridus* n. sp. (9,10- Holotype, KUDG-2005); 9- crossed nicols, 10-11- anoptral contrast.

Fig. 12- *Micrantholithus* n. sp. B, Holotype, KUDG-2006; anoptral contrast.

Figs. 9-12- Samples from the Middle Eocene of Guyabal, Mexico.

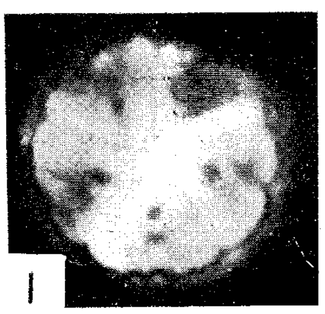
Fig. 13- *M.* aff. *M. complicatus* n. sp.; anoptral contrast; from the Middle Eocene of Guyabal, Mexico.

Figs. 15, 18-19- *M. parisiensis primordis* n. subsp.(19-Holotype, KUDG-2007); anoptral contrast; from the Lower Middle Eocene of Aragon, Mexico.

Fig. 14- *M.* aff. *M. parisiensis* Bouché; anoptral contrast.

Fig. 17- *M. parisiensis* cf. *M. parisiensis primordis* n. subsp.; anoptral contrast; from the Lower Middle Eocene of Aragon, Mexico.

Fig. 20- *Micrantholithus parisiensis* Bouché; anoptral contrast; from the Lower Middle Eocene of Aragon, Mexico.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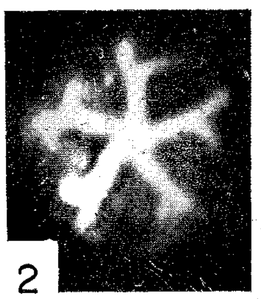
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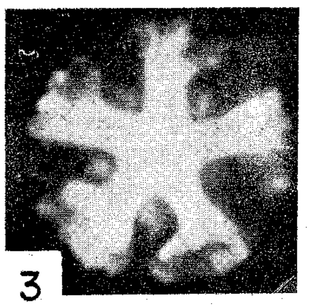
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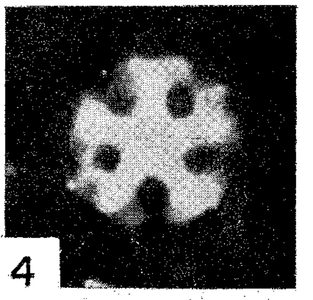
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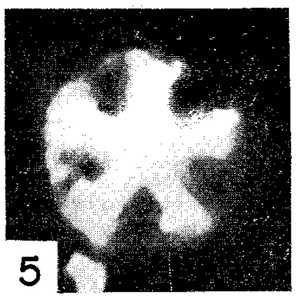
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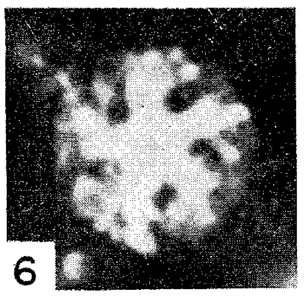
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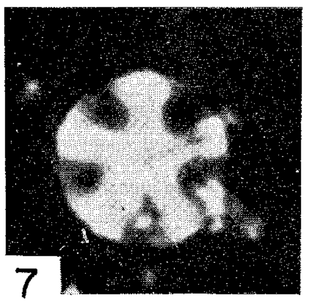
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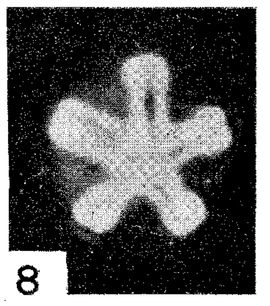
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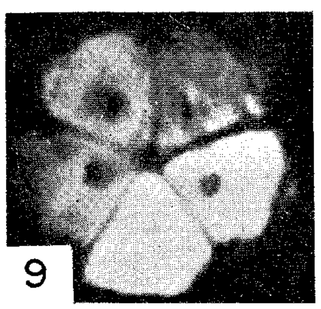
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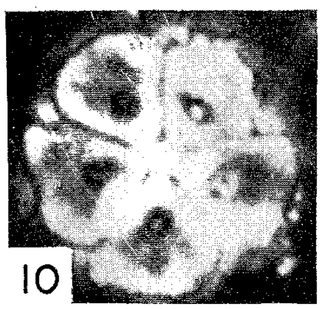
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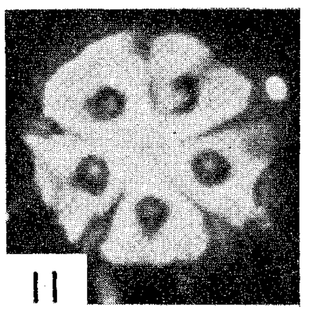
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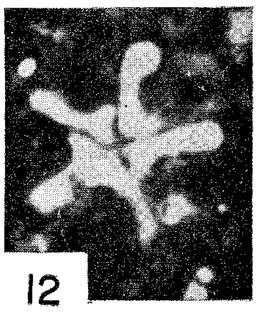
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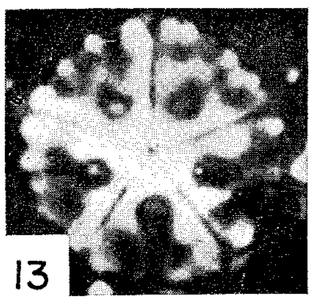
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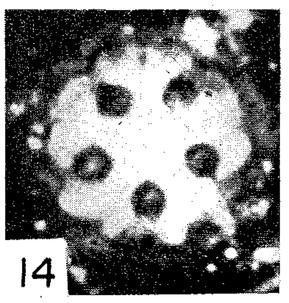
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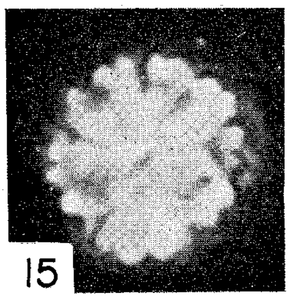
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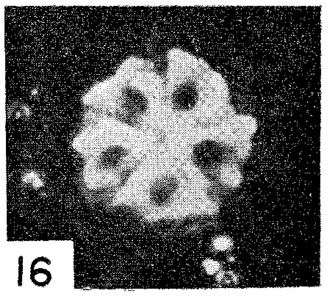
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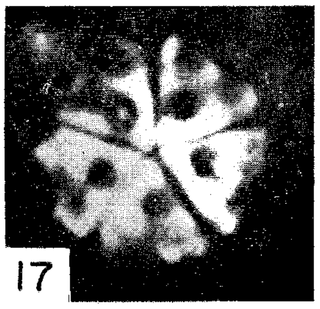
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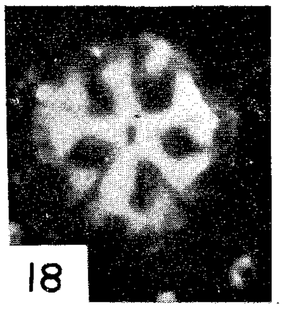
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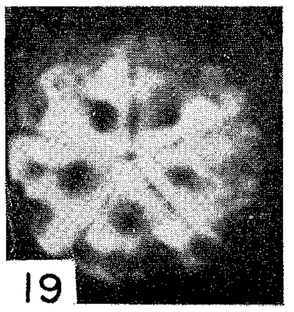
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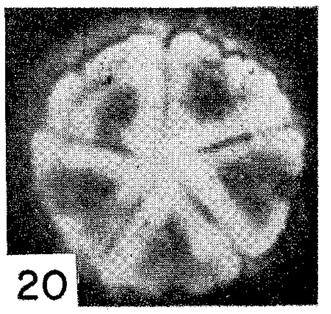
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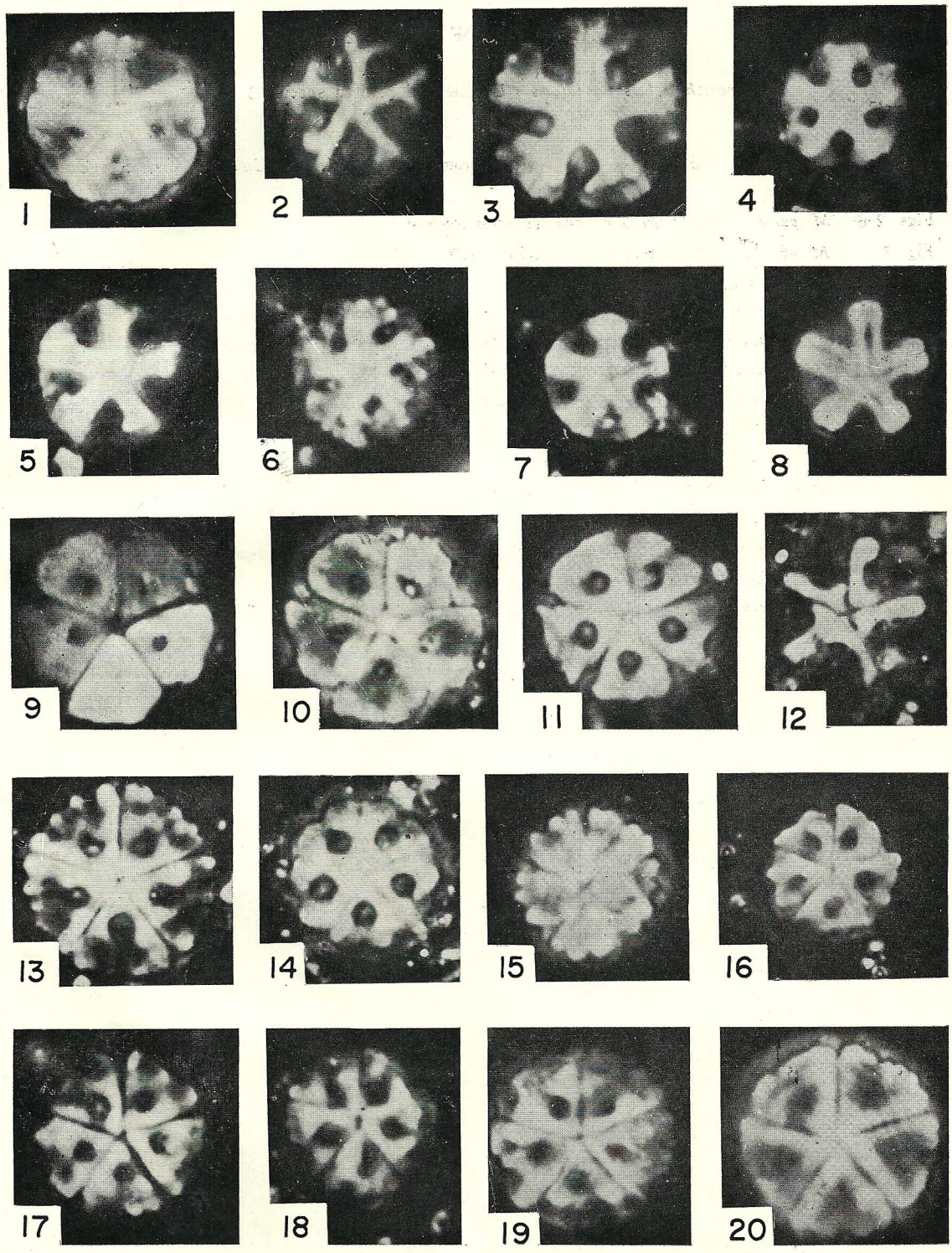
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