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On Nannoconus abundans nov. spec. and on Laminated Calcite Growth in Lower Cretaceous Nannofossils

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With 6 plates

Schlüsselwörter
Niedersachsen
Barrême
Nannoplankton
Ultrastruktur

Abstract

Nannoconus abundans nov. spec. is described and illustrated by lightmicroscopy (LM), transmission- (TEM) and scanning electronmicroscopy (SEM). Its composition of laminated calcite rhombohedrons arranged in a spire around an axial canal is compared with the ultrastructure of other types of nannoplankton fossils. Additional calcite growth, in vivo or post mortem, in the genus *Watznaueria* (Coccolithineae) results in similar patterns of crystal arrangement on the proximal side preferably. Thus a phylogenetic relationship between the Coccolithineae and the Nannoconideae, which hitherto are considered "incertae sedis", seems to be possible.

Zusammenfassung

Nannoconus abundans nov. spec. wird beschrieben und in lichtmikroskopischen (LM), transmissions-elektronenmikroskopischen (TEM) und raster-elektronenmikroskopischen (SEM) Bildern dargestellt. Die Zusammensetzung dieses Nannofossils aus geschichteten, flachen Kalzit-Rhomboedern, welche spiralig um einen Zentralkanal angeordnet sind, wird mit der Ultrastruktur anderer Nannoplanktonfossilien verglichen. Zusätzliche Kalkanlagerung kann im Genus *Watznaueria* zu ähnlichen Anordnungen der Kristallite führen, wobei ungeklärt bleibt, ob dies bereits in vivo oder erst post mortem stattfand. Bei *Watznaueria* sp. findet man geschichteten Kalkzuwachs vornehmlich an der proximalen Seite. Ein phylogenetischer Zusammenhang zwischen den Coccolithineae und den Nannoconideae scheint zu bestehen.

Material studied

The authors thankfully acknowledge the gift of a suite of samples from the Barremian of Schacht Konrad I, near Salzgitter, Germany, by Prof. Dr. E. MICHAEL, Geological Institute, TU Hannover, Germany, who has published several outstanding papers on the Lower Cretaceous, especially on the Barremian of Germany (MICHAEL, 1967, 1968). One of the Lower Barremian samples of Schacht Konrad I from a depth of 673 m contained a certain type of rather

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common, circular nannofossils, which under the lightmicroscope resisted specific and generic identification. Therefore, SEM and TEM investigations were tried to solve the problem. A small selection of the Cambridge Stereoscan Mark 2 A pictures taken at the Geological Institute of the University of Bern, Switzerland, and those taken with a Philips EM 75 C of the Geological Survey of Austria, Vienna, is shown in plate 1—5. Besides circular nannofossils which we think to be a new species of the genus *Nannoconus* KAMPTNER, 1931, we were surprised to note, that in this sample calcite growth in form of fine laminae is not restricted to the nannoconi, but is also seen in other genera of calcareous nannoplankton such as *Watznaueria* REINHARDT, 1964 (Coccolithineae).

Systematic description

Genus *Nannoconus* KAMPTNER, 1931

Type species: *Nannoconus steinmanni* KAMPTNER, 1931

Nannoconus abundans nov. spec.

Plate 1, Figures 1—6; Platte 2, Figures 1—6; Plate 3, Figures 1—5; Plate 4, Figures 1—6; Plate 6, Figures 1—16.

Derivation of name: abundans (latin) = abundant (number of laminae).

Diagnosis: A unicellular flagellate forming a sphere consisting of calcareous, cylindrical to hyperboloidal bodies (= nannoconus) built up by flat, wedge-shaped calcite plates of various length arranged around a straight axial canal forming a pillar of about the same height as its diameter, with a flaring flange presumably at the distal end and a small flange at the proximal end. The distal flange may have twice the diameter of the pillar, the proximal flange is inconspicuous and not always present. The central pillar, which is slightly constricted in its middle part, shows clockwise arranged obliquely situated grooves. The distal flange is composed of only a few layers of calcite plates and is flat-concave on its distal side. The central canal is usually narrow with a serrate inner contour.

Dimensions: Maximum diameter: 12 μ
Maximum height: 8 μ

Holotype: Nr. 71.234/9 — Platte 3, Figure 2.

Paratypes: Nr. 71.95/2 — Plate 1, Figure 1 (paratype A).
Nr. 71.95/3 — Plate 1, Figure 2 (paratype A).
Prep. Konr. I, 673 — Plate 6, Figures 1—3 (paratype B).

Locus typicus: Schacht Konrad I, near Salzgitter, Germany, at 673 m.

Stratum typicum: Lower Cretaceous, Lower Barremian.

Discussion: The newly described *Nannoconus abundans* is related to those *Nannoconus* species, which show a constriction in their outline, e. g. *Nannoconus boletus* DEFLANDRE (1962, p. 2639, fig. 6 and 1967, p. 776) and *Nannoconus dauvillieri* DEFLANDRE (1959, p. 2374, figs. 1, 2). It differs from these two species by having a thin flaring distal end composed of only few crystal layers. The axial view of *Nannoconus abundans* can be similar to *Coccolithites circumradiatus* STOVER (1966, p. 138, pl. 5, figs. 2—4) especially under the lightmicroscope. However, the SEM and TEM pictures reveal a completely different shape.

Distribution: To the authors *Nannoconus abundans* nov. spec. is known only from the Barremian of Schacht Konrad I, near Salzgitter. Considering the worldwide distribution of calcareous nannoplankton one would assume a wider occurence. However only few Barremian nannofloras have been described (BALDI-BEKE, 1965; BOUCHE, 1963; NOEL, 1959; BRONNIMANN, 1955; THIERSTEIN, 1971). This fact, a possibly limited stratigraphic range as well as ecological factors might be the reason for *Nannoconus abundans* not having become known before.

On Laminated Calcite Growth in Nannofossils

The calcareous bodies of *Nannoconus abundans* are typical examples of nannofossils built up by laminated calcite growth. We may assume that such a type of nannofossil was gradually growing by secretion of calcite in centrifugal direction. The cell near its surface presumably secreted calcite plates on or within circular plasmatic discs (compare PARKE & ADAMS, 1960) and continued secreting calcite to form flat crystal rhombohedrons till the entire test of Nannoconus-cones was completed. It is still unexplained how the clockwise coiling was achieved which is found equally in all examined *Nannoconus* species. The clockwise imbrication of the flat crystal plates and the spiral fluting also indicates gradual secretion. Considering the position of the nannoconi within the complete sphere (see TREJO, 1960) we can assume that in case of *Nannoconus steinmanni* KAMPTNER secretion started at the broader distal end of the Nannoconus and ended up at the proximal tip. In *Nannoconus abundans* we may assume that the side with the larger flange was constructed first and came to lie in distal direction. In the living cell the flanges of adjoining nannoconi might have been overlapping each other, similar to the coccoliths of *Coccolithus pelagicus* (WALLICH) or *Watznaueria barnesae* BLACK. In the complete sphere the pillars of the nannoconi of *Nannoconus abundans* evidently have gaps between each other.

In the Lower Barremian of Schacht Konrad I, however, not only the nannoconi show laminated calcite growth. The coccoliths of *Watznaueria sp.* (*? Watznaueria barnesae* BLACK) were found to have layers of additional calcite growth preferably at their proximal concave sides. The distal side, if it shows signs of recrystallisation, has straight crystallite contours (pl. 5, fig. 2) instead of the originally soft and curved lines. These were changed to more geometrical shapes. The proximal side apparently is loosing its design sooner than the distal side. The contour line of the central area disappears (pl. 5, fig. 4 and 5) and laminated calcite growth thickens the proximal plate of the coccolith until it resembles a nannoconus to some degree (pl. 5, fig. 5). The question arises, whether this additional laminated calcite growth in the coccoliths was entirely a "post mortem" phenomenon or whether it might have been a process going on already within the living cell at times of excessive calcite supply. Assuming the second possibility and considering WILBUR & WATABE's (1963) description of the coccolith-origination in the living cell, we may then compare the nannoconi built entirely of laminated calcite with cocooliths showing laminated calcite growth on their proximal side only. Therefore we find the following points in common of both *Nannoconus* and *Watznaueria:*

1. Both *Nannoconus* and *Watznaueria* have radially arranged flat crystal plates.
2. Both *Nannoconus* and *Watznaueria* have laminated crystal plates overlapping and imbricating in a similar way (compare pl. 1, fig. 6 with pl. 5, fig. 5!).

Could it be that the nannoconi and the coccoliths are the products of closely related unicellular flagellates? A comparison of *Nannoconus* with other Lower Cretaceous genera, e. g. *Lithastrinus,* might bring us closer to the answer.

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Plates 1—6

Plate 1

The nannofossils shown in plates 1—6 were all collected from sample 673 m of Konradschacht I near Salzgitter, Germany. They are of Lower Barremian age. Magnifications are indicated by scale bars of 1 μ in the SEM and TEM micrographs and of 5 μ in the LM photographs.

Fig. 1—6 *Nannoconus abundans* n. sp.

Fig. 1 Axial view, proximal side, paratype A (Nr. 71.95/2).

Fig. 2 Same specimen as Fig. 1, oblique proximal view (Nr. 71.95/3).

Fig. 3 Axial view, proximal side.

Fig. 4 Same specimen as Fig. 3, oblique view.

Fig. 5 Same specimen as Fig. 3, lateral view.

Fig. 6 Lateral view of a specimen with concave proximal side.

Stereoscan micrographs, magnification 13.000 ×.

PLATE 1

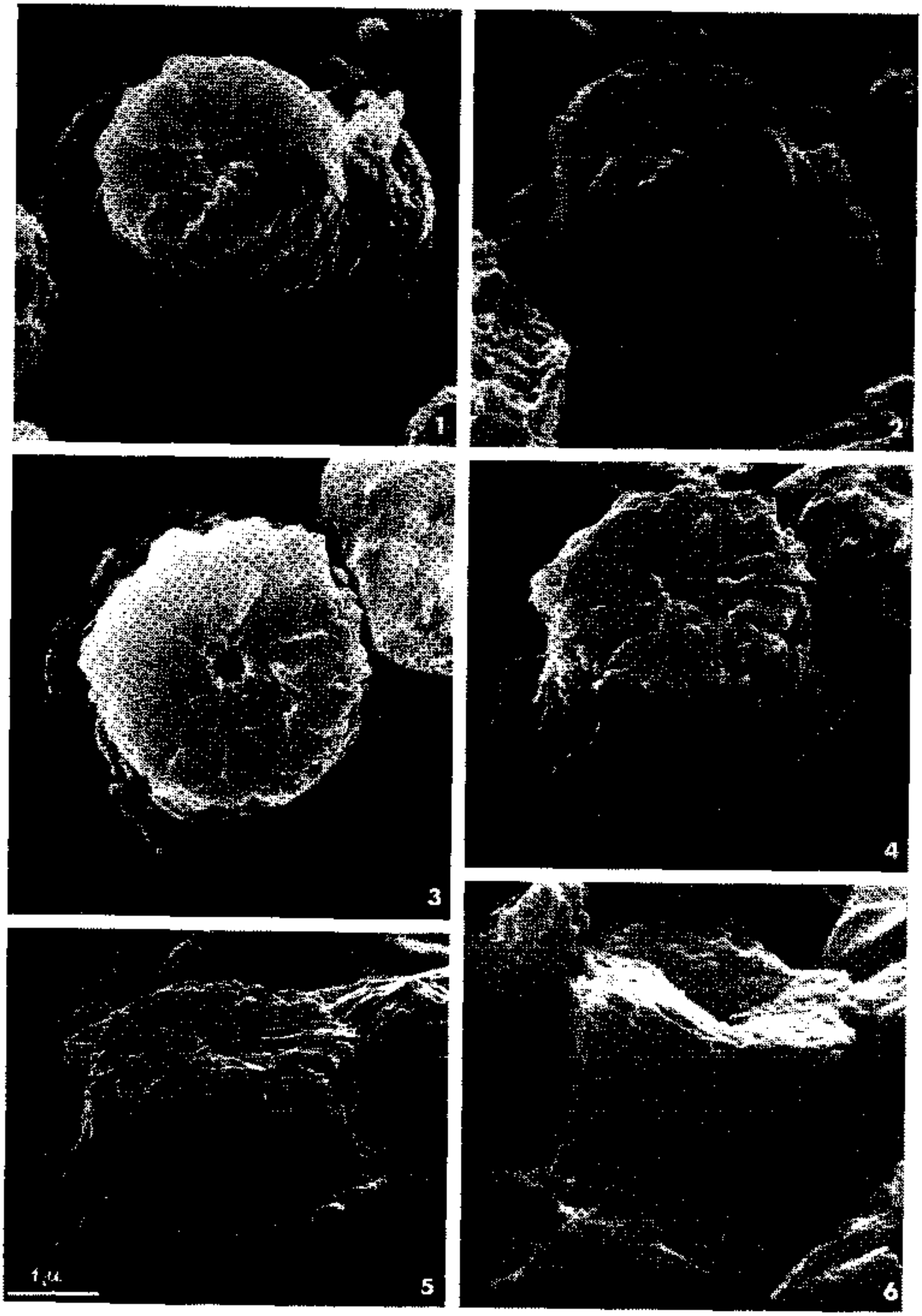

Plate 2

Fig. 1—6	*Nannoconus abundans* n. sp.
Fig. 1	Proximal axial view.
Fig. 2	Same specimen as Fig. 1, oblique side view.
Fig. 3	Same specimen as Fig. 1, lateral view.
Fig. 4	Specimen in lateral view showing imbrication of crystal plates.
Fig. 5	Specimen in oblique distal view.
Fig. 6	Specimen in oblique proximal view.

Stereoscan micrographs, magnification 14.000 ×.

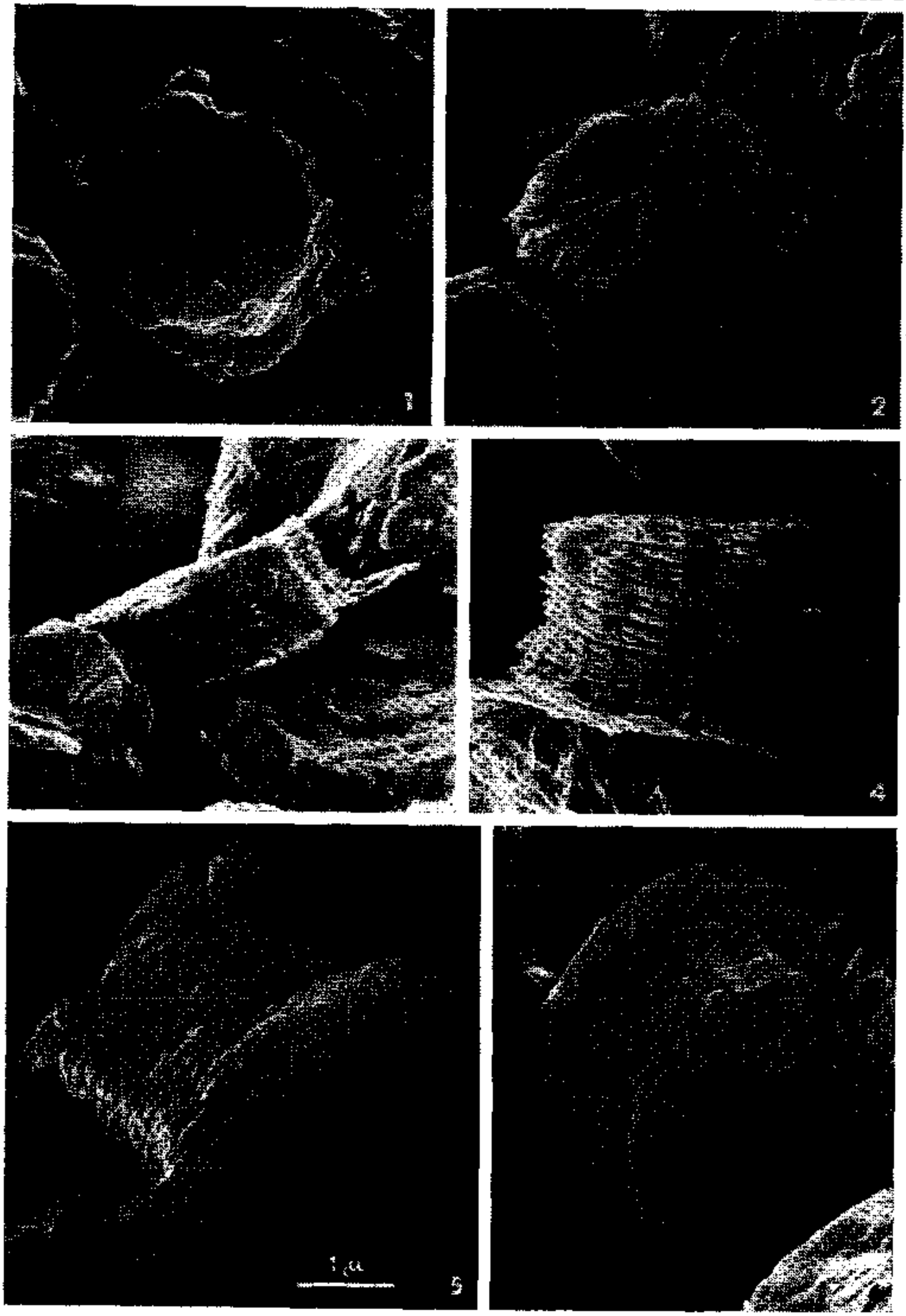
1
2
4
1 μ
5

Plate 3

Fig. 1—5	*Nannoconus abundans* n. sp.
Fig. 1	Plan view of the distal side.
Fig. 2	Oblique view on the concave distal side, holotype (Nr. 71.234/9).
Fig. 3	Specimen with curved axial canal in proximal view.
Fig. 4	Same specimen as Fig. 3, oblique side view.
Fig. 5	Specimen in proximal axial view showing the fluting of the pillar.
Fig. 6	*Micrantholithus obtusus* STRADNER 1963 Plan view.

Stereoscan micrographs, magnification 12.000 ×.

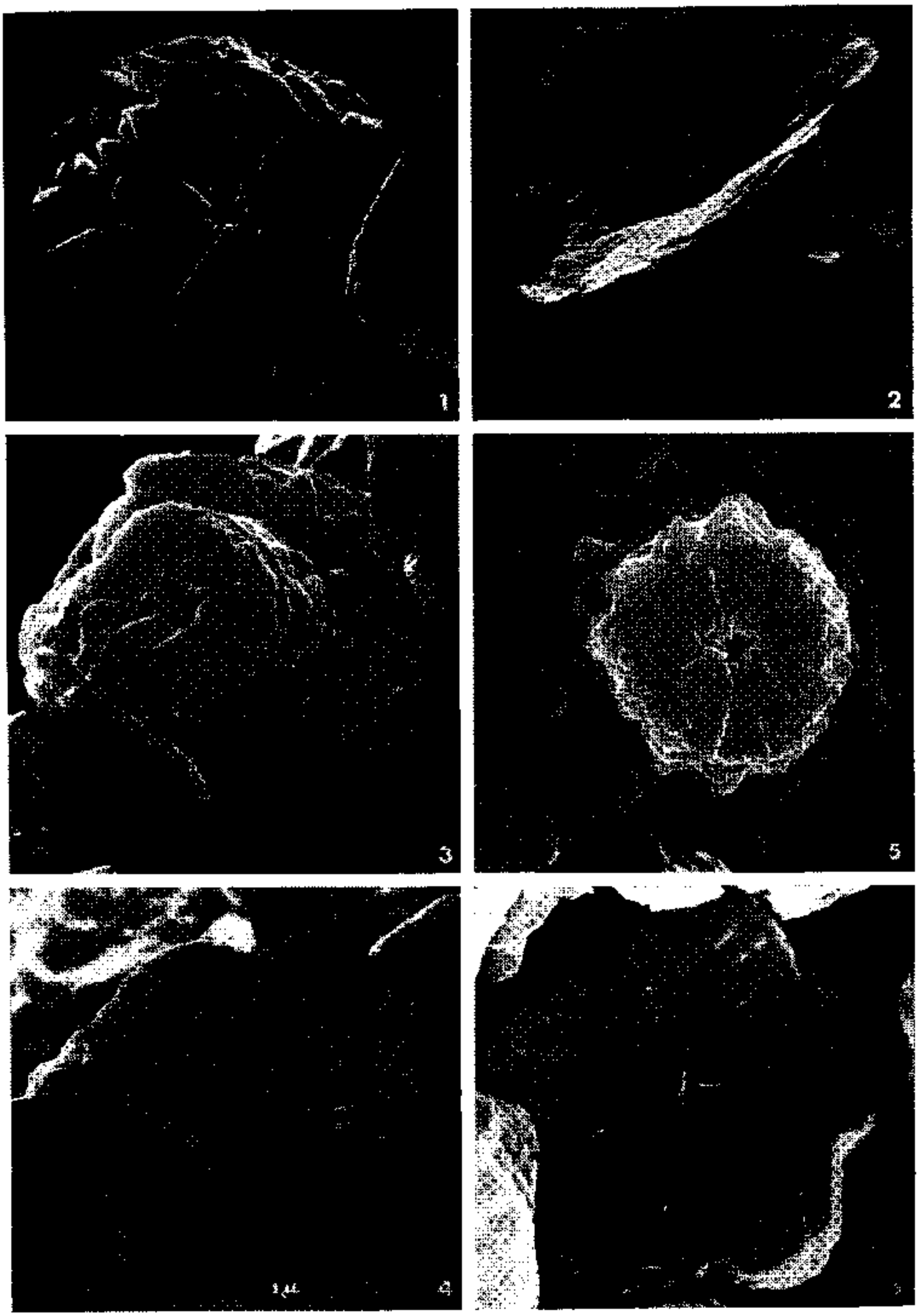
1
2
3
5

Plate 4

Fig. 1—6	*Nannoconus abundans* n. sp.
Fig. 1	Specimen with closed central canal in proximal view, 7500 ×.
Fig. 2	Axial view of a specimen with open canal, 10.500 ×.
Fig. 3	Axial view of a specimen with diameter of the canal exceeding the strength of the wall, 8000 ×.
Fig. 4	Oblique proximal view showing the imbrication of the crystal plates, 10.000 ×.
Fig. 5	Oblique view showing the fluting of the pillar, 7500 ×.
Fig. 6	Distal opening of the central canal; the crystal plates deeper inside the pillar have more acute angles than those of the wide distal flange, 22.000 ×.

Transmission electronmicrographs.

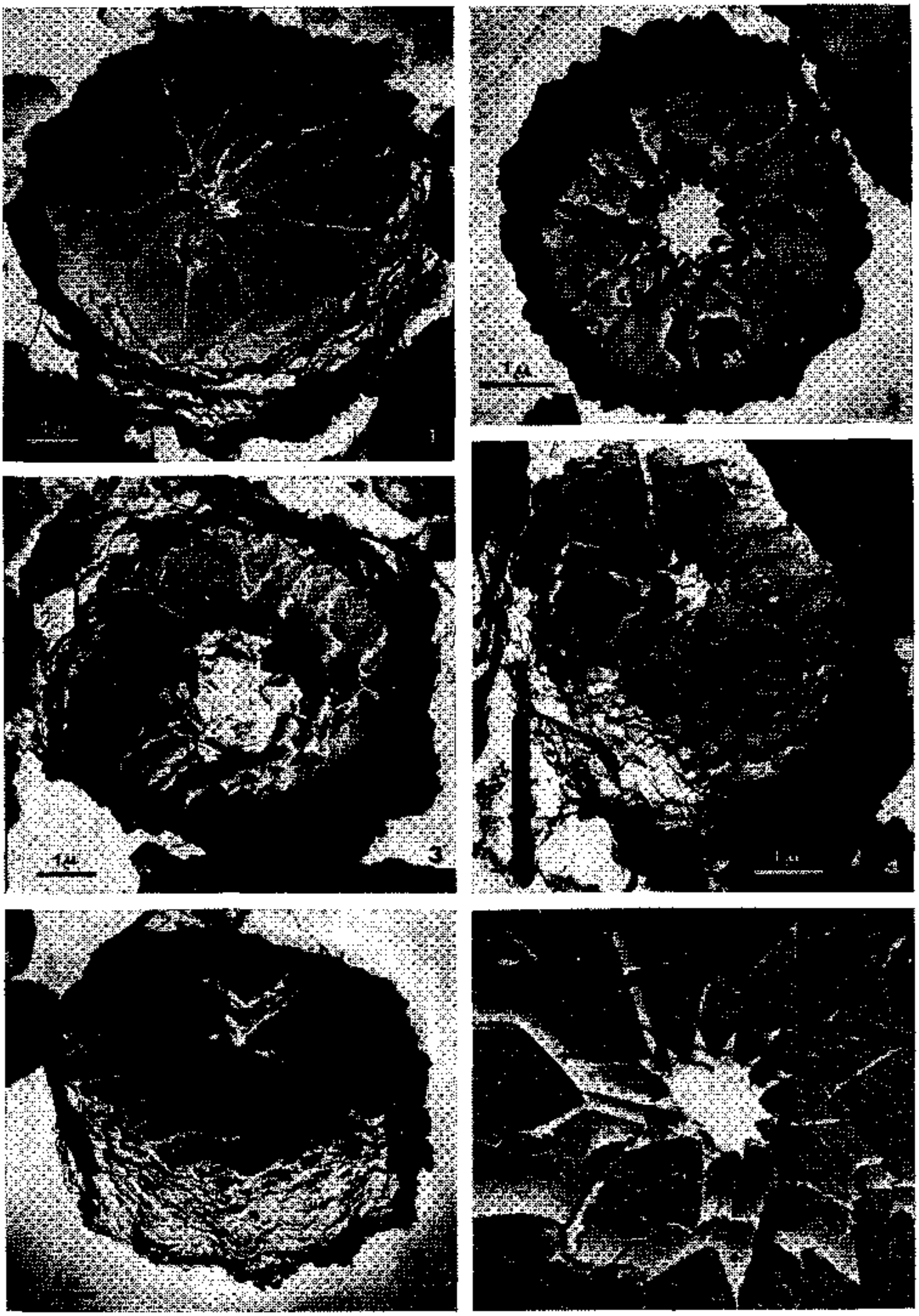

Plate 5

Fig. 1	*Micrantholithus obtusus* STRADNER, 1963 Specimen in plan view showing laminated arrangement of calcite plates, 6000 ×.
Fig. 2—6	*Watznaueria* sp.
Fig. 2	Distal side showing effects of recrystallisation: the suture lines are straightened, resulting a simplification of general design, 10.000 ×.
Fig. 3—6	Proximal sides showing the effects of heavy overcalcification. In fig. 3 the central area is still recognizable, the suture lines are transformed into jagged lines, 12.000 ×. Fig. 4 shows the increased thickness of the proximal plate caused by crystal growth of mainly one layer of crystals. Laminated overgrowth only near center, 9000 ×. Fig. 5. Proximal side with laminated crystal growth, 9000 ×. Fig. 6. Details of proximal side after heavy recrystallisation and additional calcite growth, 26.000 ×.

Transmission electronmicrographs.

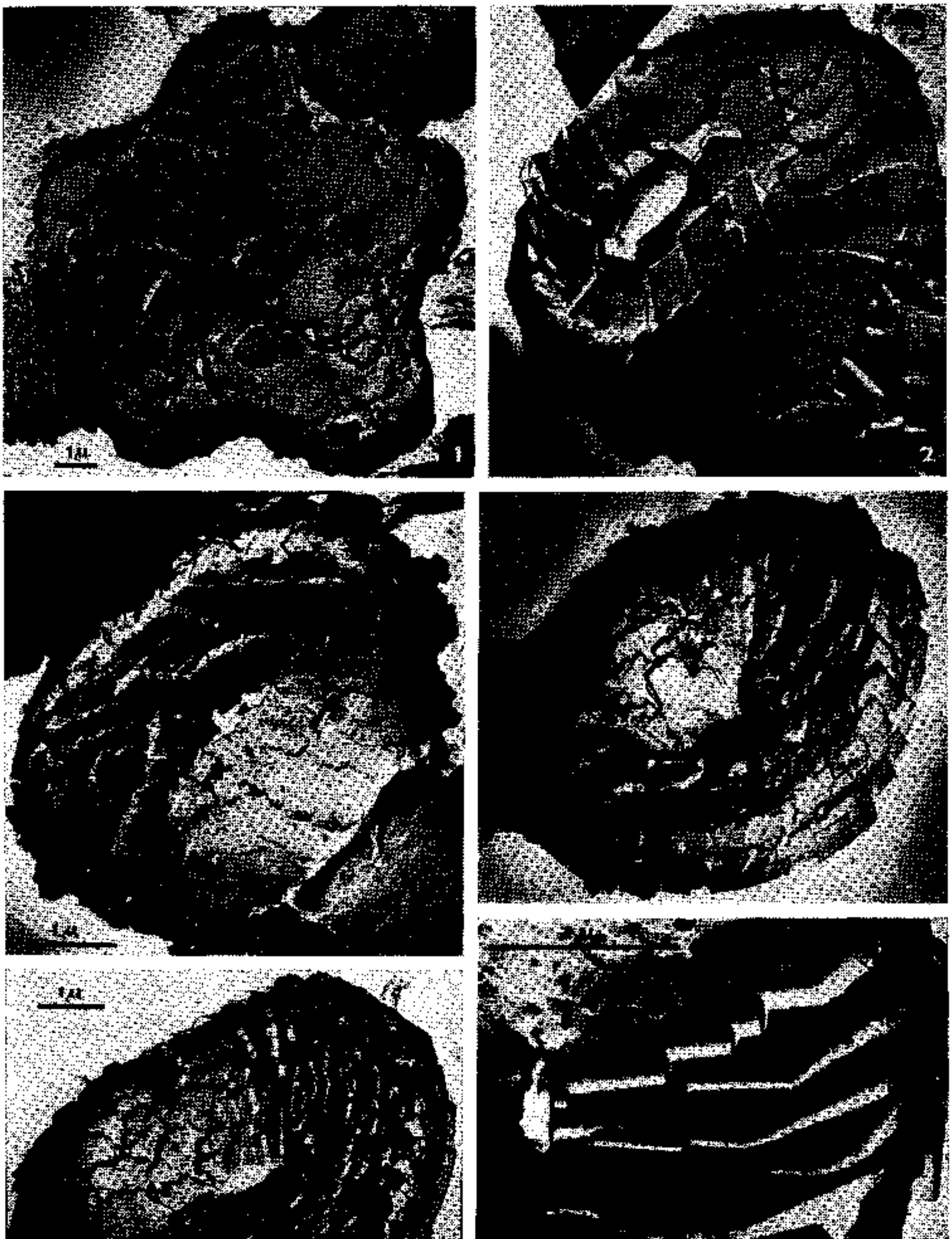
1μ
1
2

Plate 6

Fig. 1—16	*Nannoconus abundans* n. sp.
Fig. 1	Specimen in proximal axial view, phase contrast, paratype B.
Fig. 2	Same specimen as Fig. 1, anoptral contrast.
Fig. 3	Same specimen as Fig. 1, polarized light, x-nic.
Fig. 4	Specimen in distal axial view; low focus showing circumference of the pillar below the flange, phase contrast.
Fig. 5	Same specimen as Fig. 4, high focus, phase contrast.
Fig. 6	Same specimen as Fig. 4, polarized light, x-nic, gypsum red.
Fig. 7	Specimen in distal axial view, phase contrast, x-nic.
Fig. 8	Extinction pattern; the pillar is showing strong, the flange poor birefringence, x-nic.
Fig. 9	Axial view of pillar with radial sutures, phase contrast.
Fig. 10	Axial view of pillar with serrate margin, phase contrast.
Fig. 11	Extinction pattern of pillar with serrate margin, x-nic.
Fig. 12	Extinction pattern of pillar with wide central canal, x-nic.
Fig. 13	Side view, phase contrast.
Fig. 14	Side view, x-nic.
Fig. 15	Side view, phase contrast.
Fig. 16	Same specimen as Fig. 15, x-nic.
Fig. 17—20	*Micrantholithus obtusus* STRADNER 1963
Fig. 17	Plan view of small specimen, x-nic.
Fig. 18	Plan view, x-nic.
Fig. 19	Plan view of specimen with slightly contorted suture-lines, phase contrast.
Fig. 20	Plan view, x-nic.

Lightmicroscopic photographs, magnification 2600 ×.