



SEM-Revision of a Chitinozoan Assemblage from the Uppermost San Pedro Formation (Pridoli), Cantabrian Mountains (Spain)

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2 Text-Figures, 3 Tables and 5 Plates

*Spanien
Kantabrisches Gebirge
San-Pedro-Formation
Pridoli
Chitinozoa
SEM-Revision
Sammlung Cramer*

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Rasterelektronenmikroskopische Revision einer Chitinozoen-Vergesellschaftung aus der obersten San-Pedro-Formation (Pridoli), Kantabrisches Gebirge (Spanien)

Zusammenfassung

Die Chitinozoen aus dem Typusmaterial von Probe 0813 aus der obersten San-Pedro-Formation (Pridoli) des Kantabrischen Gebirges, Spanien, die von CRAMER 1964 (Abb. 6: La-Vid-de-Gordón-Profil) lichtmikroskopisch beschrieben worden waren, wurden einer neuerlichen Untersuchung im Rasterelektronenmikroskop unterzogen.

Aus der vorliegenden Chitinozoen-Gesellschaft werden hier nur *Plectochitina carminae* CRAMER 1964, Typus-Art der Gattung *Plectochitina* CRAMER 1964, *Pseudoclathrochitina carmenchui* (CRAMER 1964), Typus-Art der Gattung *Pseudoclathrochitina* CRAMER 1967, und *Urnochitina urna* (EISENACK 1934) eingehend diskutiert. Während über *Plectochitina* keine neuen Erkenntnisse gewonnen werden konnten, erwies sich die Morphologie von *Pseudoclathrochitina* als von der Originalbeschreibung verschieden.

Da Nachforschungen über den Verbleib der Präparate mit den Holotypen der von CRAMER 1964 neu beschriebenen Taxa den Nachweis erbrachten, daß diese verlorengegangen sind, wurden für *Plectochitina carminae* CRAMER 1964, *Plectochitina rosendae* CRAMER 1964 und *Pseudoclathrochitina carmenchui* (CRAMER 1964) Neotypen bestimmt.

Die Überprüfung der stratigraphischen Verbreitung von *P. carmenchui* ergab, daß diese Art ausschließlich aus der San-Pedro-Formation stammt und nicht, wie früher angenommen, in die untere La-Vid-Formation (La Vid Carbonate Member) reicht.

Aufgrund der Chitinozoen-Gesellschaft konnte Probe 0813 der *Margachitina elegans*-Biozone (mittlerer Teil des Pridoli) zugeordnet werden.

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Abstract

The chitinozoans of the type-material of sample 0813 from the uppermost San Pedro Formation (Pridoli) in the Cantabrian Mountains, Spain, in CRAMER 1964 (Fig. 6: La Vid de Gordón-section) were re-studied under SEM (Scanning Electron Microscope).

Plectochitina carminae CRAMER 1964, type-species of the genus *Plectochitina* CRAMER 1964, *Pseudoclathrochitina carmenchui* (CRAMER 1964), type-species of the genus *Pseudoclathrochitina* CRAMER 1967, and *Urnochitina urna* (EISENACK 1934) were examined in detail. While there was no new knowledge on *Plectochitina*, the morphology of *Pseudoclathrochitina* proved to be different from the original description.

The slides with the holotypes of the new taxa in CRAMER 1964 are lost, so neotypes for *Plectochitina carminae* CRAMER 1964, *Plectochitina rosendae* CRAMER 1964 and *Pseudoclathrochitina carmenchui* (CRAMER 1964) are designated.

P. carmenchui was found to be exclusively from the San Pedro Formation and not to range into the La Vid Carbonate Member.

Sample 0813 is assigned to the *Margachitina elegans*-Biozone (middle part of the Pridoli).

1. Introduction

Fritz H. CRAMER, one of the pioneers of modern research on Lower Palaeozoic palynomorphs retired from scientific work about 1984. At the beginning of the nineties the Geological Survey of Austria together with the Austrian Science Foundation purchased his extensive collection which is now housed in the Geological Survey in Vienna. It comprises thousands of permanent slides, residues and rock samples, including the sample treated in this article.

In 1964, F.H. CRAMER published his outstanding work on the Lower Silurian to Lower Devonian chitinozoans and acritarchs from the Cantabrian Mountains in northwestern Spain, in which he described numerous new taxa.

For the chitinozoan research, sample 0813 from the uppermost San Pedro Formation in the La Vid de Gordón-section (in CRAMER [1964, Fig. 6]) was of special interest, as *Plectochitina carminae* CRAMER 1964, type-species of the genus *Plectochitina* CRAMER 1964, *P. rosendae* CRAMER 1964 and *Clathrochitina carmenchui* CRAMER 1964, type-species of the genus *Pseudoclathrochitina* CRAMER 1967 were derived from it.

Sample 0813 is a green shale from the uppermost shale intercalation in the San Pedro Formation, about 10 m below the base of the La Vid Carbonate Member of the La Vid Formation.

The purpose of this work was to examine the chitinozoans of sample 0813 under the Scanning Electron Microscope, especially *Plectochitina carminae* CRAMER 1964 and *Pseudoclathrochitina carmenchui* (CRAMER 1964), as studies on the holotypes were carried out by F.H. CRAMER under light microscope only.

Furthermore the problem of the stratigraphic provenance of the holotype of *P. carmenchui* had to be settled [see under "Discussion" of *P. carmenchui* (CRAMER 1964)].

Finally the question of the depository of the permanent slides with the holotypes of CRAMER 1964's new taxa required a solution in order to treat the above mentioned species correctly according to the rules of the International Code of Zoologic Nomenclature (see under "The Chitinozoan Assemblage: General Remarks").

2. Treatment of the Sample

4,9 g of the cleaned and crushed shale were covered with concentrated hydrochloric acid and deluted with water. Since there was no reaction, the beaker was filled up with water and the liquid decanted. Then hydrofluoric acid (47 %) was added and moved constantly during the first 5 minutes, followed by movements about every 2 hours. After 1 day the shale was dissolved. The residue was washed two times with cold water and then sifted

through a 53 μ -stainless metal sieve. The remaining amorphous organic material was too high so it was put for approximately 10 minutes into 65 % nitric acid and then washed and sifted again.

Afterwards, the chitinozoans were picked with a micropipette from the residue and mounted on cover slides for SEM-investigations and then transformed into permanent slides for LM-investigations, as described by PARIS 1978. The chitinozoans which were not studied under the SEM were embedded into permanent slides with canada balsam as mounting medium.

The SEM-investigations were carried out on a JEOL JSM 200-Scanning Electron Microscope at 15 KV and 20 mm WD (University of Rennes); the applied film was an Ilford FP4 roll film.

The LM-photographs were taken on an Agfapan APX 100 roll film in a Leitz Ortholux II transmitting light-microscope with a Wild MPS 51 photo-equipment (Geological Survey, Vienna).

3. The Chitinozoan Assemblage

3.1. General Remarks

The processed sample yielded a total of 270 chitinozoans, that is about 55 specimens per gramme of rock.

They show a moderate thermal alteration, their preservation is good in most cases, only long fragile appendices are frequently broken. As usual for assemblages derived from shale, the majority of the individuals are flattened.

The chitinozoans were assigned to the following genera:

<i>Cingulochitina</i> PARIS 1981	43 %
[<i>Cingulochitina</i> sp.: Pl. 1, Fig. 3]	
<i>Pseudoclathrochitina</i> CRAMER 1967	16 %
[<i>P. carmenchui</i> (CRAMER 1964)]	
<i>Linochitina</i> EISENACK 1968, restr. PARIS 1981	10 %
[<i>Linochitina</i> sp.: Pl. 2, Fig. 4]	
<i>Plectochitina</i> CRAMER 1964	10 %
[<i>P. carminae</i> CRAMER 1964; <i>P. rosendae</i> CRAMER 1964]	
<i>Urnochitina</i> PARIS 1981	8 %
[<i>U. urna</i> (EISENACK 1934)]	
<i>Ancyrochitina</i> EISENACK 1955	5 %
[<i>A. brevis</i> TAUGOURDEAU & DE JEKHOWSKY 1960: Pl. 2, Fig. 8]	
<i>Margachitina</i> EISENACK 1968	3 %
[<i>M. elegans</i> (TAUGOURDEAU & DE JEKHOWSKY 1960): Pl. 3, Fig. 3]	
Indeterminable	5 %

From these only *Plectochitina* with its type-species *P. carminae* CRAMER 1964 and *Pseudoclathrochitina* with its type-species *P. carmenchui* (CRAMER 1964) will be discussed in detail since their holotypes originated from sample 0813.

In addition several remarks on *U. urna* (EISENACK 1934) shall be stated due to its unusual ornamentation.

In the systematic part, measurements are cited for *P. carminae*, *P. rosendae* and *P. carmenchui* with the following abbreviations:

- D:** greatest diameter of the vesicle
d.apert: diameter of the aperture
d.coll: diameter of the base of the collarette
d.neck: diameter of the neck
L: total length of the vesicle
(without processes or "carina")
l.coll: length of the collarette
l.neck: length of the neck
l.proc: length of the processes

The slides with the holotypes of the new taxa in CRAMER 1964 are not included in F.H. CRAMER'S collection, and they are not stored at the Museum of Natural History of Leiden (Netherlands) [personal communication of Dr. KÜRSCHNER via Dr. SMEENK, Laboratory of Palaeobotany and Palynology, University Utrecht, August 1996] as they should be, according to the rules of the International Code of Zoological Nomenclature. Therefore we have to assume that they are lost and to designate neotypes for the above mentioned species.

All slides produced in the course of these studies are stored in the collections of the Geological Survey of Austria, Vienna, under the number 1997/1/1–6.

3.2. Systematic Part

- Group:** Chitinozoa EISENACK 1931
Order: Prosomatifera EISENACK 1972
Family: Lagenochitiniidae EISENACK 1931
Subfamily: Ancyrochitiniinae PARIS 1981
Genus: *Plectochitina* CRAMER 1964

Type species: *Plectochitina carminae* CRAMER 1964.

Remarks: The genus *Plectochitina* CRAMER 1964 is characterized by the anastomosing and/or by the cellular structure of its appendices.

It differs from *Clathrochitina* EISENACK 1959 mainly by its spongy processes. Moreover, according to the emended diagnoses of LAUFELD 1974 for *Clathrochitina*, the appendices of the latter genus are covered by a cingulum.

Anthochitina EISENACK 1971 has a wide carina of varying shape made of spongy tissue; it is either attached directly to the basal margin of the vesicle or it is linked to the vesicle by numerous short, radially arranged, spoke-like appendices of variable shape which also – at least distally – may be composed of cellular material.

From *Ancyrochitina* EISENACK 1955 *Plectochitina* is distinguished by the (in this case originally) cellular structure and the anastomosing of its processes. [According to F. PARIS (1997, pers. comm.) the spongy structure of the appendices of, for example, *Ancyrochitina fragilis* EISENACK 1955 is a secondary feature as it is the result of erosion and partial destruction of the hollow processes]. Additional discriminating characters for species of *Plectochitina*, which do not display anastomoses, are the morphology of the spongy processes (e.g. long, broad, ribbon-like) and their occasional point of attachment aboralward from the basal margin, as well as their aboralward orientation.

The genus *Plectochitina* remains a rather heterogenous taxon as some of its species show a morphology that is considerably different from the type-species *P. carminae*. NESTOR (1994, p. 73) proposed the establishment of a new genus in order to separate species with strongly anastomosing appendices from those with simpler ones. I suggest that such a new genus should only comprise species without anastomosing processes, but with the other characters differentiating them from *Ancyrochitina* (see above).

At the moment the following species belong to *Plectochitina*:

- **?*P. articulatipelae* AL-AMERI 1989**
Cylindro-sphaeroidal vesicle with echinate ornamentation; 2 sets of relatively short processes at basal margin, each consisting of 2 cylindrical appendices which anastomose at their terminations in a bulbous joint.
Range: Pridoli.
Remark: this species is probably a junior synonym of *Plectochitina rosendae* CRAMER 1964.
- ***P. carminae* CRAMER 1964**
Cylindro-conical vesicle; six or more (according to SCHWEINEBERG [1987, p. 80] up to 15) processes at basal margin, long, intricately anastomosing and forming a star-like net.
Range: Ludlow?–Pridoli.
- **?*P. combazii* CRAMER 1967a**
Cylindro-conical vesicle; 12–24 relatively short processes at basal margin, forming 2–3 sets of simply anastomosing appendices.
Range: Llandovery.
Remark: this species is probably a junior synonym of *P. saharica* (TAUGOURDEAU 1962).
- ***P. concinna* (ACHAB 1978)**
Cylindro-conical vesicle; numerous processes at basal margin, connected at their tips and forming ogive-like sets of 2 or more relatively short, simple or multipode appendices.
Range: late Ashgill.
- ***P. fenestriculatae* AL-AMERI 1989**
Cylindro-sphaeroidal vesicle; 4–6 pairs of relatively long anastomosing fenestrate processes at basal margin; in each of the looping processes there are one or two fenestrae of about the same diameter as the width of the appendices.
Range: Pridoli.
- **?*P. filigrana* CRAMER & DIEZ 1978**
Cylindro-ovoidal vesicle; very short neck; a ring of up to 20 radially oriented appendage stems at basal margin; these stems distally support a concentric spongy cingulum.
Range: early Ludlow [in CRAMER & DIEZ (1978, p. 174)]; according to PARIS (1996, Text-Fig. 7, p. 538): late Ludfordian.
Remark: this species belongs to the genus *Anthochitina* EISENACK 1971.
- ***P. irregularis* CRAMER & DIEZ 1978**
Cylindro-conical vesicle; 10 and more relatively long processes at basal margin, slender and whip-like, variable in form and wall-composition; usually anastomosing in pairs or triplets, very rarely more appendices interconnected.
Range: late Lochkovian.
Remark: the "zipper-structure" mentioned by CRAMER & DIEZ 1978 is most probably a feature due to preservation.

- *P. jiangsuensis* GENG, GRAHN & QIAN 1987
Cylindro-conical vesicle; 25–30 processes at basal margin, short, simple or coalescent, connected in a ring with each other at the tips.
Range: Llandovery.
 - ?*P. longicornis* (TAUGOURDEAU & DE JEKHOWSKY 1960)
Cylindro-ovoidal vesicle; few processes situated aboralward of the basal margin, very long, relatively slender, ribbon-like.
Range (doubtful): zone 3 to 6 in TAUGOURDEAU & DE JEKHOWSKY 1960; according to PARIS (1981, Tab. 40, p. 357): Llandovery–Lochkovian.
Remark: this is a doubtful species as in the original material all processes of the figured specimens are broken.
 - *P. nodifera* (NESTOR 1980)
Cylindro-conical vesicle; 3–8 processes at basal margin, with nodular thickenings of uneven size in the long proximal part, unevenly branching in the distal part, some appendages with bi- or multipode bases are coalescing.
Range: Llandovery.
 - *P. nodosa* (TAUGOURDEAU & DE JEKHOWSKY 1960)
Cylindro-ovoidal vesicle; 2–4 processes at basal margin, very long, with a structure like a string of pearls.
Range (doubtful): zone 4 or 5 in TAUGOURDEAU & DE JEKHOWSKY 1960; according to PARIS (1981, Tab. 40, p. 357): upper Silurian or Lochkovian.
Remark: though in the original material the processes are broken their characteristic feature remains visible.
 - ?*P. obuti* NESTOR 1994
Cylindro-conical vesicle, granulate; 4–8 short, aborally curved, horn-shaped processes at basal margin; distal ends of processes may split.
Range: Wenlock.
Remark: this species probably belongs to *Ancyrochitina* EISENACK 1955.
 - *P. paraguayensis* WOOD & MILLER 1991
Cylindro-ovoidal to cylindro-sphaeroidal vesicle; 2–4 processes at basal margin, very long and broad, gently tapering, simple, aborally directed.
Range: Llandovery.
 - ?*P. pseudoagglutinans* (TAUGOURDEAU 1963)
Cylindro-conical to cylindro-ovoidal vesicle with minute nodules; neck long; 4–6 processes at basal margin, broad, long ? (frequently broken), not ramifying.
Range: Llandovery.
Remark: this is a doubtful species as in the original material all processes of the figured specimens appear to be broken. However, according to F. PARIS (1997, pers. comm.) a few specimens from the type-sample seem to have some appendices with distal connections.
 - *P. ralphi* NESTOR 1994
Cylindro-conical vesicle; 6–8 nodular, blunt, unbranched processes at basal margin; processes always curved in aboral direction.
Range: Llandovery.
 - *P. rosendae* CRAMER 1964
Cylindro-conical to cylindro-sphaeroidal vesicle; 3–7 (5) processes at basal margin, linked together thus forming a set of rings.
Range: Ludlow?–Pridoli.
 - *P. saharica* (TAUGOURDEAU 1962)
Cylindro-conical vesicle; 12–15 processes at basal margin, relatively short, slender, flexible, at their tips interconnected by a ring.
Range: Llandovery.
 - ?*P. spongiosa* (ACHAB 1977)
Cylindro-conical vesicle; 5–10 processes at basal margin, relatively short, thick, simple, occasionally two by two or even more connected at the distal parts of their appendages.
Range: Ashgill.
Remark: this species is regarded by some authors as a junior synonym of *Plectochitina sylvanica* (JENKINS 1970).
 - ?*P. striata* (TAUGOURDEAU 1963)
Cylindro-conical vesicle; processes at basal margin, short, thick, fragile (generally broken), probably bifurcate at the tips and simply anastomosing; neck occasionally with large, plump, anastomosing tubercules; vesicle with fine, regular, oblique striae.
Range: late Devonian.
Remark: assignment to *Plectochitina* CRAMER 1964 by CRAMER 1983, unpublished data. Moreover, this is a doubtful species as in the original material most of the processes of the figured specimens seem to be broken.
 - *P. sylvanica* (JENKINS 1970)
Cylindro-conical vesicle; 6–15 (8–12) processes at basal margin, relatively long, of uniform thickness and texture, commonly anastomosing, occasionally discrete for their full length and connected at their tips by a continuous ring.
Range: Ashgill.
 - ?*P. tapajonica* VAN BOECKEL 1967
Cylindro-ovoidal to cylindro-sphaeroidal vesicle; neck short, collarette broad; processes on the lateral flanks of the vesicle, anastomosed to the flanks, interweaving and producing a lacy framework, forming a single bulk at the end.
Range: late Frasnian.
Remark: this species is most probably not a *Plectochitina*; it is tentatively referred to *Muscochitina* PARIS 1981.
 - ?*P. taugourdeauii* CRAMER 1967a
Cylindro-piriform to cylindro-ovoidal vesicle; 2–7 processes at basal margin, thick, fragile and broken, therefore exact length and form not known.
Range: Llandovery–Wenlock.
Remark: this is a doubtful species as in the type material all processes are broken.
 - *P. vanoyenii* (CRAMER 1967a)
Cylindro-piriform vesicle; neck short; a ring of processes near the aboral pole, relatively long, hollow.
Range: Llandovery.
 - *P. variabilis* CRAMER & DIEZ 1978
Cylindro-piriform vesicle; 4–8 processes at basal margin, heteromorphic: plump, flatly tubular, tapering distally and ending in a round tip, or hollow at the base, solid distally, anastomosing two by two and sometimes more, very fragile.
Range: Pridoli–lower Lochkovian.
- In sample 0813, the genus *Plectochitina* is represented by the species *P. carminae* CRAMER 1964 and *P. rosendae* CRAMER 1964.

***Plectochitina carminae* CRAMER 1964**

(Pl. 1, Fig. 1, 7; Pl. 2, Fig. 1; Pl. 3, Fig. 1, 7;
Pl. 4, Fig. 1, 7, 8; Pl. 5, Fig. 1, 2, 6)

- 1960 *Clathrochitina* ? sp. 1. – TAUGOURDEAU & DE JEKOWSKY: 1222; Pl. 2, Fig. 32.
1964 *Plectochitina carminae* n.sp. – CRAMER: 346; Fig. 49; Pl. 20, Fig. 19, 21.
1967a *Plectochitina carminae*. – CRAMER: 123; Pl. 5, Fig. 145, 146.
1967c *Plectochitina carminae*. – CRAMER: Pl. 4, Fig. 75, 82.
1978 *Plectochitina carminae*. – CRAMER & DIEZ: 173; Pl. 1, Fig. 13.
1986 *Plectochitina carminae*. – JAGLIN: 44.
1987 *Plectochitina carminae*. – BOUMENDJEL: 97; Pl. 4, Fig. 1, 4, 7.
1987 *Plectochitina carminae*. – SCHWEINEBERG: 80; Fig. 22; Pl. 12, Fig. 3, 4, 12.
1989 *Plectochitina carminae*. – AL-AMERI: Pl. 4, Fig. 86, 87.
1989 *Plectochitina carminae*. – PARIS: 284; Fig. 174.

Holotype: CRAMER 1964, Pl. 20, Fig. 21; lost.

Neotype: Pl. 2, Fig. 1; Pl. 4, Fig. 1, 7, 8; this work [slide 1997/1/1; Engländerfinder: M. 35. 3].

Type stratum: Uppermost shale-intercalation [sample 0813 in CRAMER (1964, Fig. 6)] in the upper part of the San Pedro Formation, La Vid de Gordón section, Cantabrian Mountains, Spain.

Remarks: *P. carminae* CRAMER 1964 is common in sample 0813 (9 % of the total number of individuals).

One specimen (Pl. 3, Fig. 1; Pl. 5, Fig. 1) shows remarkably shorter processes than the average while the vesicle is of normal size. But as in only 38 % of the specimens the appendices are more or less completely preserved it is impossible to estimate the actual variability of the process length in this sample.

SEM-investigations could not clarify the nature of the processes' distal cellular parts. However, the differentiation of the processes into a proximal solid part with a stiff and smooth aspect, and a distal part of soft spongy tissue is clearly visible under the SEM. In a tilted position the partitions between the cells can be observed as small ridges tracing through the thin wall of the distal portions of the processes (Pl. 4, Fig. 1). The solid structure, usually restricted to the basal parts, can extend over about 2/3 of the total process length (Pl. 3, Fig. 7).

Specimens with completely preserved appendices sometimes show a special preservation: because of

the extensive net formed by their processes they obviously settled in a more or less upright position and became compressed in (or obliquely to) the direction of their long axes. For that reason, under the light-microscope it is often difficult to recognize the degree of the vesicles' flattening. Therefore the flattening has not been corrected for the representatives of *P. carminae*.

Discussion: Although in CRAMER & DIEZ (1978, p. 173) *P. carminae* is said to range from the upper part of Zone 9 through Zone 11 (middle Ludlow to lower Gedinian) it is most probably a species of the upper Silurian only. SCHWEINEBERG (1987, p. 80) reports it from the questionable Ludlowian to the Pridolian part of his sections and emphasizes CRAMER & DIEZ 1978's doubts concerning the long range of *P. carminae* in MAGLOIRE (1967, Tab. 3) (middle Llandovery to lower Lochkovian). According to PARIS (1989, p. 284) it is a typical Pridoli species of the Northern Gondwana realm which can start in the upper Ludlow in Spain [in PARIS (1989, Fig. 174): uppermost Ludlow to the middle part of the Pridoli].

***Plectochitina rosendae* CRAMER 1964**

(Pl. 4, Fig. 3)

- 1964 *Plectochitina rosendae* n.sp. – CRAMER: 347; Fig. 48; Pl. 29, Fig. 7.
1967a *Plectochitina rosendae*. – CRAMER: 125; Pl. 5, Fig. 139.
1973 *Plectochitina rosendae*-Complex. – CRAMER: 282; Pl. 1, Fig. 13–15, 19, 20, non Fig. 7, 18, 21, 22, 24–28.
1975 *Clathrochitina rosendae*. – RAUSCHER & ROBARDET: 84; Pl. 9, Fig. 3.
1978 *Plectochitina rosendae*. – CRAMER & DIEZ: 174.

Holotype: CRAMER 1964, Pl. 20, Fig. 7; lost.

Neotype: Pl. 4, Fig. 3 (LM-photo); this work [slide 1997/1/3; Engländerfinder: N. 37. 4].

Type stratum: Uppermost shale-intercalation [sample 0813 in CRAMER (1964, Fig. 6)] in the upper part of the San Pedro Formation, La Vid de Gordón section, Cantabrian Mountains, Spain.

Remarks: Only one single specimen of *P. rosendae* was available, which unfortunately was embedded in a permanent slide before SEM-investigation.

Table 1.

Measurements of 17 more or less flattened and partly broken specimens of *P. carminae*.

*) Specimen (Pl. 3, Fig. 1) with conspicuous shorter processes.

**) Measurements of the neotype's vesicle not possible because of its upright position on the slide and its compression in the direction of the symmetry axis.

L (8 specimens):	124-153μ (131μ*)	mean: 138μ	neotype: - **)
D (13 specimens):	85-104μ (79μ)	mean: 93μ	neotype: - **)
l.neck (10 specimens):	36-64μ (59μ)	mean: 50μ	neotype: - **)
d.neck (11 specimens):	41-59μ (45μ)	mean: 46μ	neotype: - **)
d.apert (9 specimens):	34-48μ (38μ)	mean: 40μ	neotype: 39μ
l.proc (7 specimens):	126-162μ (63μ)	mean: 147μ	neotype: 153μ
L/D (8 specimens):	1,3-1,7 (1,7)	mean: 1,5	neotype: - **)

Table 2.
Measurements of *P. rosendae*.

L:	D:	l.neck:	d.neck:	d.apert:	l.proc:	L/D:
142μ	72μ	60μ	29μ	39μ	54μ	2

Order: Operculatifera EISENACK 1972
Family: Desmochitinidae EISENACK 1931
Subfamily: ?Pterochitinae PARIS 1981
Genus: *Pseudoclathrochitina*
CRAMER 1967, emend.

Type species: *Clathrochitina carmenchui* CRAMER 1964.

Remarks: Detailed SEM-investigations of the type material of the type-species of *Pseudoclathrochitina* revealed morphological features that differ considerably from the original description of the genus. Therefore the definition of *Pseudoclathrochitina* CRAMER 1967 has to be emended.

Emended diagnosis: Chamber conical to club-shaped; flanks straight to concave; flexure and shoulder not or weakly developed; basal margin rounded; base flat to slightly convex or concave, provided with an aboral mark. Chamber terminated by a cylindrical or aborally flaring collarete of variable length and width; apertural rim straight or sculptured; operculum close to the aperture at the base of the collarete. Vesicle wall consisting of two layers; outer layer forming an irregular reticulate network that may cover the whole vesicle from the collarete to the centre of the bottom; around the basal margin it is slightly inflated to a three-dimensional meshwork. Near the margin this meshwork is supported by short, tiny pillars erected perpendicularly to the wall; when it is eroded, only the scars of the pillars are visible. Rarely forming short chains (twins of vesicles observed).

Discussion: The here found main differences to the description of *Pseudoclathrochitina* in CRAMER 1967b, which was based on observations under transmitting light microscope only, concern the structure and the location of the periderre.

At present only two species belong to this genus: *P. carmenchui* (CRAMER 1964) and *P. sharawraensis* AL HAJRI & PARIS 1997. While the type-species distinctly shows the three dimensional meshwork around the basal margin and its continuation to the bottom of the vesicle (see Pl. 1, Fig. 2, 6; Pl. 3, Fig. 2, 4), this feature is less clear in *P. sharawraensis*. In the description of their new species the authors mention a perforate or laciniate carina, extending anteaperturalward and which in a few individuals can reach a considerable length (close to the chamber length). The figured specimens are all flattened and their carinae without exception damaged. The reported length of the carina might therefore be the result of rolling out by flattening processes (see also under "Remarks" of *P. carmenchui*). On the front side of the basal margin of the holotype of *P. sharawraensis* however, part of the three-dimensional meshwork and its turning-down to the bottom seems to be preserved.

SCHWEINEBERG (1967, p. 43) already discussed CRAMER 1967's non-defined term "oral mucron" and interpreted it as a circular structure on the operculum of the type-species, which is the point scar of tearing off of the preceding vesicle's mucron.

Due to the structure of its periderre *Pseudoclathrochitina* CRAMER 1967 does neither fit into the subfamily Pterochitinae PARIS 1981 which by definition has a more or less smooth surface, a membranous carina and a solid intervesicle linkage, nor does it fit into the subfamily Eisenackitinae PARIS 1981, where the ornamentation is made of cones, spines or hairs. The establishment of a

new subfamily for this genus and probably also for those representatives of the genus *Eisenackitina* JANSONIUS 1964 which display a spongy periderre (see under "Discussion" of *P. carmenchui*) seems to be necessary. Until more relevant information is available *Pseudoclathrochitina* shall be tentatively retained in the subfamily Pterochitinae.

***Pseudoclathrochitina carmenchui* (CRAMER 1964),
emend.**

(Pl. 1, Fig. 2, 4–6; Pl. 2, Fig. 6, 7; Pl. 3, Fig. 2, 4–6;
Pl. 4, Fig. 2; Pl. 5, Fig. 3–5, 7–9)

- 1964 *Clathrochitina carmenchui* n.sp. – CRAMER: 346; Pl. 22, Fig. 8, 9, 10; Pl. 24, Fig. 18.
1966 *Pogonochitina carmenchui*. – TAUGOURDEAU: 35.
1967a *Pseudoclathrochitina carmenchuae*. – CRAMER: 94; Pl. 3, Fig. 61, 66.
1967b *Pseudoclathrochitina carmenchuae*. – CRAMER: 45–52.
1967c *Clathrochitina carmenchuae*. – CRAMER: 236.
1974 *Pseudoclathrochitina carmenchui*. – DIEZ & CRAMER: 10; Pl. 1, Fig. 3–6, 10, 11, 15, 16; Pl. 2, Fig. 1–7; Pl. 3, Fig. 6, 9.
1978 *Pseudoclathrochitina carmenchui*. – CRAMER & DIEZ: 175; Pl. 9, Fig. 5–8.
1985 *Pseudoclathrochitina carmenchui*. – JAGLIN & MASSA: 262.
1986 *Pseudoclathrochitina carmenchui*. – JAGLIN: 45.
1987 *Pseudoclathrochitina carmenchui*. – BOUMENDJEL: 69; Pl. 7, Fig. 3–9; Pl. 13, Fig. 1, 10.
1987 *Pseudoclathrochitina* cf. *carmenchui*. – SCHWEINEBERG: 43; Pl. 9, Fig. 1–6.
1989 *Pseudoclathrochitina carmenchui*. – PARIS: 284; Fig. 175: i.
1992 *Pseudoclathrochitina carmenchui*. – JAGLIN & PARIS: 155; Fig. 4: A, C.
1995 *Pseudoclathrochitina carmenchui*. – VERNIERS et al.: 663.
1996 *Pseudoclathrochitina carmenchui*. – PARIS: Pl. 2, Fig. 2.

Holotype: CRAMER 1964, Pl. 24, Fig. 18; lost.

Neotype: Pl. 1, Fig. 2, 6; Pl. 5, Fig. 8; this work [slide 1997/1/2; Englandfinder: L. 39. 3].

Type stratum: Uppermost shale-intercalation [sample 0813 in CRAMER (1964, Fig. 6)] in the upper part of the San Pedro Formation, La Vid de Gordón section, Cantabrian Mountains, Spain.

In sample 0813, from where the holotype of *P. carmenchui* was derived (see under "Discussion"), this taxon is the secondmost frequent one (16 %).

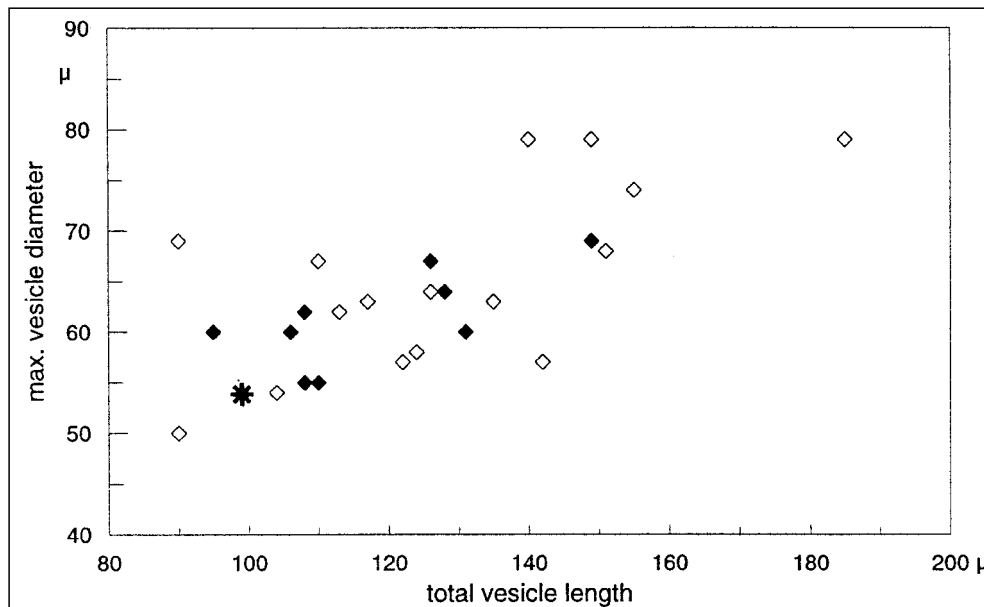
During the recent SEM-studies, the construction of the periderre, the characteristic feature of this species, was found to be quite different from all the descriptions hitherto given in the literature. Therefore it is necessary to emend the definition of *Pseudoclathrochitina carmenchui* (CRAMER 1964).

Emended diagnosis: Chamber conical, terminated by a collarete; flanks straight to concave; flexure and shoulder not or weakly developed; basal margin broadly rounded; bottom more or less flat; very short mucron present; collarete of variable length, wide and cylindrical, or narrow and flaring; apertural rim straight or dentate; operculum close to the aperture. Vesicle wall consisting of two layers; outer layer forming an irregular reticulate network covering the vesicle from the collarete to the bottom; around the basal margin it is slightly inflated to a three-dimensional sponge-like meshwork, which is supported by short, tiny pillars erected perpendicularly to the wall.

Rarely forming short chains (twins of vesicles observed).

Description: The species is extremely variable concerning its size, shape and the development of its outer layer.

Text-Fig. 1.
Variation of the vesicle length in proportion to the vesicle diameter among *P. carmenchui* (26 measurements).
star = neotype; black rhombs = specimens with long, cylindrical collarettes.



The shape of the vesicle is determined to a high degree by the shape of the collarette: in most cases it is short with a narrow base, flaring more or less strongly oralward. The minority of the individuals show a wide cylindrical collarette of variable, sometimes considerable length which grades into the conical chamber.

The flanks are straight to concave, depending upon the position of the greatest diameter of the vesicle which can be situated in the section between the basal margin and the middle part of the chamber length. In most cases the flexure and the shoulder are missing, only in a few specimens they are weakly developed. The basal margin is broadly rounded, the bottom more or less flat (the latter feature is difficult to estimate because of the flattening of the vesicles). A very short mucron with a small central depression is present on the base.

The apertural rim is straight to dentate. An operculum with a short flange in aboral and oral direction is situated close to the aperture at the base of the collarette.

The vesicle wall is made up of two layers. The ectoderme is relatively thick (2 μ), smooth or with minor sculpture of low, short rugae. The periderme forms an irregular reticulate network that covers the entire vesicle from the collarette to the centre of the bottom [however, according to F. PARIS (1997, pers. comm.) in some Libyan and Algerian representatives of *P. carmenchui* this reticulate outer layer is only visible around the basal margin]. On the aboralmost part of the vesicle and around the broad basal margin it is slightly inflated to a three-dimensional meshwork with the holes in at least two planes. Here the meshwork is supported by short, tiny pillars erected perpendicularly to the wall; when it is eroded, only the scars of the pillars are visible (Pl. 3, Fig. 2). Oralward the mesh-like structure becomes rapidly thinner and finally forms a fine net. In many cases this reticulum fades out into more or less connected wrinkles. Aboralward the meshwork (Pl. 1, Fig. 2, 6; Pl. 2, Fig. 6, 7; Pl. 3, Fig. 2, 4) continues to the bottom: here over a very short distance it grades into a delicate net that

continues to the centre as fine wrinkles and/or granulae (Pl. 1, Fig. 2, 6).

The structure of the meshwork enveloping the basal margin is diverse and irregular, the size and shape of the holes and bars vary considerably within one specimen and especially from specimen to specimen: they range from tiny to small holes bordered by broad bars (Pl. 3, Fig. 5, 6) to huge meshes surrounded by predominantly slender rods (Pl. 3, Fig. 2, 4).

Very rarely individuals of *P. carmenchui* can be found in short chains (twins of vesicles observed by F. PARIS [1996, pers. comm.]).

Remarks: The impression of a "perforated cingulum" as the periderme's aboral extension over the vesicle's basal margin, which was originally defined by CRAMER 1964 after investigations under the transmitting light-microscope, is caused by optical delusion due to the flattening of the vesicles.

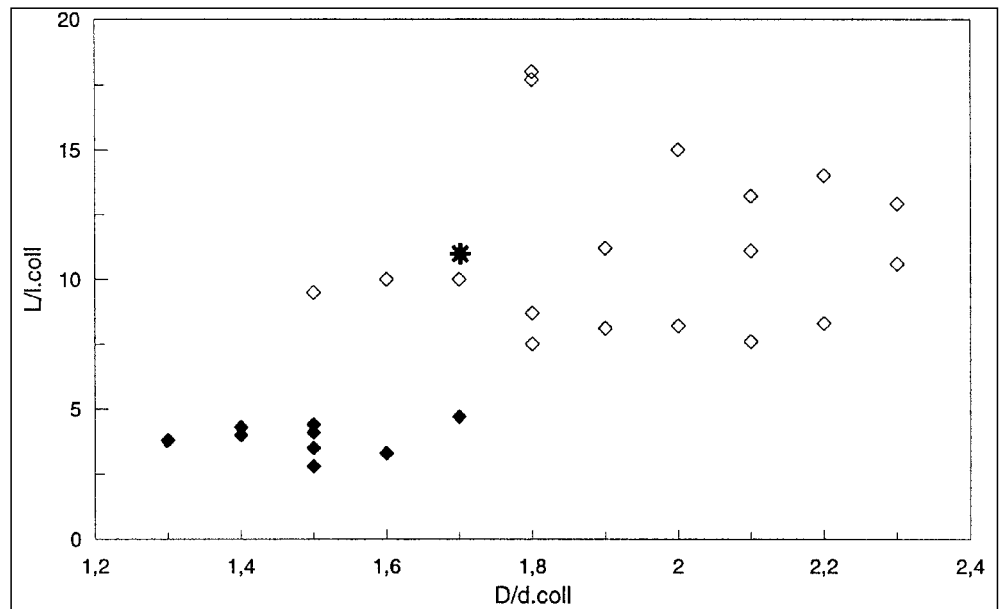
When the specimens of *P. carmenchui* are more or less three-dimensionally preserved, under the light-microscope the periderme around the basal margin looks like a very short perforated cingulum.

When they are compressed, the originally inflated meshwork covering the basal margin becomes rolled out and thinned and more or less lengthened in the aboral direction. Furthermore the points of attachment of the network on the bottom seem to be rather weak and to tear off easily. This part of the periderme may then become more or less straightened in the aboral direction (Pl. 1, Fig. 2, 6; Pl. 2, Fig. 6, 7; Pl. 3, Fig. 2, 4). The above examples result in structures with the appearance of irregularly perforated monolayered keels of variable length.

Table 3.
Measurements of 26 completely preserved, but flattened specimens of *P. carmenchui*.
Flattening corrected for D, d. coll and d. apert (coefficient: 0,7).
In parenthesis the measurements without correction.

L:	90 - 185μ	mean: 126μ	neotype: 99μ
D:	54 - 79μ (78-113μ)	mean: 64μ (92μ)	neotype: 54μ (77μ)
d.coll:	25 - 49μ (36-70μ)	mean: 37μ (52μ)	neotype: 32μ (45μ)
d.apert:	29 - 50μ (43-71μ)	mean: 37μ (53μ)	neotype: 35μ (50μ)
l.coll:	7 - 43μ	mean: 19μ	neotype: 9μ
L / D:	1,3 - 2,3 (1-1,8)	mean: 2 (1,4)	neotype: 1,8 (1,3)
D / d.coll:	1,3 - 2,3	mean: 1,8	neotype: 1,7
L / l.coll:	2,8 - 18	mean: 8,7	neotype: 11,0

Text-Fig. 2.
Variation of the ratio vesicle length: length of the collarette in proportion to the ratio vesicle diameter: diameter of the base of the collarette among *P. carmenchui* (26 measurements).
star = neotype; black rhombs = specimens with long, cylindrical collarettes.



It is not clear if the wrinkles on the oral parts of the vesicles are a normal morphologic variation in the development of the periderre or the product of corrosion of a former reticulum.

Moreover the periderre can have been totally removed. Then only traces (tiny wrinkles, granulae) of the network are left (Pl. 1, Fig. 4, 5). Under the light-microscope they can be seen clearly on the flanks of even completely opaque specimens and thus allow a positive identification of the taxon.

In the studied assemblage of *P. carmenchui* the majority of the specimens (a little more than two thirds) display slightly inflated conical chambers terminated by short flaring collarettes with relatively narrow bases (length of the flaring collarettes: 7–20 μ). In the rest the chambers grade into broad, cylindrical, neck-like collarettes (length of the cylindrical collarettes: 25–43 μ).

Concerning the variations of the vesicles' dimensions, Text-Fig. 1 shows a normal distribution of the specimens, including those with a long cylindrical collarette. In Text-Fig. 2 on the other hand the specimens with long broad collarettes are clearly separated, but on the whole a continuous trend from long and broad to short and narrow collarettes is visible.

Discussion: The figured specimens of *P. carmenchui* in DIEZ & CRAMER 1974 have very similar shapes, but slightly greater sizes and seem to be more or less corroded. Only Fig. 3 and 5 on plate 2 show the compressed and slightly lengthened, but completely preserved meshwork of the periderre on the basal margin of the vesicle.

The representatives of *P. cf. carmenchui* in SCHWEINEBERG (1987, Pl. 9, Fig. 1–6) are less strongly flattened and probably therefore their shape is a little different from the individuals found here: in most cases their flanks are straight. Moreover they generally seem to be a little larger than in sample 0813.

The main difference is the development of the periderre: the reticulate network in *P. cf. carmenchui* is restricted to the very basal margin. But as far as it is possible to conclude from the photographs, the specimens in SCHWEINEBERG 1987 seem to be heavily corroded. However, Fig. 5a,b in plate 9 show clearly the sponge-like periderre enveloping the rounded basal margin and continuing to the bottom of the vesicle.

SCHWEINEBERG (1987, p. 43) already discussed DIEZ & CRAMER 1974's negation of an ornamentation on the bottoms of the vesicles [in D & C (1974, p. 12)] and also their negation of the presence of an aboral mark [in

D & C (1974, p. 10)]. Both features, observed by the former author, were confirmed during the investigations of sample 0813.

P. sharawraensis AL HAJRI & PARIS 1997 differs from *P. carmenchui* by its generally smaller size, the different shape of its vesicle due to the invariably wide and long collarette and by the lacinated and/or perforate apertural rim. The variable construction of the meshwork around the basal margin however is quite similar to that in *P. carmenchui*.

Eisenackitina varireticulata SWIRE 1990 and *E. spongiosa* SWIRE 1990 have similar sizes and shapes. Their periderre is made of a spongy meshwork like that enveloping the basal margin of *P. carmenchui*, which however, in the former taxa covers the whole vesicle.

A special problem, which also SCHWEINEBERG (1987, p. 44) dealt with, concerns the provenance of the holotype and the ranges of *P. carmenchui* given by CRAMER (1964, 1967a,b):

CRAMER 1964 (p. 346): "*Common in the upper part of the San Pedro Formation and the lower part of the La Vid Carbonate Member. Holotype from 0814, La Vid de Gordón, NW-Spain*".

[Sample 0814 is from the lower part of the La Vid Carbonate Member – see Fig. 6 in CRAMER 1964].

CRAMER 1967a (p. 94): "*Previous records. – Clathrochitina carmenchui, in CRAMER, 1964 – Holotype and three additional specimens figured and described from the upper part of the San Pedro Formation (Ludlovian, part, to basal Lower Gedinnian) of the Cantabrian Mountains in NW Spain*".

[Unfortunately the stratigraphical distribution of *P. carmenchui* at the La Vid de Gordón locality (Fig. 2) is not indicated].

CRAMER 1967b (p. 46): "*The species is a common constituent of certain samples of the upper part of the San Pedro Formation (Ludlovian to probably, basal Lower Gedinnian), León, Spain*".

Apart from CRAMER 1964, *P. carmenchui* has not been reported from the La Vid Carbonate Member or from series of an equivalent age.

In VERNIERS et al. (1995, Fig. 2) the taxon, which is a typical species of the Northern Gondwana realm, ranges from the base of the *Margachitina elegans*-biozone to the

lower part of the *Anthochitina superba*-biozone (middle to upper part of the Pridoli). The base of the *M. elegans*-biozone was defined by VERNIERS et al. (1995, p. 663) by the first occurrence of the index-species in the Oued Saret (OS-1) borehole (–2287 m), Oued Mehaiguène Formation, Algeria (BOUMENDJEL 1987), where also *P. carmenchui* appears. As well as *Urnochitina urna* (EISENACK 1934), *Eisenackitina filifera* (EISENACK 1931) and *Pterochitina perivelata* (EISENACK 1937), it is mentioned as an important accompanying species of the index-species in this biozone. The base of the subsequent *A. superba*-biozone lies in the same borehole at –2068 m, still in the Oued Meahiguène Formation. Its top coincides with bed 21 at the global stratotype section at Klonk, Prague Basin, Bohemia – i.e., a very short distance above the Silurian/Devonian boundary. In the lower part of this biozone *P. carmenchui* disappears.

The topmost green shale intercalation in the San Pedro Formation seems to be the most favourable horizon for *P. carmenchui*: the numerous specimens figured in DIEZ & CRAMER 1974 came from it [p. 12: village of Felechas, Province of León], as does sample 0813 of this work [La Vid de Gordón-section, in CRAMER (1964, Fig. 6)]. It contains the best assemblage of *P. carmenchui* in this section (personal data).

From this and especially from CRAMER'S 1967a statement that the holotype originated from the upper part of the San Pedro Formation, I conclude that sample number 0814 was designated erroneously and that the holotype actually was derived from the next deeper sample (= 0813) in the section.

This assumption was confirmed by a personal communication of F.H. CRAMER in August 1996.

Subfamily: Margachitinae PARIS 1981

Genus: *Urnochitina* PARIS 1981

Type species: *Desmochitina ? urna* EISENACK 1934.

Urnochitina urna (EISENACK 1934)

(Pl. 1, Fig. 8, 9; Pl. 2, Fig. 2, 3, 5; Pl. 4, Fig. 4–6)

Synonymy: cf. PARIS 1981, p. 153.

1980 *Eisenackitina* cf. *urna*. – WRONA: 142; Pl. 31, Fig. 1–7.

1982 *Urnochitina urna*. – DE BOCK: 855; Pl. 2, Fig. 5–19.

1982 *Urnochitina urna*. – PARIS in KŘIŽ & PARIS: 394.

1986 *Urnochitina urna*. – JAGLIN: 45.

1986 *Urnochitina urna*. – PARIS: 55–60; Pl. 3, Fig. 3.

1986 *Urnochitina* gr. *urna*. – PARIS in KŘIŽ et al.: 338; Pl. 6, Fig. 8, 10.

1987 *Urnochitina urna*. – BOUMENDJEL: Pl. 6, Fig. 8; Pl. 24, Fig. 1, 2, 4, 9.

1987 *Urnochitina urna*. – SCHWEINEBERG: 33; Pl. 10, Fig. 11, 12.

1987 *Kalochitina lorensis* n.sp. – SCHWEINEBERG: 37; Pl. 8, Fig. 5, ?6, 7a, b, 8.

1989 *Urnochitina urna*. – PARIS: 282; Fig. 175: L.

1991 *Urnochitina urna*. – PARIS in BALAISE et al.: 176; Pl. 2, Fig. 2, 7.

1992 *Urnochitina urna*. – PARIS & LE HÉRISSE: 20.

1992 *Urnochitina* gr. *urna*. – KŘIŽ: 44, 47, 48, 50, 51, 63, 89–93, 96; Pl. 3, Fig. 6.

1995 *Urnochitina urna*. – VERNIERS et al.: 663; Fig. 6: f.

1996 *Urnochitina urna*. – PARIS: Pl. 2, Fig. 1.

1996 *Urnochitina urna*. – PARIS & GRAHN: Pl. 1, Fig. 12.

Remarks: *Urnochitina urna* (EISENACK 1934), a cosmopolitan species indicative for the Pridoli, is a common constituent (8 %) of the chitinozoan assemblage of sample 0813.

In his original diagnosis for the species, EISENACK (1934, p. 70) stated a smooth vesicle surface, while PARIS in

DEGARDIN & PARIS (1978, p. 773) reported a felt-like to spongy structure of the periderre after SEM-investigations of specimens from the type locality.

In sample 0813 *U. urna* shows a completely smooth (Pl. 2, Fig. 3) or a sculptured surface. At low magnifications the latter has either a rough appearance (Pl. 2, Fig. 5, aboral part of the vesicle) or tiny wrinkles seem to converge forming small pillars at the points of their fusion (Pl. 1, Fig. 8).

Only at relatively high magnifications is the true nature of this "ornamentation" visible: in Pl. 2, Fig. 2 at the bottom and at the basal margin of the vesicle the periderre has a rather dense and felt-like appearance which becomes more and more spongy oralward. The upper part of the photograph already shows a coarse spongy structure. In Pl. 1, Fig. 9 the corrosion of the outer layer is even more advanced: only the very basal part of the coarse spongy periderre is left.

The new species *Kalochitina lorensis* in SCHWEINEBERG (1987, p. 37) which was derived from the Pridolian part of the investigated sections, seems to be an *U. urna* with a corroded outer layer. Shape and size are very close to those for the representatives of *U. urna* in sample 0813, although the specimens from Palencia do not show the typical peduncle, most probably as a result of their preservation. The high magnification of the ornamentation given in SCHWEINEBERG (1987, Pl. 8, Fig. 7b) shows an identical structure with the one of *U. urna* in Pl. 2, Fig. 2 of this work, which however, is without doubt an effect of corrosion.

4. Conclusions

- In his publication of 1964, F.H. CRAMER did not mention the composition of the chitinozoan assemblage of sample 0813. However, the association of this sample in CRAMER (1967a, Fig. 2) shows some differences to the one discussed in this work. In addition to the species found here, the author also cited questionable *Ancyrochitina fragilis* EISENACK 1955, *A. fragilis regularis* TAUGOURDEAU & DE JEKHOWSKY 1960, "*Desmochitina*" *leonensis* CRAMER 1964 and questionable *Plectochitina pseudoagglutinans* (TAUGOURDEAU 1963), while *Ancyrochitina brevis* TAUGOURDEAU & DE JEKHOWSKY 1960 and *Pseudoclathrochitina carmenchui* (CRAMER 1964) were missing. This discrepancy could be explained by different quantities of the processed sample and/or by an error in the drawing of the La Vid de Gordón-section.
- The present study of the type-species of the important, mainly Silurian genera *Plectochitina* CRAMER 1964 and *Pseudoclathrochitina* CRAMER 1967 from the type-material under the Scanning Electron Microscope led to varying results: while no new knowledge on *Plectochitina* could be gathered, the morphology of *Pseudoclathrochitina* was found to be so different from the original description, that probably a new subfamily has to be created to include this genus.
- Furthermore, the actual type-stratum of *P. carmenchui* may be established: it is not the lower part of the La Vid Carbonate Member as cited in CRAMER (1964, p. 346) but the uppermost shale-intercalation in the upper part of the San Pedro Formation [sample 0813 in CRAMER (1964, Fig. 6)].
- The chitinozoan assemblage of sample 0813, which was derived from about 10 m below the boundary between the San Pedro Formation and the La Vid Carbonate Member allows an exact age determination: the

presence of *Margachitina elegans* (TAUGOURDEAU & DE JE-KHOWSKY 1960) and the absence of *Anthochitina superba* EISENACK 1971, the index-species of the subsequent biozone, suggest the *Margachitina elegans*-biozone [VERNIERS et al. 1995 (p. 663)], even though two important species of this biozone, *Pterochitina perivelata* (EISENACK 1937) and *Eisenackitina filifera* (EISENACK 1931), are missing. The *M. elegans*-biozone is indicative for the middle part of the Pridoli. The remaining species of the chitinozoan assemblage of sample 0813 are in accordance with this age. Thus the San Pedro Formation probably does not extend into the Lochkovian.

Acknowledgements

The Austrian Science Foundation and the Geological Survey of Austria, Vienna, made the purchase of F.H. CRAMER'S collection possible.

Dr. Florentin PARIS, University of Rennes, France, suggested the subject of this work; he enabled me to stay in his laboratory, made the SEM-photographs and read the manuscript. I want to thank him sincerely for his assistance.

Plate 1

Plectochitina carminae CRAMER 1964.

Fig. 1: Slide 1997/1/1, EF (= England Finder): M.33.3.
× 320.

Fig. 7: Detail of the processes in Fig. 1.
× 1250.

Pseudoclathrochitina carmenchui (CRAMER 1964).

Fig. 2: Detail of Fig. 6.
Coarse three-dimensional meshwork of the periderre surrounding the basal margin, grading into a delicate net on the bottom of the chamber; short mucron present.
× 1000.

Fig. 4: Detail of the vesicle wall in Fig. 5.
Only traces of the removed periderre left.
× 1000.

Fig. 5: Slide 1997/1/2, EF: P.38.
× 420.

Fig. 6: Neotype.
Slide 1997/1/2, EF: L.39.3.
× 570.

Cingulochitina sp.

Fig. 3: Slide 1997/1/2, EF: Q.40.3.
× 400.

Urnochitina urna (EISENACK 1934).

Fig. 8: Slide 1997/1/1, EF: M.32.2.
× 420.

Fig. 9: Detail of Fig. 8.
Corrosion of the periderre.
× 1000.

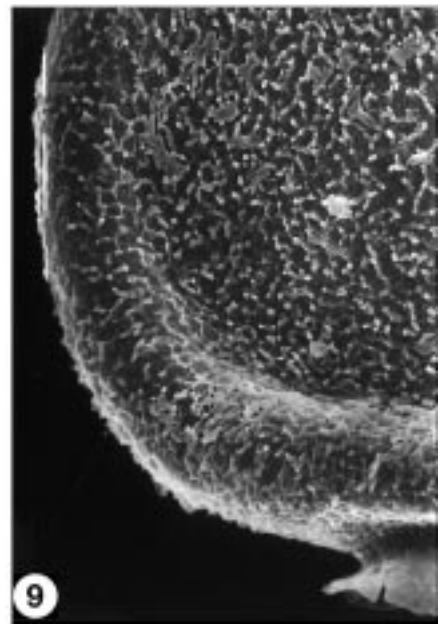
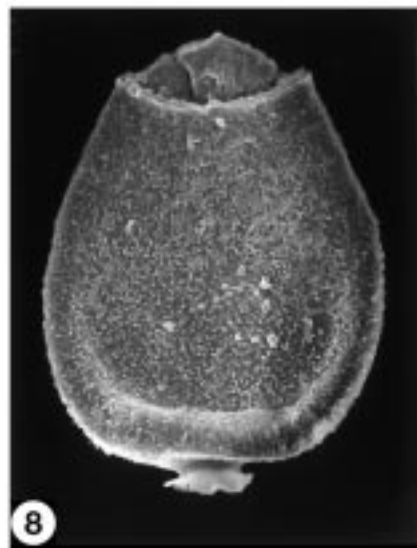
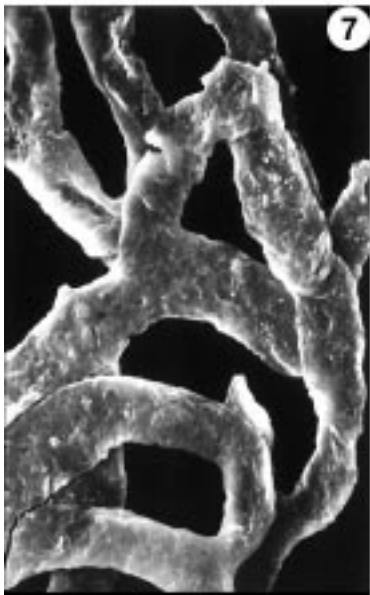
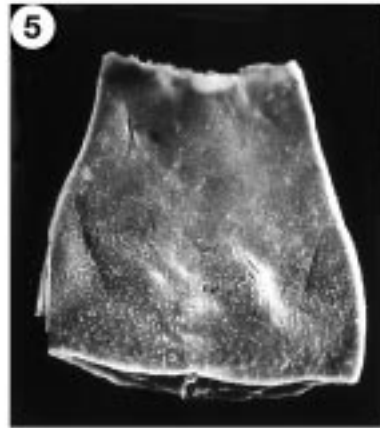
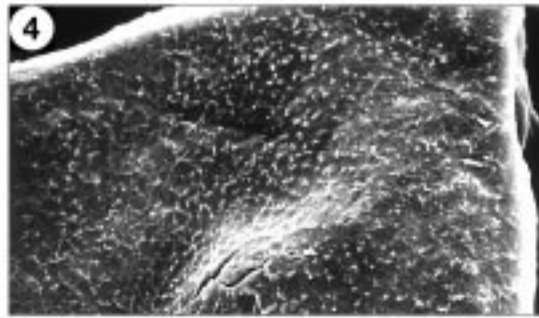
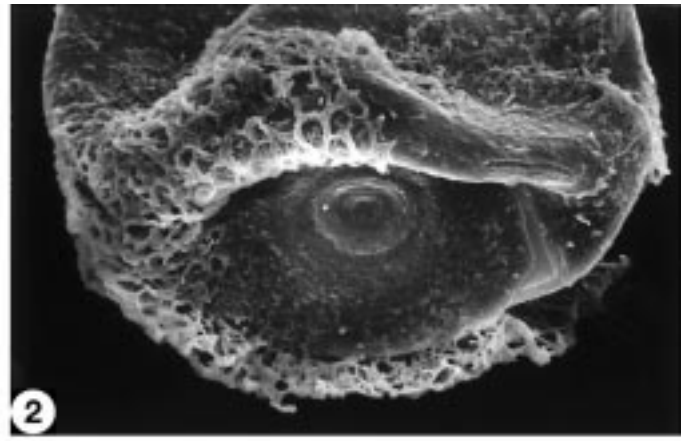
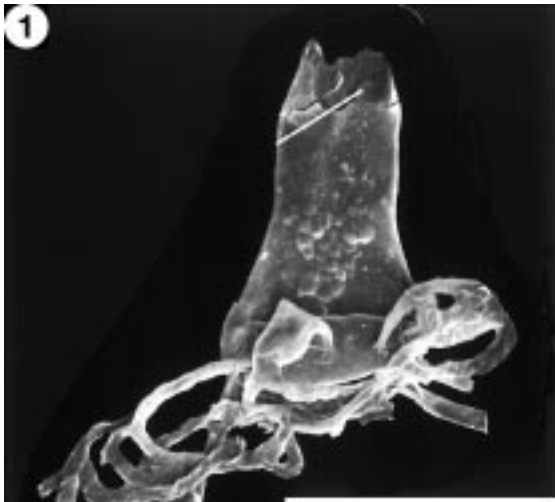


Plate 2

Plectochitina carminae CRAMER 1964.

Fig. 1: Neotype.
Slide 1997/1/1, EF: M.35.3.
× 300.

Urnochitina urna (EISENACK 1934).

Fig. 2: Detail of Fig. 5.
Corrosion of the periderre.
× 1000.

Fig. 3: Slide 1997/1/1, EF: L.35.1.
Smooth vesicle wall.
× 400.

Fig. 5: Slide 1997/1/1, EF: P.33.
× 420.

Linochitina sp.

Fig. 4: Slide 1997/1/2, EF: P.38.3.
× 400.

Pseudoclathrochitina carmenchui (CRAMER 1964).

Fig. 6: Detail of Fig. 7.
Three-dimensional meshwork of the periderre on the aboralmost part of the vesicle and around the basal margin (slightly compressed and lengthened) continuing to the bottom; meshes of medium size.
× 1000.

Fig. 7: Slide 1997/1/1, EF: Q.33.
× 500.

Ancyrochitina brevis TAUGOURDEAU & DE JEKHOWSKY 1960.

Fig. 8: Slide 1997/1/1, EF: P.38.1.
× 400.

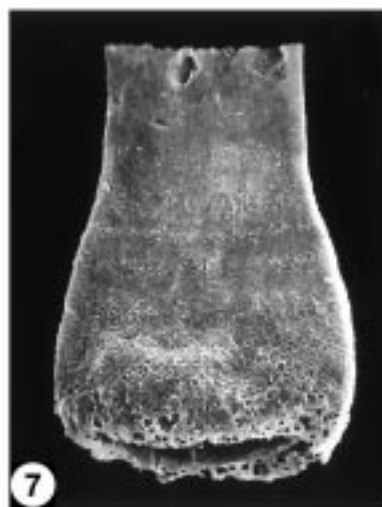
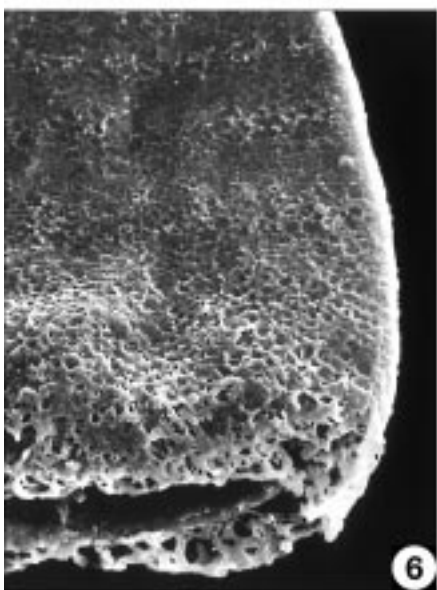
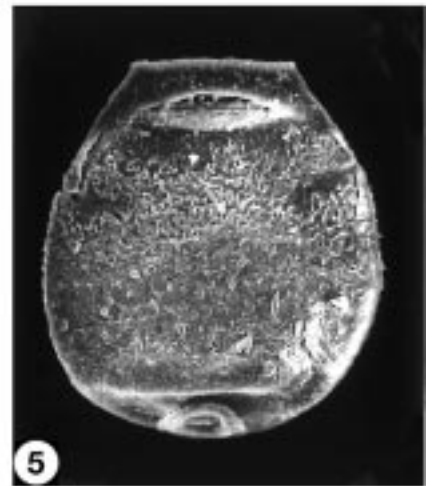
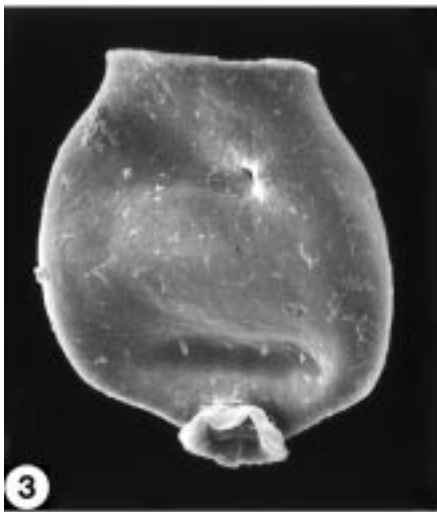
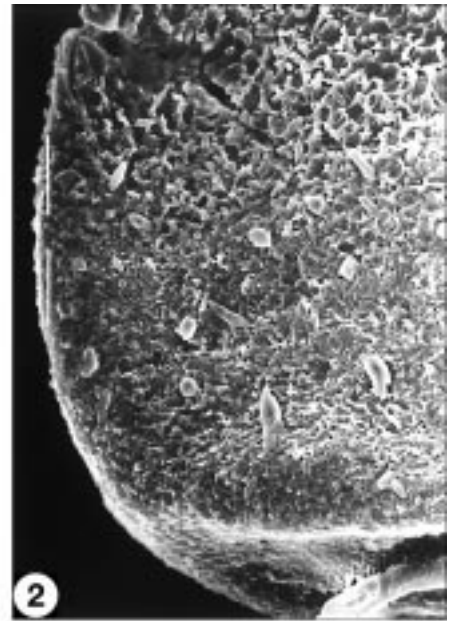
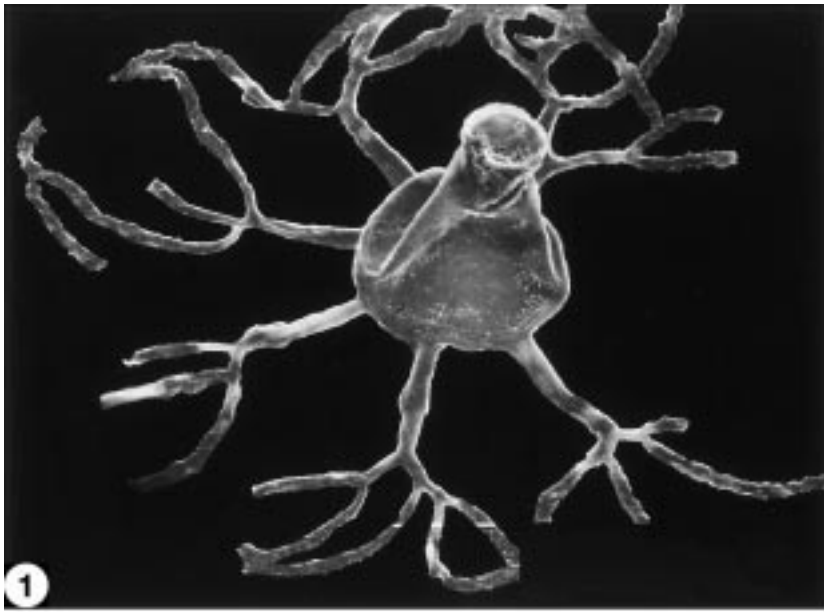


Plate 3

Plectochitina carminae CRAMER 1964.

Fig. 1: Slide 1997/1/2, EF: N.36.2.

Specimen with shorter processes than the average of the representatives of *P. carminae* in sample 0813.
× 330.

Fig. 7: Slide 1997/1/2, EF: K.39.3.

× 300.

Pseudoclathrochitina carmenchui (CRAMER 1964).

Fig. 2: Detail of Fig. 4.

Three-dimensional meshwork of the periderre enveloping the basal margin and continuing to the bottom of the vesicle; the meshes are coarse, the rods slender; part of the periderre is torn off from the bottom and lengthened in the aboral direction; small pillars which fix the meshwork to the ectoderre are visible on the inner wall-layer's outer surface facing the background.
× 1000.

Fig. 4: Slide 1997/1/2; EF: L.40.2.

× 560.

Fig. 5: Detail of Fig. 6.

Originally three-dimensional meshwork of the periderre on the aboralmost part of the vesicle and around the basal margin (compressed and slightly lengthened); meshes reduced to small holes.
× 900.

Fig. 6: Slide 1997/1/1, EF: L.37.3.

× 520.

Margachitina elegans (TAUGOURDEAU & DE JEKHOWSKY 1960).

Fig. 3: Slide 1997/1/1, EF: O.37.2.

× 300.

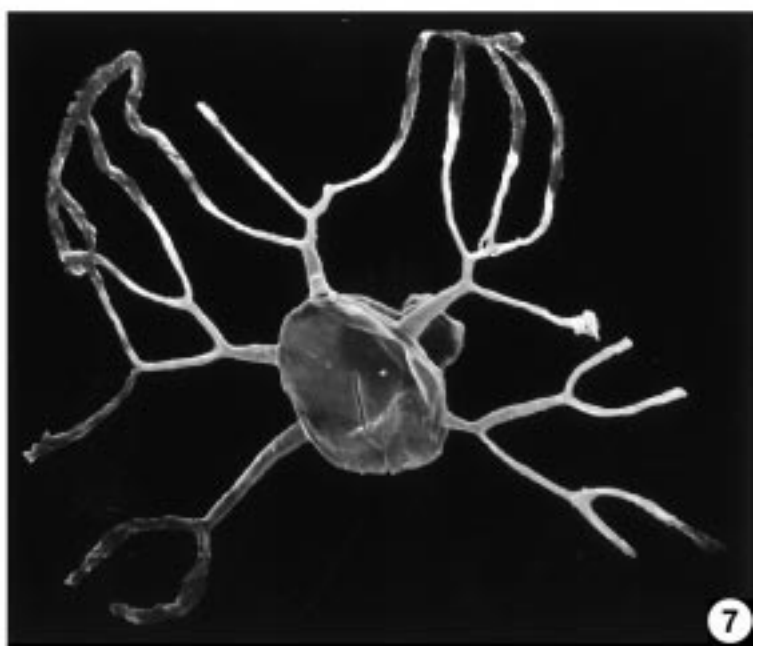
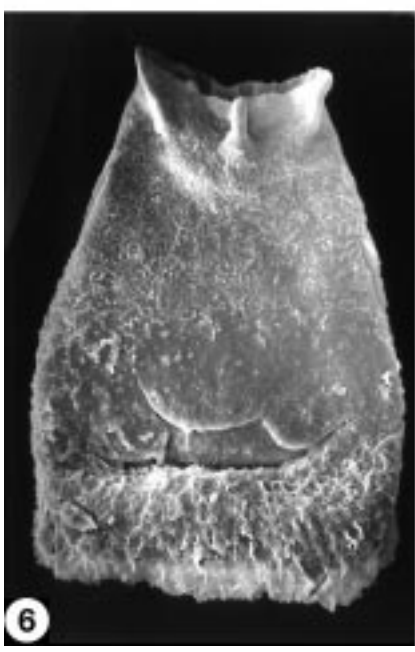
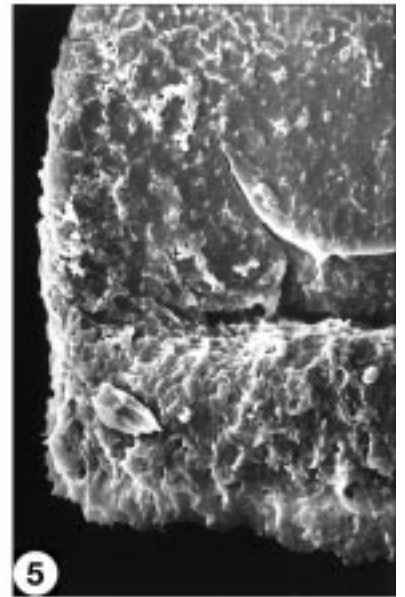
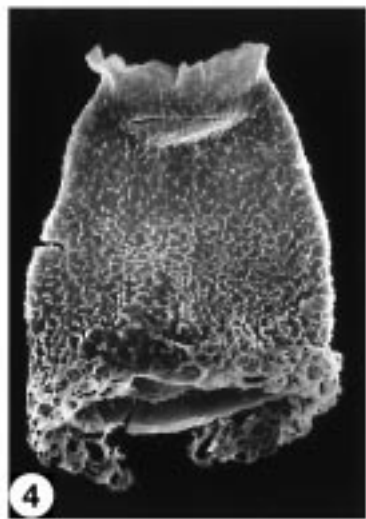
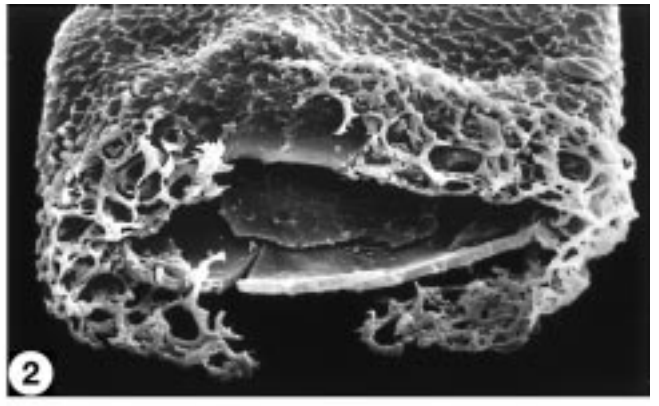
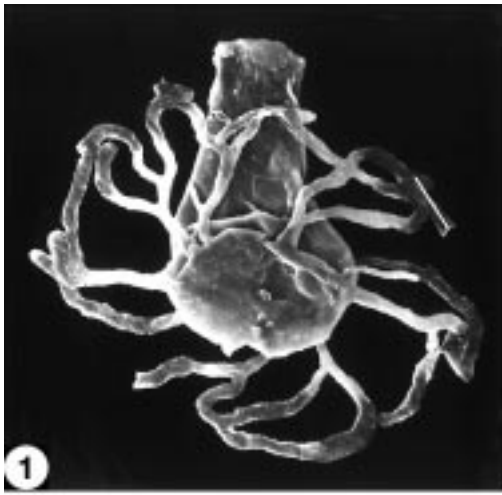


Plate 4

***Plectochitina carminae* CRAMER 1964.**

Fig. 1: Neotype (tilted specimen of Pl. 2, Fig. 1).

Slide 1997/1/1, EF: M.35.3.

In the distal parts of the processes partitions between the cells visible, tracing through the thin wall.

× 300.

Fig. 7: LM-(light microscope-)photo of Fig. 1.

× 300.

Fig. 8: Detail of the distal part of the processes in Fig. 7.

× 1200.

***Pseudoclathrochitina carmenchui* (CRAMER 1964).**

Fig. 2: LM-photo of the specimen on Pl. 3, Fig. 6.

× 300.

***Plectochitina rosendae* CRAMER 1964.**

Fig. 3: Neotype.

Slide 1997/1/3, EF: N.37.4.

× 300.

***Urnochitina urna* (EISENACK 1934).**

Fig. 4: LM-photo of the specimen on Pl. 1, Fig. 8.

× 300.

Fig. 5: LM-photo of the specimen on Pl. 2, Fig. 5.

× 300.

Fig. 6: LM-photo of the specimen on Pl. 2, Fig. 3.

× 300.

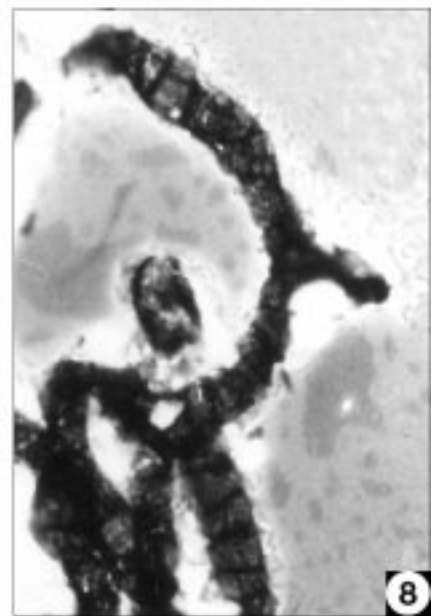
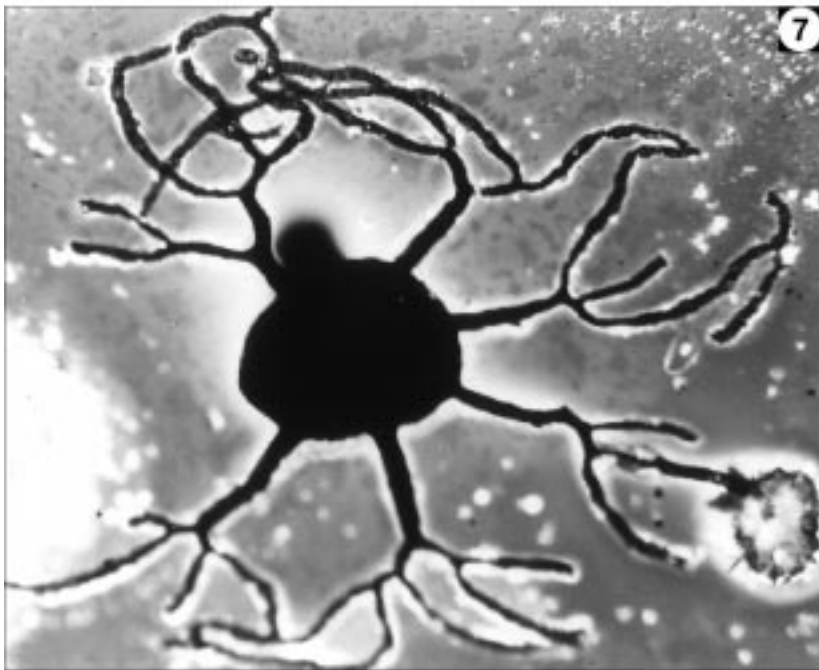
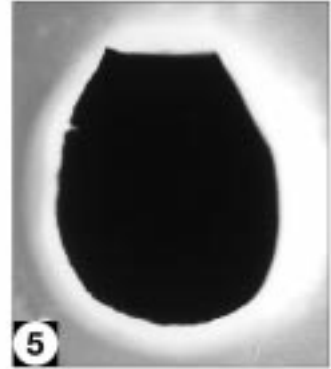
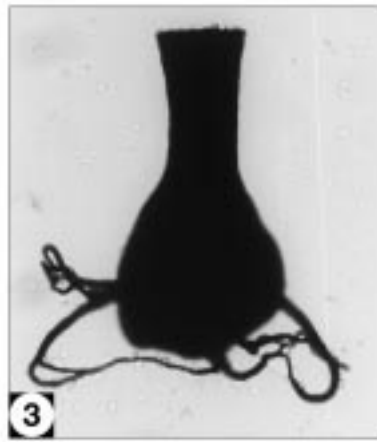
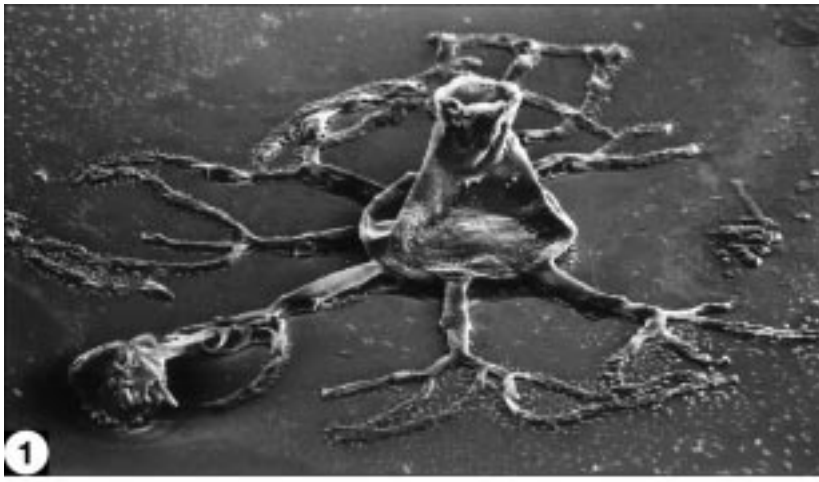


Plate 5

Plectochitina carminae CRAMER 1964.

Fig. 1: LM-photo of the specimen on Pl. 3, Fig. 1.
× 300.

Fig. 2: LM-photo of the specimen on Pl. 3, Fig. 7.
× 300.

Fig. 6: LM-photo of the specimen on Pl. 1, Fig. 1.
× 300.

Pseudoclathrochitina carmenchui (CRAMER 1964).

Fig. 3: LM-photo of the specimen on Pl. 1, Fig. 5.
× 300.

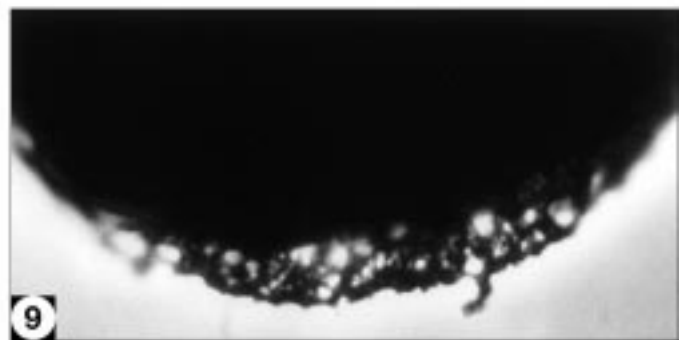
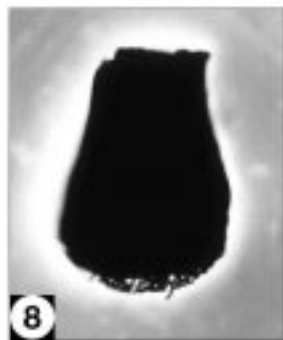
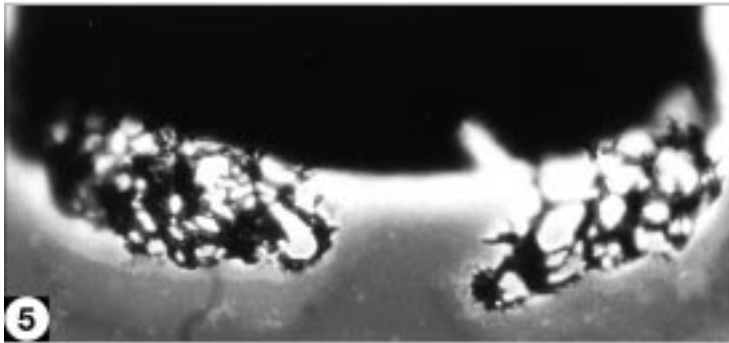
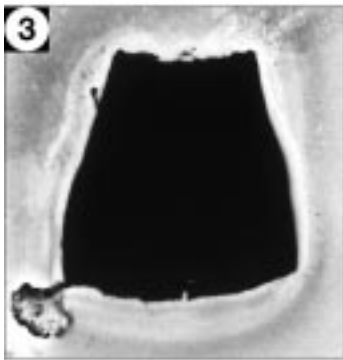
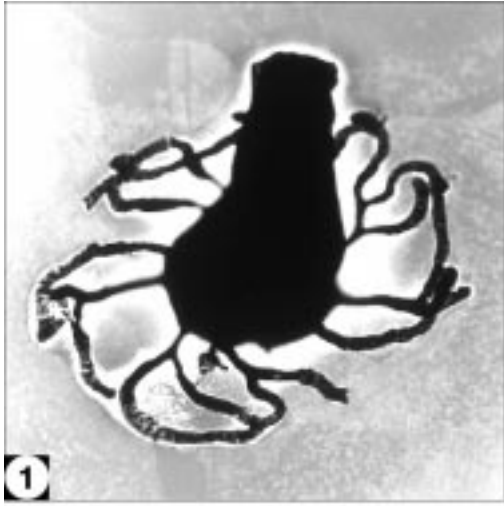
Fig. 4: LM-photo of the specimen on Pl. 3, Fig. 4.
× 300.

Fig. 5: Detail of Fig. 4.
Meshwork of the periderme, originally enveloping the basal margin, here torn off from the bottom of the vesicle and lengthened in the aboral direction.
× 1200.

Fig. 7: LM-photo of the specimen on Pl. 2, Fig. 7.
× 300.

Fig. 8: LM-photo of the neotype on Pl. 1, Fig. 6.
× 300.

Fig. 9: Detail of Fig. 8.
Meshwork of the periderme around the basal margin, partly torn off from the bottom and slightly compressed and lengthened in the aboral direction.
× 1100.



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