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Micropaleontological aspects of the "Calcite Eyes" phenomenon in the family Orbitolinidae

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Abstract

The presence of the "calcite eyes" is related to an internal physiological reason rather than genetically reason or parasite inhabitation. The individual of this family tries to create open spaces in the areas of its body intensively crowded by the main partition or its branches to avoid oxygen scarcity (dysoxic condition). This mechanism keeps the living matter in touch each to the other as well as continuity of the animal life. After death and burial, these created spaces are filled with pure calcite, as it is the case in the chamber passage. This phenomenon took place in both megalospheric and microspheric generations.

Keywords: calcite eyes, Orbitolinidae, micropaleontology, Cretaceous, foraminifera.

المظاهر المستحاثية لظاهرة "العيون الكلسية" لعائلة الاوربتوليندي

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الخلاصة:

فسرت ظاهرة وجود "العيون الكلسية" في عائلة Orbitolinidae بأنها تعود إلى سبب داخلي و ليس إلى تأثير جيني أو علاقة طفيلية. يتم ذلك بإستحداث أماكن فارغة لتلافي انسداد الممرات الغرفية (الامر الذي يؤدي الى شحة الاوكسجين) نتيجة تشعب و تفرع الحواجز الرئيسية و بالتالي بقاء المادة الحية على اتصال مع بعضها البعض و استمرار حياة الكائن الحي. ان هذه الفراغات تمتلئ بالكالسايت النقي بعد موت الكائن الحي كما هو الحال في الممرات الغرفية. هذه الظاهرة تحدث في كلا الجيلين الجنسي واللاجنسي.

Introduction

The "calcite eyes" (calcite eyes, after [1]), is a characteristic phenomenon present in the family Orbitolinidae. They are holes created by the living orbitolinids through areas of their bodies intensively crowded by the main partitions or its branches, to permit passing of cytoplasm in order to continue its growth, then after death they are filled with pure calcite.

This phenomenon is thought to be present in the genus *Orbitolina* only [2,3]. Also, the presences of these objects are mentioned by [4-7]. On the light of our previous experience dealing with this family [8, 9], this phenomenon extends to comprise the following genera, *Conicorbitolina*, *Mesorbitolina*, *Montseciella*, *Neoiraqia*, *Paleodictyoconus*, *Palorbitolona* and *Praeorbitolina*, all of the family Orbitolinidae.

So far, and from the available literatures, this phenomenon did not take any interesting from micropaleontologist point of view as it is not of classification significance, only for one case at species level done by [2] (viz. *Mesorbitolina oculata* ($D_{OUGLASS}$). [10, 11] refer to these objects without any explanation for how and the causes of their formation. In fact, their thoughts will be discussed later.

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The time distribution of this phenomenon within this family is unlimited, as the geological time interval of the previous genera is extending from Late Barremian till the end of Early Cenomanian.

Geographically, it is not restricted for a specific area. By other word, this group of benthonic foraminifers lives in areas of normal salinity, of the photic neritic zone at shallow depth and away from the action of neritic waves. Any changes in these environmental parameters will form an ecological circumstance unsuitable for their living or thriftiness.

Materials and Methods

So, what is the reason behind the formation of these objects? To understand and decipher this phenomenon, we select materials of the current study from wells penetrated through all formations contain individuals of the previously mentioned genera of the family Orbitolinidae using thousands of pre-prepared thin sections (including oriented thin sections) and specimens collected through the period 1981-2001 from different locations (subsurface sections) of Iraq Figure-1. The wells from north to south are: - Kirkuk (K-109), Makhul (Mk-2), Samara (Sr-l), Musayib (Mu-l), Halfiah (HF-2), West Qurnah (WQ-3), Nahr Umr (NU-2), Ratawi (Rt-2), Ratawi (Rt-5) and Tuba (Tu-1). Of these materials, only thin sections from the wells Kirkuk (K-109), Halfiah (HF-2), West Qurnah (WQ-3), Nahr Umr (NR-2), Ratawi (Rt-2), and Ratawi (Rt-5) are figured due to that this phenomenon is well developed and is highly concentrated in the individuals of the previously mentioned genera of the family Orbitolinidae. Rest thin sections are used to explain method of calcite eyes formation ignoring their nomination or amount of magnification.

Discussion

In fact, we do not know the reasons behind careless deal with this phenomenon. As we stated previously, it is not of significant importance from classification point of view and this phenomena do not form any base for chronological, environmental or evolution aspects. From biological point of view, this phenomena may be restricted to the individual its self, as it does not present almost in the same species. By other word, some individuals of the one species try to use this mechanism, creation of holes occupying living matter, as an adaptation and as survival trying due to internal physiological reason excluding the external effects. The later exclusion is supported by the fact submitted by [2] which claims that these objects are not reflecting relics of parasite borings, as they are not extending beyond the ovoid shape [2].

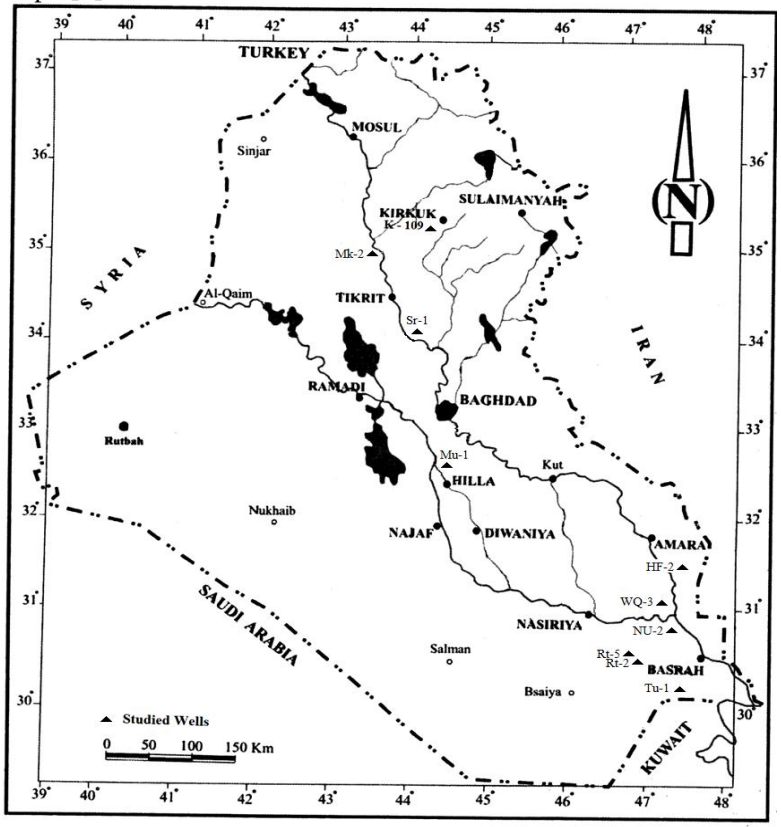

Figure 1- Location map shows the studied wells.

During this study, a considerable example is seen (pl. 1, Figure-6). It discriminates clearly between probable boring (external effect of parasite inhabitation) and calcite eyes. As both criteria are present in one specimen, the dimensions and shapes are clearly judge that each criterion is of different origin. No relics had been seen on the external surface of the examined specimen tests, the matter that eliminates parasite inhabitation as a reason of calcite eyes formation.

[2] Stated that the main partitions are broken up (bifurcating and anastomosing) after their entrance to the central zone of an orbitolinids. This action is happened due to the increasing in the numbers, and possibly in the size, of the main partition. Of course, this is a natural genetically action took place during their propagation from the marginal zone to the radial zone, and from the later to the reticulate zone. In some cases, the presence of little accumulation of foreign detritus materials, i.e. sand grains if any (in our opinion, this presence, is the main cause for bifurcation and anastomosing), lead to the same state. Their optical properties and irregular outline can easily discriminate between sand grain (Quartz) and calcite eyes (calcium carbonate) [2]. Consequently, this subdivision makes the central complex clogged and crowded by these partitions and their branches toward the chamber center. That is meant; the only open spaces remained to occupy living matter in touch are the partition pores (pl. 1, Figure-1).

According to [12], the complexity of the internal components of the living matter is likely to be correlated positively with its ability to adjust to its environment. If it is more complex, it is in general likely to have more adjustment processes. From this, we thought that orbitolinid individuals try making a self-regulation or adjustment (excluding nucleus removing as it is not natural external process) in order to survive its life by creating holes help in cytoplasm occupying, depending on orders from the essential decider sent from the nucleus.

So, some individuals of this family characterized by the presence of these vexing and embracing features termed as calcite eyes after [1]. These objects take rounded, semi-rounded, oval or kidney-like shapes. They occur sporadically through the radial zone and concentrated but with scattered manner through the central complex.

Only [11] thought that there is a link between these objects and *Pithonella*. First of all, the calcite eyes lack the double-layered wall as well as the aperture, the characteristics of *Pithonella* [10]. The submitted figures (see plate l, Figures l-8 and 10) supported this fact. On the other hand, and according to [13], the abundance of calcisphere (Pithonilled) appears to constitute a global event in the Cenomanian-Turonian boundary, the matter that may solve the age determination of some formations [14, p. 157] if we know that the stratigraphic range of calcite eyes in Iraq is from Late Barremian to end of Early Cenomanian. Also, no arguments has been concluded from the microfacies studies for the Iraqi sediments (entire Cretaceous) join between the presence of calcite eyes in highly detritus sediments (shallow neritic environment) in contrast to the typical occurrence of *Pithonella* in deep-sea sediments as claimed by [11].

Moreover, no resemblance has been founded between these objects and the statoliths of invertebrate (notably crustaceans and gastropods). We are coincide more or less with [11] that the actual organism by which the calcite eyes were secreted have not yet been determined, but ultimately this determination cannot be reached as this phenomenon took place in different parts of the orbitolinid tests. [6, 7, 15] are independently shown that the curious "calcite eyes" of orbitolinids are in reality agglutinated kidney-shaped sponge spicules. These objects are filled with pure calcite lacking any internal structure and their shapes do not match with the sponge spicules term whatever is the orientation of the thin section, at least for our materials of the current study.

On the other hand high magnification elucidate that *Montseciella arabica* (Henson) incorporated globular or pear-shaped *Nannocouns* sp. (after [15], pl. 1, Figure-9) (pl. 1, Figure-10 of the current study). It clearly shows that it has 2-3 alternating pale and dark zones of fibrous to massive textures in contrasting to transparent structureless calcite of calcite eyes.

Therefore the following procedure may elucidate some facts about the formation of the calcite eyes and may put things in its proper places.

Procedure of formation:

The formation of these objects could be interpret as follows: during the life of the orbitolinids animal (neanic or ephepic stage) the main partition may tend to either thicken or bifurcate and anastomose as they are propagating toward the central zone. In the areas where one or both processes continue intensively, the main partitions will attach one with each other. Consequently, these areas

will be closed, the matter that cause a deficiency in oxygen. Either way, only remnant open spaces to be occupied by the living matter are the partition pores.

The later state will lead to complication in the internal structure, due to oxygen reduction, and it could regarded as a trend toward increasing entropy of Orbitolinidae individuals to coincides with intensification of oxygen minimum zone of the filled or crowded areas. In this dysoxi condition and in order to facilitate gaseous exchange under low oxygen condition, the individuals propensity to create means decreasing there death by strangulation.

For this reason, the animal tries to use a mechanism to create open spaces, by secreting solvent materials, through the closed areas to open them. These open spaces takes the previously mentioned shapes (oval, circular, kidney-like shape ...etc.) depending on the rigidity of the internal competency of the main partitions and closing intensity. The formation of these geometric shapes reflects the known biological fact that the movement of the living matter took place through areas of smooth linking in order to prevent scratching of tissues of the living matter as well as its uniform propagation through these created opening.

These open spaces permit the living matter to continue touching from one chamber to the next, and in our opinion, the animal will be able to proceed its life and survive by using this method only. On the other hand, the studied thin sections show that these spaces are filled with pure crystalline calcite as in the radial chamber passages. This argument supports the fact that these spaces are filled after death and burial of the animal tests. Figure-2 shows details of these stages.

Conclusions:

The current study interprets "calcite eyes" as a phenomenon accompanied some individuals of some genera of the family Orbitolinidae based on the following conclusions:

1. The formation of these objects is caused by inner physiological reason rather than genetically or parasitism factors for any species of the previously mentioned genera of this family.
2. No arguments available yet explain the presence of these objects in some genera of this family rather the others. Also, not all individuals of the same species passing through this phenomenon.
3. There is no resemblance in presence of these objects within individuals of the Orbitolinidae family (shallow neritic environment) and *Pithonella* of the deep water environment.
4. *Pithonella* is double layered wall and *Nannocouns* has two to three internal zones, both hold apertures in contrast to structureless calcite eyes.
5. The size of these objects remain nearly constant, the matter that eliminate any relationship of them to any other microfossil.
6. The attachment and bifurcation of the main partitions lead to clog the cytoplasm spaces (inward direction) and this is accompanied contemporaneously by creation of holes occupying cytoplasm mass.

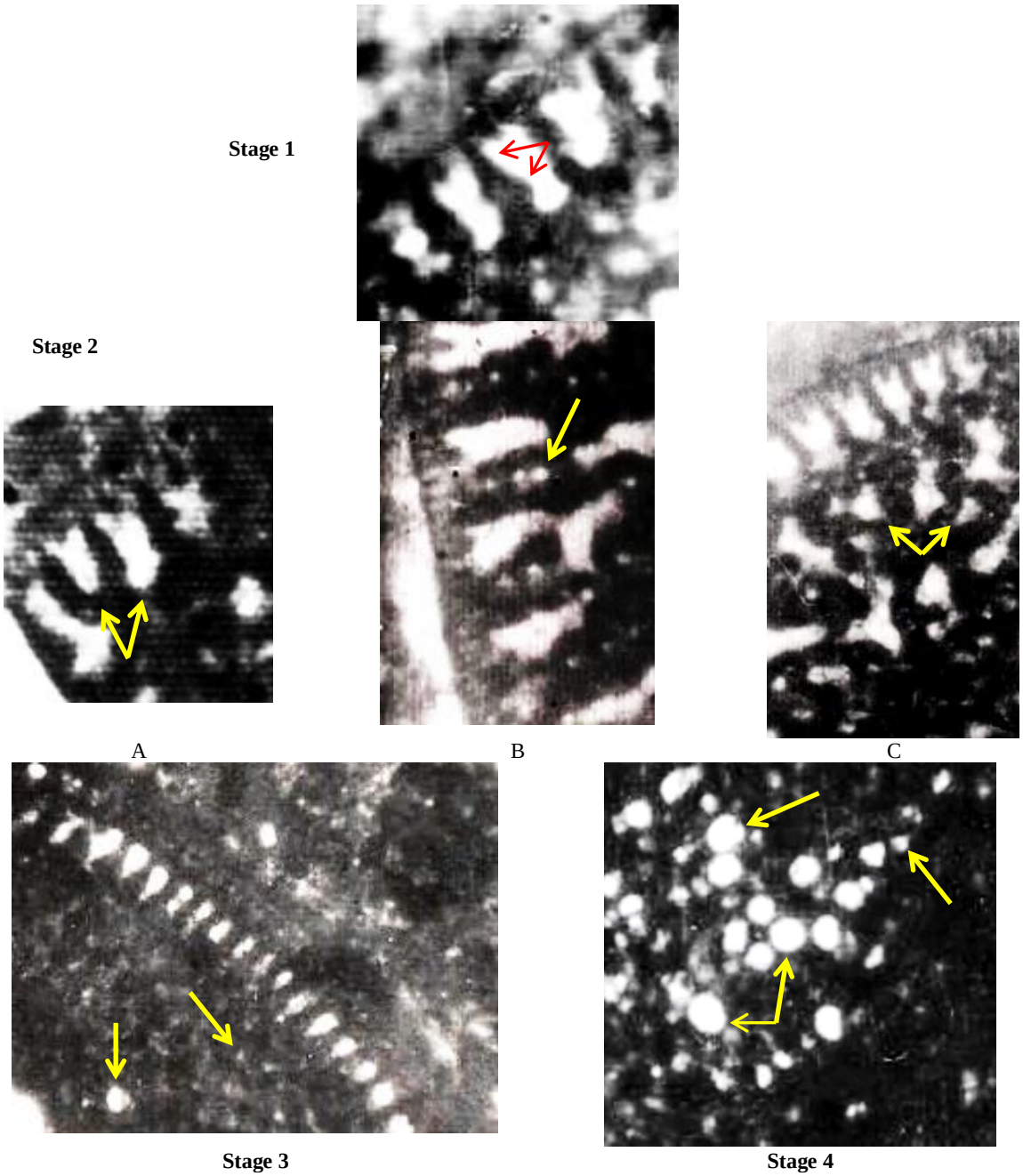

Figure 2- Selected photos show stages of "calcite eyes" formation taken from different species of the family Orbitolinidae. **Stage 1;** main partition begin thickening. **Stage 2;** attachment of the main partitions (A), two main partitions attached confining partitional pores between them (B), bifurcation of the attached main partitions lossing their identity (C). **Stage 3;** Formation of calcite eyes begun in the closed areas (right arrow) and incompelet one (left arrow). **Stage 4;** completed formation of calcite eyes with different shapes. (Not to scale).

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Explanation for Plate 1

1. *Orbitolina arcuala* Mohammed. Part of parallel section at the middle portion of the test. See the connected chamber passages confining pores at their reentrants. Upper Qamchuqa (Mauddud Formation); Upper Albian; Kirkuk well 109; 1427.9-1429.1m; x32.5.

2. *Orbitolina concava* (Lamarck). Random section shows some calcite eyes of rounded and semi-rounded shape, all of them situated in the reticulate zone only. Upper part of Mauddud Formation; Lower Cenomanian; Ratawi well 2; 2523.17m; x12.5.

3. *Conicorbitolina conica* ($D'A_{RCHIAC}$). Random section shows many calcite eyes of different shapes. Upper part of Ahmadi Formation; Lower Cenomanian; West Qurna well 3; 2608.80m; x25.

4. *Mesorbitolina oculata* (Douglass). Oblique section slightly deeper near the apex showing many rounded calcite eyes at the outer part of the reticulate zone. Upper Qamchuqa (Mauddud Formation); Upper Albian; Kirkuk well 109; 1416m; x20.

5. *Orbitolina sefini* Henson. Part of oblique section shows complication and the fine mesh of the reticulate zone contains plenty of calcite eyes of different shapes i.e. rounded, semi-rounded, oval and kidney-like shape. They are disseminated throughout the zone. Upper part of Mauddud Formation; Lower Cenomanian; Nahr Umr well 2; 2569.1m; x20.

6. *Orbitolina qatarica* Henson. A good example proves that calcite eyes are not product of parasite inhabitation. See the probable tubular boring (arrow) which remove the embryonic apparatus and below it see the rounded calcite eyes (left-hand side). Mauddud Formation; Upper Albian-Lower Cenomanian; Halfiah 2; 3390m; x20.

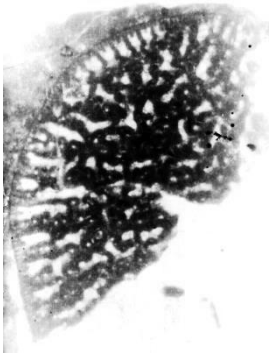
7. *Paleodictyoconus* sp.1. Basal section slightly oblique showing oval and kidney like-shape calcite eyes. Upper parts of Sarmord Formation; Middle Albian; Kirkuk well 109; 1541.1m; x14.5.

8. *Paleodictyoconus* sp.2. Parallel section, slightly oblique passing through several primary chambers shows only one oval-shape calcite eye. Upper parts of Sarmord Formation; Middle Albian: Kirkuk well 109; 1542.3-1543.8m; x25.

9. *Montseciella arabica* (Henson). Horizontal section through a part of a septum of consisting almost exclusively of closely arranged *Nannocouns* sp. x540. (After [15], pl. 1, fig. 9).

10. *Orbitolina sefini* Henson. Portion of oblique section of a large microspheric individual (dia. = 2.9 cm). See the spreading of calcite eyes of different shapes throughout the test. Also three adjacent holes representing worm tracks (arrow). Mauddud Formation; Upper Albian-Lower Cenomanian; Ratawi well 5; 2416m; x12.5.

Plate 1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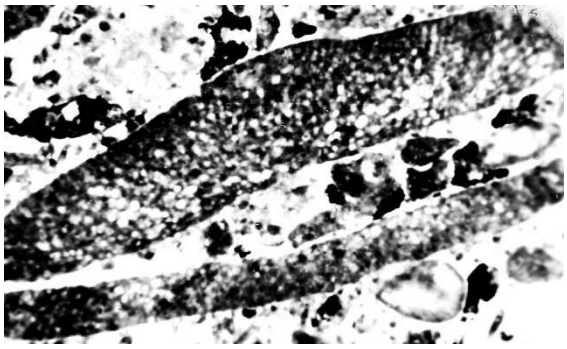
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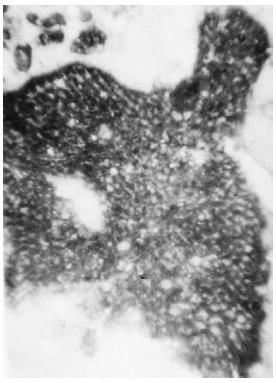
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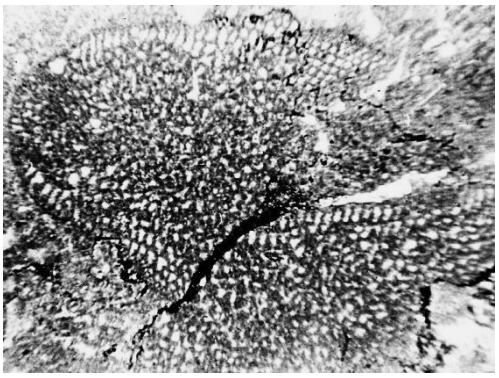
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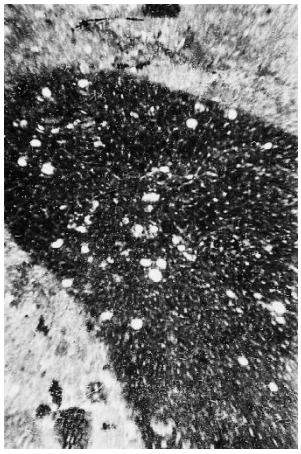
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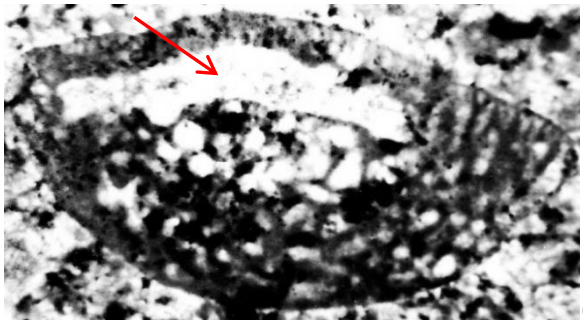
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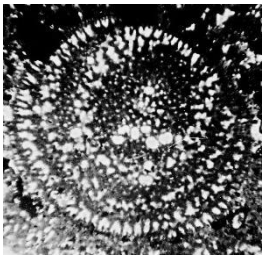
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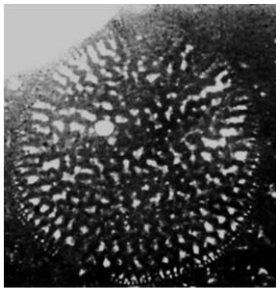
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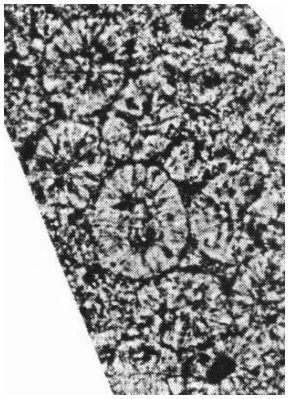
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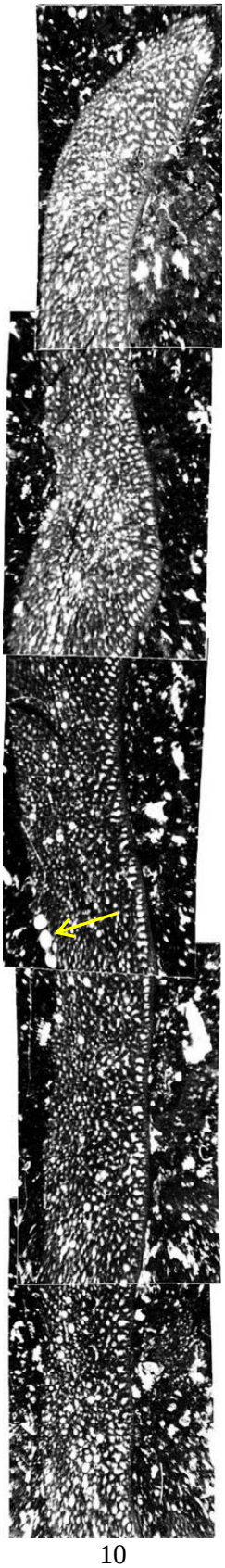
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