

**Chitinozoans of a composite section of Upper Llandoveryian to basal Lower Gedinnian sediments in northern León, Spain.
A preliminary report,**

by FRITZ H. CRAMER (*).

SUMMARY. — *Chitinozoans occur through most of the well-exposed section of Upper Llandoveryian to Ludlovian (or possibly basal Lower Gedinnian) rocks of the Cantabrian Mountains in northern León, Spain. Chitinozoan assemblages of three sections, which, together, are representative of this time interval, are analyzed, and the ranges of the most common taxa are illustrated within this section. A major change in the chitinozoan assemblage composition occurs in the basal part of the ironbearing San Pedro Formation. The assemblage below this break (Upper Llandoveryian and younger, but older than Ludlovian, according to sparse and poorly preserved marine megafossils) comprises abundant, relatively large chitinozoans of the genera Conochitina and Cyathochitina, and few Angochitina and Ancyrochitina. Many of these taxa are similar to forms previously described from the Sahara, Southern France and the Baltic region. The younger assemblage (of Ludlovian, and possibly basal Lower Gedinnian age) is characterized by the occurrence of abundant small species of the genera Desmo-chitina, Angochitina, Ancyrochitina, and Plectochitina. This younger assemblage is quite similar to assemblages described from the Sahara.*

I. — STRATIGRAPHIC PART.

INTRODUCTION.

The strata from which the microfossils for this study were recovered, are of Silurian age. In the region considered, the stratigraphic section is usually divided into three formations which are, from oldest to youngest, the Barrios Quartzite Formation, the Formigoso Formation, and the San Pedro Formation. Several workers have treated this succession, and additional pertinent information may be found in MALLADA (1887), KEGEL (1930), COMTE (1937, 1959), HERNÁNDEZ SAMPELAYO (1942), GÓMEZ DE LLARENA (1950), RADIG (1959), POLL (1962), OELE (1964).

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In this paper the stratigraphic units recognized by COMTE (1959) are followed. Geologic maps covering most of the region in which the sections are located have been prepared by COMTE (1937, 1959); WAGNER (1962); DE SITTER (1962).

The Formigoso and the San Pedro Formations crop out over long distances in the western and northern parts of the Cantabrian Mountains of the provinces of León and Oviedo, NW Spain. The insoluble residues of samples from the units yielded spores, acritarchs, scolecodonts, and chitinozoans.

STRATIGRAPHY.

The *Barrios Quartzite Formation* is a massive, finely to coarsely grained white quartzite with local shale lenses and partings. The unit is several hundred meters thick and because of its great resistance to weathering, forms prominent ridges in the landscape. Fossil tracks referring to genus *Cruziana* have been recorded, but no other megafossils have been reported. However, the formation is pre-Upper Llandoveryan and post-Postdamian of age, as indicated by the megafossils of the over and underlying formations. Microfossils are rare, difficult to concentrate from the rocks, and poorly preserved. The few recognizable elements apparently indicate an Ordovician rather than Lower Silurian age. However, there is a possibility that selective destruction during the lithification and possible tectonisation of the rocks may have eliminated Silurian forms originally present in the assemblage.

The *Formigoso Formation* conformably overlies the Barrios Quartzite Formation, with a basal zone not more than a few meters thick showing intermediate lithologic characteristics. The formation is a mappable unit of essentially black, ampelitic shales alternated with thin beds of sandstone. In the Luna and Bernesga River region, where the samples of this unit were collected, the lower part of the formation is predominantly black, fissile, and the unit grades upward into coarse brown sands and minor dark gray to brownish gray shales. By comparing the microfossil content of samples from distant outcrops, a mild diachronism of the boundaries of this lithostratigraphic unit is conspicuous, but for the sections in the region considered here the amount of lateral diachronism with respect to the vertical sample spacing is too small to be of influence for the correlations attempted. The age of the basal layers of the

Formigoso Formation, a junior but widely used synonym of the « Bernesga Formation » of KEGEL (1930), is Upper Llandoveryan as indicated by the graptolites recorded by MALLADA (1887), KEGEL (1930), COMTE (1959): *Monograptus jaculum* LAPWORTH; *M. concinnus* L.; *M. circularis* ELLES and WOOD; *M. cf. becki* BARRANDE; *M. (Rastrites) peregrinus* B.; *D. (Glyptograptus) tamariscus incertus* E. and W.; *M. gregarius* L.; *M. sedgwicki* PORTLOCK; *M. cf. convolutus* HISINGER; *M. turriculatus* B.; *M. priodon* BRONN.

Neither an abrupt lithologic break is observed within the Formigoso Formation nor is a sudden microfossil content change apparent. However, distinctive change in the assemblages occurs near the top of the formation, but here the general preservation of the microfossils is poor, and the vertical and lateral sample spacing is large owing to lack of fossiliferous strata. It is uncertain whether this break coincides with upper boundary of the formation. The overlying San Pedro Formation is, at youngest, of Ludlovian age, therefore the Formigoso Formation might include the Upper Llandoveryan and possibly Wenlockian or at least the lower part of the Wenlockian. The chitinozoan assemblages recovered from the black shales of the basal part of the Formigo Formation confirm a Llandoveryan age for the lower part of the sequence.

The *San Pedro Formation* is a easily recognized in the field by its maroon color and resistance to erosion. It consists of 70 to 220 meters of alternating maroon to white quartzites and thin green to brown, fissile shales. The thicknesses of the shales vary considerably over short distances and it has been suggested by OELE (1964), COMTE (1959) and POLL (1962), that the formation was deposited in a shallow water, high energy environment.

Megafossils are rare and generally poorly preserved; the lower part of the formation in a series of outcrops which are 10 to 25 miles NW of the study area, is tentatively dated Ludlovian by POLL (1962); the upper part is attributed to basal Lower Gedinnian by the same author.

Near the base of the formation, a conspicuous change in the microfossil assemblages was noted. The microfaunal assemblage change may be either an expression of the facies change at the boundary of both formations, or may represent a hiatus of indeterminate length of time.

The three stratigraphic sections from which chitinozoan assemblages were recovered were measured and collected in the Cantabrian Mountains of the province of León, NW Spain. They are

located in the vicinity of 42 degrees 50' N; 5 degrees 45' W near the headwaters of the Bernesga and Luna Rivers. The locations are :

1. *El Tueiro*. The section measured and sampled is in the southernmost outcrop of the Formigoso Formation at the east side of road C-630 north of the village Villasimpliz (de Gordón).

2. *Aralla*. This locality is in an outcrop of the uppermost part of Formigoso Formation, and the San Pedro Formation at the side of the dirt road from Villamanín by Cubillas (de Arbas) and Aralla (de Luna) to road C-623 which runs along the reservoir lake of the river Luna (Pantano de Luna). This section is the second outcrop of the San Pedro Formation at the left side of the dirt road after the topographically lowermost hairpin curve, running from Aralla (de Luna) to Cubillas (de Arbas).

3. *La Vid*. The section measured and sampled is in the first outcrop of the Formigoso and San Pedro Formations at the left side of the dirt road which leads from La Vid (de Gordón) by Villar del Puente to Vegacervera at the river Torío.

THE CHITINOZOAN ASSEMBLAGES OF THE THREE SECTIONS.

Section Aralla.

(Figure 1.)

The preservation of the palynomorphs in most cases is fair to excellent; however, in the tectonized parts of the section, the preservation is generally poorer, and the majority large palynomorphs (over 200 μ) are broken. A decrease in transparency of the palynomorphs has also been noted in tectonized samples.

The chitinozoan taxa found in this section are plotted in figure 1.

Section La Vid.

(Figure 2.)

Most samples yield fairly well preserved chitinozoans, invariably accompanied by small spores and acritarchs, which show a fair to excellent preservation. Two samples from this section, 0812 and 0814, could not be completely analyzed as the slides were inadvertently destroyed. The assemblages shown in the range chart, therefore, are not completely representative for these samples. The chitinozoan taxa occurring in this section are plotted in figure 2.

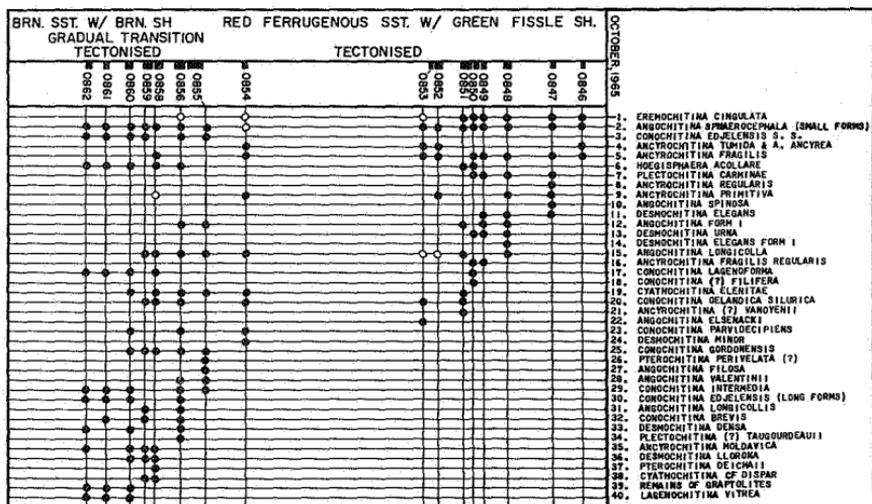


FIG. 1. — Locality Aralla de Luna, stratigraphic occurrences of chitinozoans.

In this figure, as well as in the figures 2, 3 and 4, a solid dot indicates the presence of a taxon; a circle indicates a doubtful identification. One centimeter in the stratigraphic columns equals approximately 14 m 50 cm of stratigraphic thickness.

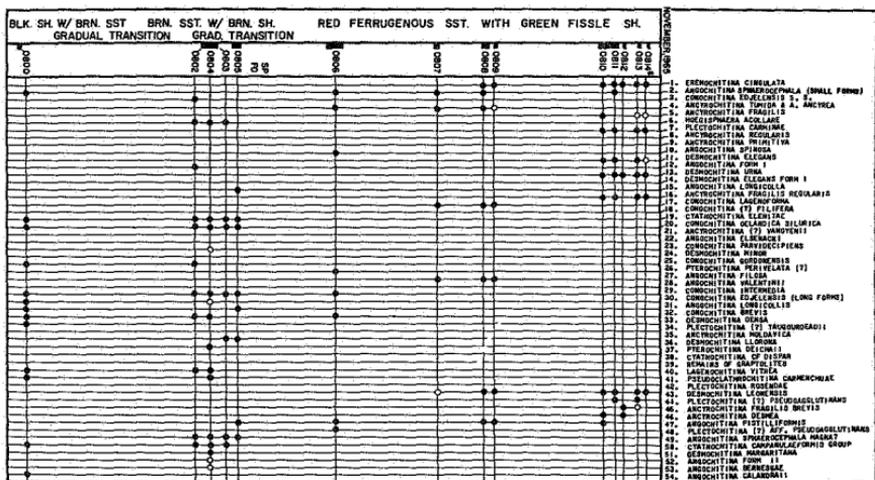


FIG. 2. — Locality La Vid de Gordón, stratigraphic occurrences of chitinozoans.

Section El Tueiro.

(Figure 3.)

Most samples of this section yield well-preserved chitinozoans, except for the uppermost three, (0922, 0923, 0924), in which the palynomorphs are frequently broken. The samples 0901 to 0914 contain an abundant and well preserved assemblage of chitinozoans, acritarchs, and scolecodonts. The latter two groups are not as well-preserved and abundant in this formation as in the overlying San Pedro Formation. Throughout the entire section small numbers of simple trilete spores of the genera *Retusotriletes*, *Punctatisporites*, and *Cyclogranisporites* were observed. Palynomorphs attributed to the genus *Cymatiosphaera* were also recovered.

The chitinozoan taxa occurring in this section are plotted in figure 3 and those found exclusively in this section are indicated with an asterisk. It should be noted that the taxa recorded in the samples 0902 to 0924 are only those which were found to occur in quantities of more than five specimens per five hundred specimens counted per sample.

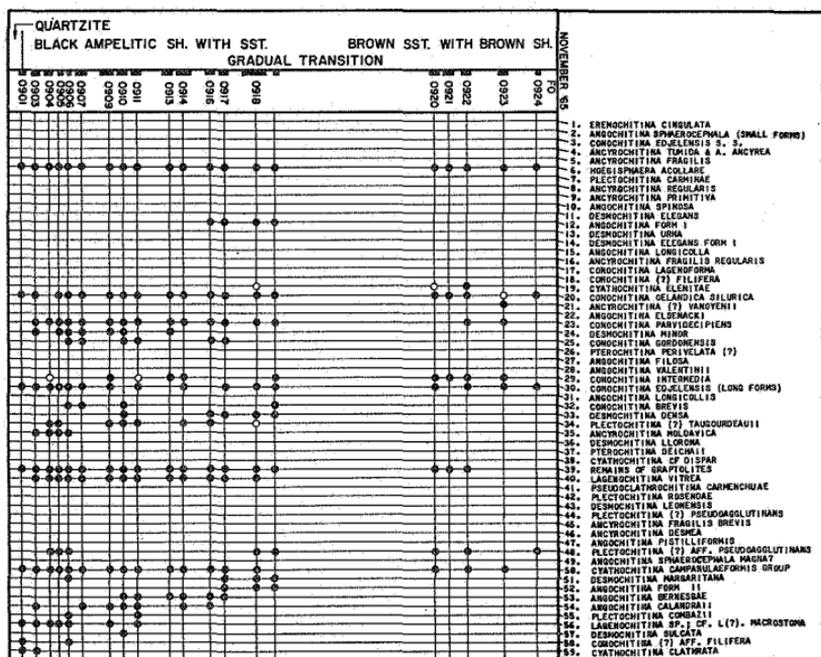


FIG. 3. — Locality El Tueiro, stratigraphic occurrences of chitinozoans.

The only assemblages of roughly equivalent age with which the Spanish material can be compared considering the size of the material examined, are those described by TAUGOURDEAU, and TAUGOURDEAU and DE JEKHOWSKY from the Sahara and Southern France. The Spanish material has more taxa in common with time equivalent Sahara assemblages than with the material from Southern France. This is possibly a result of the more restricted part of the column occupied by the French forms compared with the Sahara material; but also, the Spanish material might not be contemporaneous with the French material. In the latter case, the French chitinozoans should be pre-Upper Llandoveryan of age, provided that the age determination of the Formigoso graptolites is correct.

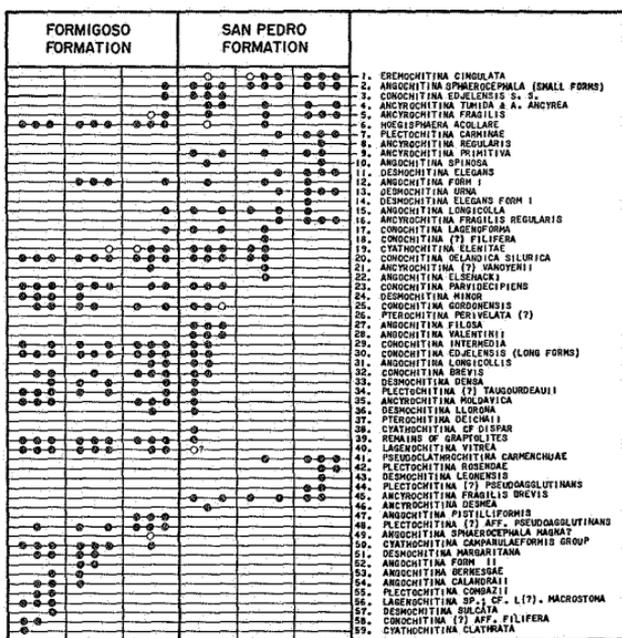


FIG. 4. — Occurrences of chitinozoans in the Bernesga — Luna region. This chart summarizes data obtained from seven sections located in this region.

Figure 4 shows the compilation of the ranges of the most common chitinozoa taxa found in the study region. The sequence of the tops seems to be consistent in an area approximately 45 miles wide. Whether this range chart is of any good in further distant regions has not yet been determined. However, it seems that the Wenlock

Limestone in England is characterised by assemblages which are strikingly similar to the *Conochitina edjelensis* s.l. and *C. intermedia* type of associations, which are also found in the part of the Spanish sequence which overlies the strata dated as Upper Llandoveryan and underlies the iron bearing part of the San Pedro Formation, which, at its top, is of Ludlovian age or even younger. Forms like *Plectochitina carminae* and *P. rosendae*, in the study area restricted to the San Pedro Formation, were not found in the Wenlock Limestone. Therefore, the Wenlockian — Ludlovian boundary is tentatively placed in the study area, at the top of the *Conochitina edjelensis* complex range and at the base of the *Plectochitina carminae* complex range, that is, in the lower part of the San Pedro Formation.

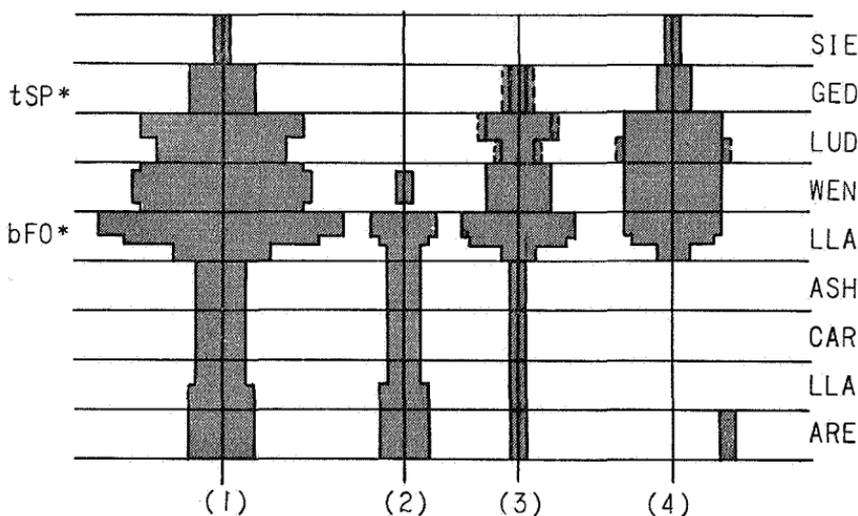


FIG. 5. — Compilation of ranges of previously described chitinozoans found in the Bernesga — Luna region.

In figure 5 are plotted the ranges of species previously described from other regions which occur also in the two formations discussed here. Of course, this was only possible for those few species of which more or less precise occurrence information is given in their descriptions. (In many cases only a system or even larger time units are mentioned as ages of small faunules. These taxa were omitted from this compilation. Plotted in figure 5 are those taxa of which

tops and bottoms were recorded with an exactness of a stage or less. The first column in the figure represents a cumulative plot of all described species. A maximum occurs between the Llandoveryan and the top of the Ludlovian. This seems to confirm the megafossil age determination of the studied formations: the base of the Formigoso Formation at the type locality is most probably (Upper) Llandoveryan, and the top of the San Pedro Formation is supposed to be basal Lower Gedinnian or uppermost Ludlovian. Even though this compilation is based essentially on the assemblages from two regions only — mostly pebbles from the Baltic region, and samples from wells in the Sahara — the facies of these two fairly distant assemblages are different enough, to give some confidence in this chitinozoan age confirmation. It also might suggest the consistent similarities of the ranges known from other areas and the occurrences of the same species in sediments of supposedly the same age, are no mere coincidences. The second column represents the compiled ranges of species which occur in the Formigoso Formation only. It is interesting to see that these are almost exclusively species of *Cyathochitina* and *Conochitina*. Column three shows the ranges of species found in the top of the Formigoso Formation and in the basal part of the San Pedro Formation. The fourth column, finally, represents the compiled ranges of species recorded in the San Pedro Formation, but not in the underlying strata.

Even though it is inviting to explain away this overlap of ranges of previously recorded taxa, which apparently have more restricted occurrences in the study area, the author of this preliminary note prefers to omit this, and leaves it to the knights of the fountain pen or the typewriter instead.

II. — SYSTEMATIC TAXONOMIC PART.

GENERAL.

The morphographic terms used in the descriptions are those of COMBAZ and POUMONT (1962), TAUGOURDEAU (1965, thesis), JANSONIUS (1964). When more than one term was found for the same characteristic, the most widely used one was employed.

As illustrations are almost always a more effective means of communication than the written word, the morphographic terms are diagrammatically represented in figures 6 and 7.

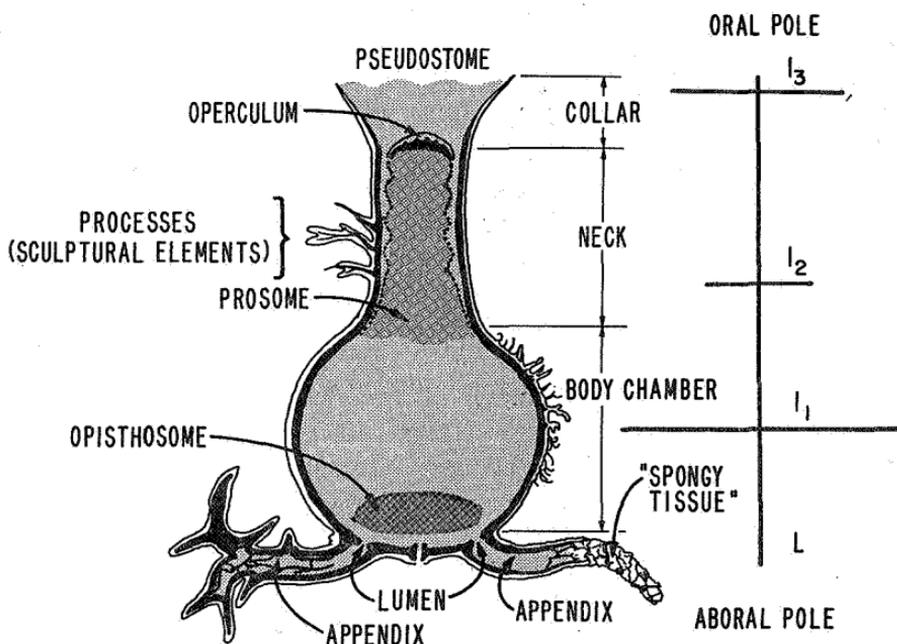


FIG. 6.

Unless otherwise stated, no specimens on the microphotographs are retouched. Pictures were taken with a Leitz Orthomat on Kodak Panatomic-X films. A dark red filter was used in most cases.

New species were established only after a sufficiently great number of specimens (generally 25 to 50) were examined, to exclude the possibility of taking aberrant forms as norms for further work. After completion of the entire investigation, the type and reference slides will be deposited according to the recommendations of the International Code of Botanical Nomenclature.

Many new taxa of Spanish chitinozoa are named after people, and this tradition is continued here. Several new species have received names of students of chitinozoans, and since the number of workers in this field grows steadily, no difficulties are anticipated in naming future new species of Spanish chitinozoans. The rapid increase of chitinozoan students is most fortunate, as the

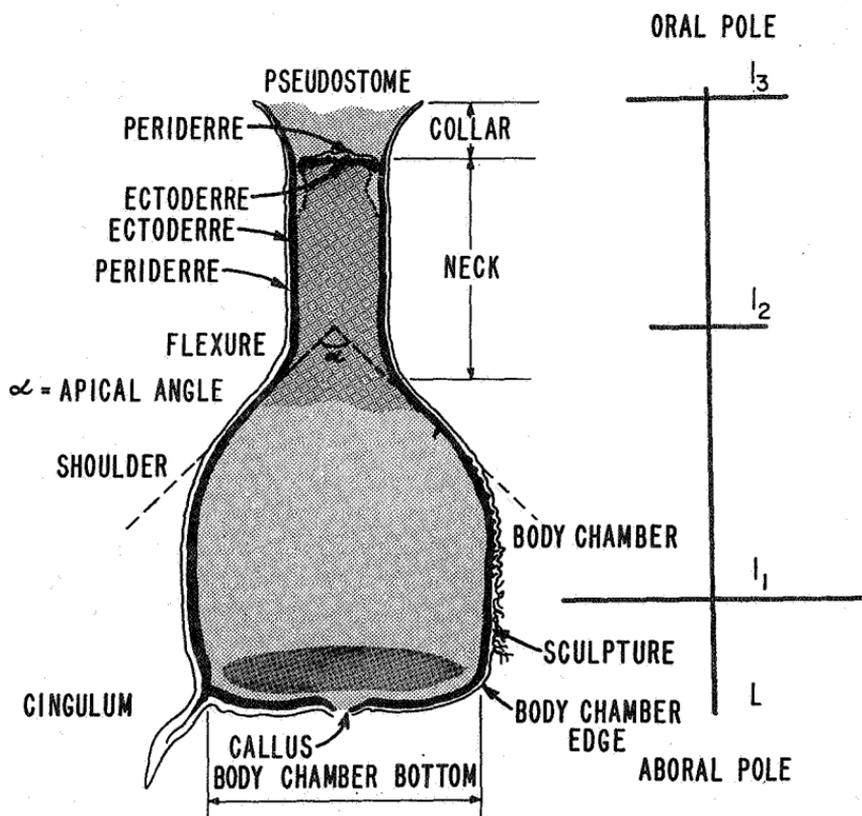


FIG. 7.

names of one's relatives are rather restricted in number and although presently much work is being done, this number multiplies quite slowly.

Note. — In the descriptions no occurrences are indicated, they can easily be checked in figure 4.

LIST OF TAXA IDENTIFIED IN NORTHWESTERN LEÓN.

In the last two years several tentative classifications have been designed to replace the classification essentially constructed by Eisenack. These new classifications are, in many instances, rather subjective, and although they appear to be more adequate than

the old classification, they all are unsatisfactory in that no space is provided for graded series of morphographically transitional forms belonging to, e.g., two « genera ». The new classifications are based on at least two criteria: (1) A morphographic pigeon hole system, (2) An expression of assumed biological relationships between the different taxa in the proposed system.

The last criterion is, in the author's opinion, a very subjective one, and might produce as many different interpretations as there are students, and this is undesirable. One condition to successfully study stratigraphically useful elements, such as chitinozoans, is by systematically comparing the differences of the elements when they are plotted against time. A prerequisite is a stable taxonomic classification and no one classification can be stable if it is based on such subjective criteria as supposed biologic relationships in a (polyphyletic?) group of fossils extinct since Carboniferous time. As differences in form, expressed in standard terminology are objective and can be studied by all students alike, a taxonomic classification should be established on these characteristics only. However, no such taxonomic morphographical classification exists at this moment, and because the author does not wish to increase the present classification entropy, taxa discussed in this paper are listed below without attempting to accommodate them in any of the systems presently in existence.

The taxa listed below, are plotted in figure 4. The numbers between the parentheses refer to the numbers in the heading of figures 1 thru 4.

A. — Formgenus *Cyathochitina*.

- | | |
|-----------------------------------|-----------------------------|
| <i>C. alata</i> (not plotted), | (38) <i>C. cf. dispar</i> , |
| (50) <i>C. campanulaeformis</i> , | (19) <i>C. elenitae</i> . |
| (59) <i>C. clathrata</i> , | |

B. — Formgenus *Conochitina*.

- | | |
|--------------------------------------|-------------------------------------|
| (32) <i>C. brevis</i> , | (25) <i>C. gordonensis</i> , |
| (3) <i>C. edjelensis</i> , | (29) <i>C. intermedia</i> , |
| (30) <i>C. edjelensis elongata</i> , | (17) <i>C. lageniforma</i> , |
| (30) <i>C. edjelensis alargada</i> , | (20) <i>C. oelandica silurica</i> , |
| (18) <i>C. ? filifera</i> , | (23) <i>C. parvidecipiens</i> . |
| (58) <i>C. ? aff. filifera</i> , | |

C. — Formgenus *Eremochitina*.

- (1) *E. cingulata*.

D. — Formgenus *Pseudoclathrochitina*.(41) *P. carmenchuae*.E. — Formgenus *Desmochitina*.(33) *D. densa*,(11) *D. elegans*,(14) *D. elegans*, form I,(43) *D. leonensis*,(36) *D. ? llorona*,(51) *D. marganitana*,(24) *D. minor*,(58) *D. sulcata*,(13) *D. urna*.F. — Formgenus *Pterochitina*.(37) *P. deichaii*,(26) *P. perivelata* (?).G. — Formgenus *Hoegisphaera*.(6) *H. acollare*.H. — Formgenus *Lagenochitina*.(40) *L. vitrea*,(56) *Lagenochitina* sp.; cf. *L.* (?)
macrostoma.I. — Formgenus *Angochitina*.(53) *A. berneseae*,(54) *A. calandrai*,(22) *A. eisenacki*,(27) *A. filosa*,(15) *A. longicolla*,(31) *A. longicollis*,(47) *A. pistilliformis*,(10) *A. spinosa*,(2) *A. sphaerocephala*
(small forms),(49) *A. sphaerocephala magna* ?,(28) *A. valentini*,(12) *Angochitina* form I,(52) *Angochitina* form II.J. — Formgenus *Ancyrochitina*.(4) *A. ancyrea*,(46) *A. desmea*,(5) *A. fragilis*,(16) *A. fragilis regularis*,(35) *A. moldavica*,(9) *A. primitiva*,(8) *A. regularis* (not described
in the present paper),(4) *A. tumida*,(21) *A.* (?) *vanoyenii*.K. — Formgenus *Plectochitina*.(7) *P. carminae*,(55) *P. combazii*,(44) *P. ? pseudoagglutinans*,(48) *P. ? aff. pseudoagglutinans*,(42) *P. rosendae*,(34) *P. taugourdeauii*.

A. — Formgenus **Cyathochitina**, EISENACK 1955,
restr. JANSONIUS 1965.

Generic diagnosis as restricted by JANSONIUS (1965):

« Vesicle bell-shaped, with conical body chamber and well developed cylindrical neck; strong flexure, shoulder weak or not developed; basal edge sharp, often with a strong basal scar; wall smooth or with minute sculpture; prosome (?) and operculum very similar to that described in *Conochitina* (compare JANSONIUS, 1965) outer layer of cuticle often poorly developed. »

Cyathochitina alata TAUGOURDEAU and DE JEKHOWSKY 1960.

(Plate I, figure 9.)

C. alata occurs infrequently throughout the Formigoso Formation.

Previous records. — *Cyathochitina alata*, in TAUGOURDEAU and DE JEKHOWSKY 1960. — Holotype and an additional specimen figured and described. Reported from the Arenigian-Llandoveryan of a well in the Sahara.

Cyathochitina campanulaeformis (EISENACK 1931).

(Plate I, figures 1 thru 6.)

Body chamber funnel shaped with inconspicuous or absent shoulder. Flexure pronounced, neck cylindrical to conical with widest opening at the pseudostome; apical angle 50 to 70 degrees (average 60 degrees), fairly consistent in specimens of different size. Transition from neck to collar gradual, upper part of collar transparent. No internal structures observed in neck or collar. Pseudostome periphery straight. Bottom of body chamber flat to slightly concave; basal scar small or absent, concentric darker, less transparent lines present on bottom. Number and size of these lines variable and apparently unrelated with the specimen size. Cingulum transparent, with numerous concentric lines which are slightly darker than the rest of the cingulum, and with numerous radial folds. The width of the cingulum is variable (less than 5 to 30 μ) and apparently unrelated to the specimen size $L = 160-340 \mu$; $l_1 = 90-200 \mu$; $l_{2,3} = 40-100 \mu$. The length of the neck varies from 0.5 L to zero; the specimens with a greatly reduced neck show no signs of damage. (compare: TAUGOURDEAU, 1965.)

The wall of the bottom of the body chamber of *C. campanulaeformis* is double, a similar structure is described for *C. clathrata*. The specimens have an essentially psilate wall, but a longitudinal striation is present at the upper part of the body chamber, the neck and lower part of the collar. The width and number of the striae on the neck is variable, but the width does not exceed $5\ \mu$, and the number of striae is near to 40 at the upper part of the neck. The structure of the striae is not certain. As they occur as alternations of lighter and darker longitudinal regions in the transparent parts of the vesicle and, seen with incident light, continue as more or less reflecting structures on the opaque part, they could represent:

(1) Folds, which are structurally controlled because they consistently occur in all specimens examined. (However, these folds have a different aspect than folds shown in *C. stentor* by EISENACK, 1939, figure A:1. These folds are larger.) The folds on *C. campanulaeformis*, might continue on the cingulum.

(2) Thickened regions of the wall. The interpretation that the darker regions are remnants of an outer wall layer, torn during the growth of the specimen cannot be sustained, because in this case the distance between the striae should be smallest in small specimens and larger in large specimens. This is not the case in the more than hundred specimens examined.

Previous records, comments. — *Conochitina campanulaeformis*, in EISENACK, 1931. — Holotype and five additional specimens from Silurian erratic pebbles. L up to $300\ \mu$; no reference made to presence of striae on wall. Outline and size comparable with the Spanish forms.

Conochitina campanulaeformis, in EISENACK, 1939 — Remarks as above.

Conochitina campanulaeformis, in EISENACK, 1948 — Four specimens figured from Llanvirnian siliceous concretions in Bohemia. The reported forms are morphographically linked with *Cyathochitina calix*; L up to $266\ \mu$. No reference made to wall sculpture or structure of cingulum. The Spanish assemblages contain forms similar to those figured by Eisenack 1948.

Cyathochitina campanulaeformis, in EISENACK, 1955 — Reference is made to this species, and the possible synonymy of *Cyathochitina* with *Illichitina* is discussed at length. *Cyathochitina* is preferred

over *Illichtina*. JANSONIUS (1965) discusses this synonymy problem also, and for similar reasons as Eisenack's, retains *Cyathochitina*.

Cyathochitina campanulaeformis, in TAUGOURDEAU, 1962 — Occurrence reported in Upper Llandoveryan sediments of the Sahara. Many of the Saharan forms have a short neck (0.1 L), and several specimens possess longitudinal striae.

Cyathochitina campanulaeformis, in EISENACK, 1962 — Neotype and three additional specimens described and illustrated. As to size, sculpture of wall, outline, the Spanish specimens closely resemble the specimens figured here. Reported: Echinospaeriten Limestone (C₁) to Lyckholmer Formation (F₁) (Caradocian to Lower Ashgillian), Estland; *Schroeteri*-Limestone, Öland; Vaginaten-Limestone (B₃), Llandeilian, Baltic region.

Cyathochitina campanulaeformis, in CRAMER, 1964 — Six specimens illustrated from the Upper Llandoveryan Formigoso Formation and the basal part of the overlying San Pedro Formation. Some of the specimens illustrated show a transparent cingulum, in the other specimens this structure is absent.

Cyathochitina campanulaeformis, in TAUGOURDEAU, 1965 — Six specimens illustrated; these have a more bell-shaped body chamber than the average Spanish forms. The length of the neck varies from 0.5 L and zero (this has been observed also in the Spanish assemblages.) The size of the cingulum is variable. Occurrences reported: upper part of Ordovician, Iowa; Middle and Upper Ordovician, Oklahoma.

***Cyathochitina clathrata* (EISENACK, 1959).**

(Plate I, figures 12 thru 15, and 17 thru 19.)

A lengthy discussion of *C. clathrata* is given in CRAMER, 1966.

Previous records. — *Clathrochitina clathrata*, in EISENACK, 1959 — One specimen recorded, and used as holotype. L=116 μ ; l₁=77 μ ; l₂=29 μ ; l₃=33 μ . One illustration. Occurrence: Wenlockian Slite Formation, Gotland. Under the heading of *Ancyrochitina primitiva*, EISENACK (1964) refers to *C. clathrata*, and shows some specimens that differ from the Spanish forms in having a widely spaced set of crenate structures formed by, and continuous with, the ectoderm of the body chamber. *Cyathochitina clathrata* has a perforate cingulum which is formed by the periderre.

Cyathochitina cf. dispar BENOIT and TAUGOURDEAU, 1961.

$L=320-500\ \mu$; $l_1=175-225\ \mu$; $l_2=90-125\ \mu$; l_3 in complete specimens: $150\ \mu$ and up. If complete and not damaged, the specimens, which occur as infrequent constituents of Formigoso assemblages, are distinguished from those reported from other parts in the world by the gradual increase in diameter of the upper part of the neck towards the pseudostome ($l_2 \leq l_3$). Whether specimens with a wide pseudostome occur exclusively in sediments of age equivalent to the Formigoso Formation, cannot be determined at this stage of the investigation. However, no reports are made of this characteristic feature in *C. dispar* from older sediments.

Previous records, comments. — *Cyathochitina dispar*, in BENOIT and TAUGOURDEAU, 1961 — Holotype and three additional specimens described and illustrated from the Hamra Quartzite Formation and overlying strata (Ordovician) in the Sahara. A central callus and concentric striae are reported on the body chamber bottom; l_2 equals l_3 .

?*Cyathochitina dispar*, in CRAMER, 1964 — Three specimens figured from the Formigoso and basal San Pedro Formations in NW Spain; $l_2 > l_3$.

Cyathochitina elenitae CRAMER, 1964.

[Plate I, figures 10 and 11; plate II, figure 39 (cf.); plate III, figure 59.]

$L=160-290\ \mu$; $l_1=80-120\ \mu$; $l_2=40-70\ \mu$; $l_3=50-85\ \mu$; $L/l_1=2.5-3$; $L/l_2=4$.

The cingulum is formed by the body ectoderre; the body chamber bottom is flat to slightly inflated; the pseudostome periphery is straight.

Previous records. — *Cyathochitina elenitae*, in CRAMER, 1964 — Holotype and an additional specimen described and figured. Range indicated incorrect; it should read: Wenlockian? (part) to basal part of Ludlovian? Compare figure 4 in the present paper.

Comparisons. — *Conochitina* spp. of similar size and habitus, miss the distinct cingulum found in *Cyathochitina elenitae*.

Cyathochitina alata TAURGOURDEAU and DE JEKHOWSKY, 1960 — The species has a conical not inflated body chamber without the distinct shoulder found in *C. elenitae*, and has a very thin cingulum.

Cyathochitina cylindrica TAURGOURDEAU and DE JEKHOWSKY, 1960 — $L/1_1 =$ approximately 6; $L/1_2 = 6$.

Cyathochitina calix (EISENACK, 1931) — Average size larger; *C. calix* shows conspicuous callus, and has a larger cingulum than *C. elenitae*.

Cyathochitina stentor (EISENACK, 1937) — $L =$ up to 1100 μ .

B. — Formgenus **Conochitina** EISENACK (1931) 1955
restr. JANSONIUS 1965.

« Vesicle elongated conical, club- or pear-shaped, with conical body chamber; base flat or slightly convex, often with concentric thickening and basal callus with perforation; basal edge rounded, always distinct; sides straight or slightly convex; shoulder poorly developed, flexure more or less distinct; neck cylindrical but not always distinct; lip long, distinctly thin-walled, often slightly widening at aperture; aperture straight or finely fimbriate; prosome simple, short, membranous, attached to operculum; operculum internal, below the thin-walled lip, often with faint concentric structure; cuticle smooth, roughened or granulose; ornamentation confined to spines or warts on basal edge, or completely absent. »

Type species. — *Conochitina claviformis* EISENACK, 1931.

Remarks. — « The apical angle may be very narrow. The lack of ornament on the sides of the vesicle differentiates this genus from *Belonechitina* n. gen., *Hercochitina* n. gen., and *Kalochitina* n. gen. Chain formation is rare in *Conochitina*.

» In blackened specimens, the presence or absence of overall ornamentation can seldom be observed without red or infrared light, oblique dark field or incidental illumination. »

No representatives of JANSONIUS' genera *Herkochitina*, *Kalochitina* and *Baloneychitina*, separated from *Conochitina*, were found in the part of the column studied. *Kalochitina* spp. occur in sediments of Ordovician age in Asturias.

Conochitina brevis TAUGOURDEAU and DE JEKHOWSKY, 1960.

(Plate II, figures 23 and 24; plate III, figure 62.)

C. brevis is a common constituent of Formigoso assemblages. Beside forms attributable to *C. brevis*, quite a number of specimens occur which morphographically link this species with *Cyathochitina elenitae*. They are characterised by a longer neck and the presence of a tiny cingulum. In one specimen an operculum was found. These transitional forms are more frequent in the upper part of the Formigoso Formation than in the lower part; they are absent near the base.

Previous records. — *Conochitina brevis*, in TAUGOURDEAU and DE JEKHOWSKY, 1960 — Ordovician to Llandoveryan in three wells in the Sahara. Holotype and two additional specimens described and illustrated.

Conochitina brevis, in TAUGOURDEAU, 1961 — One specimen illustrated. Reported in Silurian rocks in SW France.

Conochitina brevis, in TAUGOURDEAU, 1962 — Occurrence reported in Middle and Upper Llandoveryan sediments of some wells in the Sahara. The wall near the pseudostome of certain specimens shows annular striae, which are interpreted as growth lines.

Conochitina brevis, in CRAMER, 1964 — One specimen illustrated. Occurrence: Formigoso Formation, basal part of the San Pedro Formation, León, Spain.

Conochitina edjelensis complex.

The group comprises a graded series of morphologically related forms with characteristics transitional between *Conochitina edjelensis*, *Conochitina edjelensis elongata* and a taxon called « *Rhabdochitina conocephala* » in CRAMER, 1964. As these taxa are not separable at this stage of the investigation, they are treated here as one complex. The three components have the same geological range in the study region, though not necessarily the same frequency relation throughout the part of the section in which they occur together. In some samples, representatives of one taxon occur almost to the exclusion of the other two, but this trend is not consistent in different sections and cannot be used for correlation purposes, even over short distances (less than approximately twenty meters).

***Conochitina edjelensis* TAUGOURDEAU, 1963.**

[Plate II, figures 33 and 34 (cf.), and figure 40.]

L=70-275 μ ; l_1 =50-85 μ ; (holotype L=150 μ ; l_1 =95 μ). Reported from Middle and Upper Llandoveryan sediments in some wells in the Sahara.

***Conochitina edjelensis elongata* TAUGOURDEAU, 1963.**

(Plate II, figures 48, 49, 50.)

Holotype L=205 μ ; l_1 =85 μ . Middle and Upper Llandoveryan, Sahara.

***Conochitina edjelensis alargada* n. var.**(non: *Rhabdochitina conocephala*, in CRAMER, 1964).

(Plate III, figure 55.)

Except for the greater vesicle length, no differences with the other varieties of *C. edjelensis* were observed. L= up to 360 μ ; l_1 =60-70 μ ; l_2 =50-70 μ ; l_3 =60-80 μ .

***Conochitina* (?) *filifera* EISENACK, 1931.**

The species is a very rare constituent of the Spanish assemblages. Most of the specimens are quite similar to the ones figured in EISENACK, 1955, plate I, figures 3, 4. The sculpture of the vesicle wall might exclude the present taxon from *Conochitina* as restricted by JANSONIUS (1965).

Previous records. — *Conochitina filifera*, in EISENACK, 1931 — Three specimens figured and described from Upper Silurian erratic pebbles.

Conochitina? cf. *filifera*, in EISENACK, 1934 — The species is discussed here at length, and its variability is stressed. Reported occurrence: Karlstein Limestone, Silurian (E₂). The species shows morphological links with *C. bohémica*.

Conochitina filifera, in EISENACK, 1955 — Neotype and an additional specimen described and figured. The species shows morphographic transitions to *C. lagenomorpha*. Beyrichia Limestone (Upper Ludlovian), Gotland.

Conochitina filifera, in TAUGOURDEAU and DE JEKHOWSKY, 1960 — One specimen figured from the lowermost Devonian (pre-Siegenian) of a well in the Sahara.

***Conochitina* (?) aff. *filifera* EISENACK, 1931.**

A few specimens were found in the lower part of the Formigoso Formation, which have a nearly psilate body chamber bottom and a well developed filose sculpture on the flanks of the body chamber. The sculptural elements are 2 to 4 μ thick and up to 30 μ long.

***Conochitina gordonensis* CRAMER, 1964.**

(Plate II, figures 21 and 22; plate III, figure 56.)

Previous records. — *Conochitina gordonensis*, in CRAMER, 1964 — Three specimens illustrated and described from the Formigoso Formation in Spain. As the species accommodates a wide variety of forms, its stratigraphic value is apparently restricted. Therefore the taxon needs to be revised.

***Conochitina intermedia* EISENACK, 1955.**

(Plate II, figures 41 and 46; plate III, figure 62.)

Body chamber elongately funnel shaped with absent or inconspicuous shoulders; flexure pronounced; neck cylindrical and of variable length. Apical angle 25 to 35 degrees, fairly consistent in specimens of different size. Transition from neck to collar gradual; upper part of collar in some specimens transparent to translucent. No internal structures observed. Pseudostome periphery straight.

The vesicle wall is uniformly covered with tiny granulose elements (less than 1 μ high and wide). Also psilate specimens occur. $L = 130-160 \mu$; $l_1 = 80-95 \mu$; $l_2 \leq l_3 = 55-70 \mu$.

The species is quite variable in outline, and the length of the neck may vary from almost zero to nearly 0.3 L; the pseudostome width is in most specimens equal to the neck diameter, but may exceed the diameter of the neck. These variations occur independent from the stratigraphic and the size of the specimens. Numerous specimens have been found that are morphographically transitional to *C. parvidecipiens*, *C. brevis* and, occasionally, to *C. elenitae*.

Previous records. — *Conochitina intermedia*, in EISENACK, 1955 — Holotype described and figured; $L=119-173\ \mu$; $l_1=101-119\ \mu$; $l_2=55-67\ \mu$; l_3 is slightly smaller than l_2 . Wall psilate to granulate. Recorded in the Upper Ludlovian Beyrichia Limestone, Gotland.

Conochitina intermedia, in BÉJU and DANET, 1962 — One specimen illustrated and briefly described. The apical angle is approximately 20 degrees. Silurian, Moldavian basin.

Conochitina intermedia, in CRAMER, 1964 — One specimen figured. Occurrence: Formigoso Formation and basal San Pedro Formation, Spain.

Conochitina intermedia, in EISENACK, 1964 — Two specimens figured illustrating the wide variability of the species. In the Baltic region, *C. intermedia* occupies a morphographic position between *C. latifrons* and *C. lagenomorpha*. (The latter two species have not been found in the study region). Upper Ösel and Hemse Formations (Lower Ludlovian), Gotland.

***Conochitina lageniforma* n. sp.**

(Plate II, figures 28 thru 30, 35* and 36.)

Body chamber funnel shaped, rarely with a short cylindrical portion, apical angle 50 to 60 degrees, basal edge sharp. Gradual transition from body chamber to neck; neck conical to cylindrical; collar conical with wide pseudostome. transparent. Pseudostome periphery straight. No internal structures observed. Vesicle walls smooth.

$L=110-145\ \mu$; $l_1=110-120\ \mu$; $l_2=40-60\ \mu$; the upper part of the vesicle tends to be broken along the flexure so that it is often impossible to correctly measure L and l_3 .

Holotype: 0861-A-6: 119.3×33.8 , section Aralla de Luna.

Comparison. — *Conochitina conulus* EISENACK, 1955 — Average apical angle smaller; body chamber longer; pseudostome periphery crenulate.

Conochitina edjelensis TAUGOURDEAU, 1963 — Vesicle outline rhabdiform.

Conochitina intermedia EISENACK, 1955 — This species is quite similar to *C. lagenomorpha*, but its average apical angle is smaller, its body chamber longer, and it has a more slender outline. The

average size of *C. intermedia* is larger, but, as both taxa have partly the same range, they might be parts of a morphographically graded series which links smaller, more corpulent forms with a larger apical angle and a pronouncedly conical collar (*C. lagenomorpha*) with larger forms with a smaller apical angle and a less pronounced or even absent collar (*C. intermedia*).

Conochitina lagenomorpha EISENACK, 1931 — Basal edge rounded; collar inconspicuous.

Conochitina oelandica EISENACK, 1955 — Basal edge rounded; collar inconspicuous. L=67-(84)-109 μ .

***Conochitina oelandica* EISENACK, 1955 *silurica* TAUGOURDEAU, 1963.**

(Plate II, figures 37, 38, 42 and 44.)

Previous records. — *Conochitina oelandica silurica*, in TAUGOURDEAU, 1963 — Taugourdeau discusses at length the supposed relationship, differences, occurrences of *C. oelandica silurica*, *C. pachygaster*, *C. edjelensis*. *C. oelandica silurica* was first described from Middle and Upper Llandoveryan sediments of some wells in the Sahara.

Conochitina oelandica silurica, in TAUGOURDEAU, (1965 - thesis) — A specimen is shown with an operculum and a prosome. Silurian, Sahara.

***Conochitina parvidecipiens* n. sp.**

(Plate II, figures 26* and 27.)

Vesicle outline subcylindrical with an inflated lower part. Aboreal pole flat to slightly inflated. A callus is present in some specimens. Vesicle wall psilate and opaque. Apical angle 40 to 50 degrees; basal edge sharp. In one specimen an operculum-like structure was observed, but no other internal structures were seen. No periderme found.

L=220-280 μ ; $l_1=110-140 \mu$; $l_2=l_3=60-90 \mu$; L/ l_1 approximately 2. In outline, the species is quite similar to *C. decipiens*, but its dimensions are nearly 50 % smaller. The variability in vesicle outline is also comparable with that of *C. decipiens*.

Holotype: 0917-A-5: 111.5 \times 33.6, section el Tueiro.

Comparison. — *Conochitina armillata* TAUGOURDEAU and DE JEKHOWSKY, 1960 — L/ l_1 approximately 3. *C. armillata* is

reported from the uppermost Silurian in some wells in the Sahara. The taxon is closely related in form to *C. parvidecipiens*.

Conochitina brevis TAUGOURDEAU and DE JEKHOWSKY, 1960 — L/l_1 approximately 2; l_1/l_2 approximately 1.

Conochitina communis TAUGOURDEAU, 1961 — This species has a funnel shaped body chamber.

Conochitina conulus EISENACK, 1955 — This species has a funnel shaped body chamber and is approximately $110\ \mu$ long.

Conochitina decipiens TAUGOURDEAU and DE JEKHOWSKY, 1960 — approximately $500\ \mu$; L/l_1 approximately 3; l_1/l_2 = between 0.5 and L. Range reported as Arenigian to Llandoveryian in some wells in the Sahara.

Conochitina edjelensis TAUGOURDEAU, 1963 — L/l_1 between 1.4 and 3; l_1/l_2 nearly 1. *C. edjelensis* is on the average, smaller than *C. parvidecipiens*.

Conochitina intermedia EISENACK, 1955 — This species is smaller and has a more pronounced funnel shaped body chamber, which also lacks the cylindrical lower part as in *C. parvidecipiens*.

Conochitina turris TAUGOURDEAU, 1961 — The vesicle wall of this species has a granulate sculpture; the body chamber is funnel shaped and lacks the cylindrical part as in *C. parvidecipiens*. The aboral pole is convex.

C. — Formgenus **Eremochitina**

TAUGOURDEAU and DE JEKHOWSKY, 1960.

The new definition of the genus as proposed by TAUGOURDEAU (thesis - 1965) is given here :

« Conique, claviforme, sub-cylindrique, non globuleux, col peu ou pas marqué, copula tubulaire importante, généralement d'un diamètre voisin de 0.5 de celui du pseudostome, parfois très longue, non en mucron, ni dilatée pour former l'opercule de la loge suivante. »

Eremochitina cingulata (EISENACK, 1937).

(Plate III, figures 71 and 72.)

The species shows relatively little variation. Occasionally, a specimen with a slightly granulate vesicle wall is found.

Previous records, comments. — *Desmochitina cingulata*, in EISENACK, 1937 — Holotype and one additional specimen figured and described from an erratic pebble of Silurian age, from the Baltic region.

Desmochitina cingulata?, in EISENACK, 1955 — Two specimens figured. Occurrence of the species reported in the Wenlockian or Lower Ludlovian Graptolithengestein of the Baltic region.

Desmochitina cingulata serrata, in TAUGOURDEAU and DE JEK-HOWSKY, 1960 — Five specimens figured and described. Some specimens show a horizontal striation in the upper part of the vesicle. No essential differences between the holotype of the species proper and that of the variety could be detected from either the descriptions or the figures. The taxon occurs in Llandoveryian to Emsian sediments in some wells in the Sahara.

Desmochitina cingulata, in TAUGOURDEAU, 1962 — Numerous poorly preserved specimens reported in Middle and Upper Llandoveryian sediments in some wells in the Sahara.

Desmochitina cingulata, in CRAMER, 1964 — One specimen figured; occurrence reported: Formigoso Formation, San Pedro Formation.

Remarks. — The species is common only in the upper part of the San Pedro Formation, but scattered specimens were found also in the upper part of the Formigoso Formation and in the lower part of the San Pedro Formation. A few specimens of doubtful identification were found in the lower part of the Formigoso Formation.

The species apparently has a more restricted range in the Cantabrian Mountains than in the Sahara wells.

D. — Formgenus **Pseudoclathrochitina** CRAMER, 1966
(ex **Clathrochitina**, pars).

The genus *Clathrochitina* EISENACK, 1959, which accommodated three major formgroups of chitinozoans characterised by, successively *C. clathrata* EISENACK 1959, *C. oblonga* BENOIT and TAUGOURDEAU, 1961, and *C. carmenchuae* CRAMER, 1964, was revised in CRAMER 1966. Because of its morphology, *C. clathrata*, the type species of *Clathrochitina*, was attributed to *Cyathochitina*. Therefore, for the remaining species placed in *Clathrochitina*, the generic name may not be retained according to the rules and regulations of the International Code of Botanical Nomenclature. Two new genera were proposed: *Clathrochitinella* for species with morphologic characteristics similar to those of *C. oblonga* (type species of the genus *Clathrochitinella*) and *Pseudoclathrochitina* which will comprise species of a morphology similar to that of *P.* (ex *C.*) *carmenchuae* (type of the genus *Pseudoclathrochitina*).

Remarks. — *Plectochitina* CRAMER, 1964, emend. 1966, is distinguished from *Clathrochitinella* and *Pseudoclathrochitina* by its anastomosing appendices and its vesicle outline which is similar to that of an *Ancyrochitina* or *Angochitina* sp. e. g. *Ancyrochitina ancyrea*.

Formgenus **Pseudoclathrochitina** CRAMER, 1966.

Vesicle outline essentially similar to that of *Eremochitina cingulata*, but with a perforate cingulum. The numerous perforations of the cingulum are arranged in a pattern parallel to the longitudinal axis of the vesicle. The internal structure is comparable with that of *E. cingulata* and related species.

Type species of the genus: *P. carmenchuae* (CRAMER, 1964).

Pseudoclathrochitina carmenchuae (CRAMER, 1964).

(Plate III, figure 61.)

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.

Pseudoclathrochitina carmenchuae, in CRAMER, 1966 — See above discussion of the genus.

E. — Formgenus **Desmochitina** EISENACK, 1931
restr. Proc. C.I.M.P., 1964 (1965).

« Forme de vase ou de cruche, rétrécissement fréquemment avant l'ouverture, pour passer ensuite à un col court ou à un cou, cylindrique ou en forme d'assiette ou en plat. Le col peut être nettement distinct de la partie ventrue ou se différencier progressivement; on n'observe pas de copula cylindrique importante (*Eremochitina*). »

Desmochitina densa EISENACK, 1962.

(Plate III, figure 69.)

The taxon is found in most samples of the Formigoso Formation and the basal part of the San Pedro Formation as well.

A cingulum is consistently present and, though variable in size, distinguishes this taxon from *Hoegisphaera* spp. which lack this structure. Except for the copula, occasionally obscured by the cingulum, no internal structures could be found. Apparently, a peridere is present on most of the body wall, but it could not be determined if the peridere also covers the region between the inner side of the cingulum and the copula of the next unit. A horizontal banding of the ectoderre is often apparent in translucent specimens. This feature is also reported by JANSONIUS (1965) in specimens belonging to *D. nodosa*.

Previous records, comments. — *Desmochitina densa*, in EISENACK, 1962 — Holotype (a colony of six units) and an additional specimen illustrated and described from the Llandoveryan Visby Marl in Gotland. The Spanish specimens are nearly identical with those reported by EISENACK (1962) and TAUGOURDEAU (1965 - thesis).

Desmochitina densa, in CRAMER, 1964 — Three specimens figured. Range indicated not correct, it should read: Llandoveryan (part) to possibly basal Ludlovian.

Desmochitina elegans TAUGOURDEAU and DE JEKHOWSKY, 1960.

(Plate III, figures 63 and 64.)

Previous records. — *Desmochitina elegans*, in TAUGOURDEAU and DE JEKHOWSKY, 1960 — Holotype and an additional specimen figured and described. Reported from post-Llandoveryan to pre-Siegenian sediments in some wells in the Sahara.

Desmochitina elegans, in CRAMER, 1964 — Two specimens illustrated from the upper part of the Formigoso Formation and the San Pedro Formation in NW Spain.

Desmochitina elegans TAUGOURDEAU and DE JEKHOWSKY, 1960
forma **corta** CRAMER, 1964.

Previous records. — *Desmochitina elegans corta*, in CRAMER, 1964 — Reported from the San Pedro Formation, NW Spain; geological age indicated incorrect, it should read: Wenlockian (part) to basal Lower Gedinnian.

Desmochitina leonensis CRAMER, 1964.

(Plate III, figures 65, 70, 74 and 75.)

Specimens placed in this formgroup are common in the San Pedro Formation. Nearly all specimens show a periderre loosely enveloping the copula, however, it is not certain at this stage of the investigation if the periderre continues over the entire body chamber. If it does, this is not conspicuous. Many specimens with translucent vesicle walls show a horizontal banding of darker regions on the copula.

Previous records. — *Desmochitina leonensis*, in CRAMER, 1964 — Holotype illustrated and described from the San Pedro Formation, NW Spain.

Desmochitina (?) llorona CRAMER, 1964.

Previous records, comments. — *Sphaerochitina llorona*, in CRAMER, 1964 — Holotype and two additional specimens figured and described from the middle part of the San Pedro Formation in NW Spain.

The attribution of the present taxon to *Desmochitina* rather than to *Angochitina* (*Fungochitina*, *Sphaerochitina*) is tentatively preferred because of the vesicle outline which is in many respects comparable with that of *Desmochitina minor typica* (in TAUGOURDEAU, 1965).

Desmochitina margaritana complex.

In this formgroup are placed the specimens occurring in varying amounts throughout the Formigoso and the San Pedro Formations. Upon examining single specimens of the formgroup, one often gets the impression to be working with representatives of morphographically widely separated different taxa. However, in a sufficiently large material, all different kinds of transitional forms are present, and it is frequently difficult to attribute a certain specimen to any one species. In the assemblages of the present study, the complex comprises a graded series of morphographically transitional forms, linking the extremes: *D. margaritana* (cf. EISENACK, 1937: figure 10; TAUGOURDEAU and DE JEKHOWSKY, 1960: figures 96, 100; EISENACK, 1962: figures 12, 13); *D. leonensis* (cf. CRAMER, 1964: plate XXI: 14, 15) and the specimens shown in plate III, figure 68 of the present paper (*D. elegans* form I).

Although the complex is represented throughout both formations, it was found that forms similar to *D. margaritana* are the more common in the Formigoso Formation, and that *D. leonensis* is common in the San Pedro Formation and all but absent in the underlying part of the sequence. Yet it should be noted that this conclusion is based on examination of no more than some eighty specimens in for measured sections only, and therefore needs not to be valid outside the study region.

The characteristics of the different constituents of the complex are discussed under their taxonomic identifications.

Desmochitina margaritana EISENACK, 1937.

(Plate III, figure 82.)

Typical forms of this species are uncommon in the Formigoso Formation and absent in the San Pedro Formation. No periderme was found around the copula of this species as in the forms closely related to it; whether this is accidental or not could not be determined because of the relatively low number of specimens examined.

Previous records. — *Desmochitina margaritana*, in EISENACK, 1937 — Holotype and two additional specimens figured and described. EISENACK mentions the presence of an operculum

in some of his specimens; in the present Spanish material no such structure was found. Silurian, Baltic region, no precise occurrence indicated.

Desmochitina margaritana, in TAUGOURDEAU and DE JEKHOWSKY, 1960 — Six specimens figured. They were found in post-Llandoveryian to pre-Eifelian sediments of some wells in the Sahara. The Sahara forms are highly variable, and formgroups are differentiated, however, no precise ranges are given for the individual formgroups.

Desmochitina margaritana, in EISENACK, 1962 — Neotype and one additional specimen described from an pebble of the Wenlockian or Lower Ludlovian Graptolithengestein. Other occurrences listed: Upper Llandoveryian Visby Marl, Lower Wenlockian Höglint Limestone.

Desmochitina margaritana, in EISENACK, 1964 — Occurrences of *D. margaritana* listed: Visby Marl, Höglint Limestone, Wenlockian Slite Marl.

Desmochitina cf. *margaritana*, in BACHMANN, SCHMID and PREY, 1964 — One specimen illustrated and described at length from Silurian sediments in Austria. The specimen differs from the type specimen by its echinate sculpture and larger size ($l_1=125 \mu$).

Desmochitina margaritana, in TAUGOURDEAU (1965 - thesis) — One specimen illustrated from the Silurian of the Sahara.

Desmochitina elegans

TAUGOURDEAU and DE JEKHOWSKY, 1960 form I.

(Plate III, figure 68.)

Specimens accommodated in this taxon form a morphographic link between *D. elegans* and *D. leonensis*. They have a fairly elongate body and copula. No periderme was found. The taxon has a scattered occurrence throughout the San Pedro Formation.

***Desmochitina minor* EISENACK, 1931.**

The species is a rare constituent of some assemblages of the lower part of the Formigoso Formation. As the species occurs in the study region completely out of the range established in other parts of the world, it might be derived from underlying Ordovician sediments.

Previous records. — *Desmochitina minor*, in EISENACK, 1931 — Reported in erratic pebbles derived from the Ostseekalk of the Baltic region. Holotype and two additional specimens illustrated and described. $L=70-80\ \mu$; $L/l_1=1.4:1$. Sculpture slightly granulate.

Desmochitina minor, in EISENACK, 1939 — Eight specimens figured. The species may be colonial, but most commonly occurs as specimens of one single unit. Additional occurrence listed: Herscheider Schiefer, Rahlenberg.

Desmochitina minor, in EISENACK, 1958 — EISENACK splits the species and distinguishes now several subspecies:

D. m. typica, relatively small, body chamber elliptical to ovoidal, $l_3 < l_1$, psilate to granulate; Arenigian Glaukonitkalk (B_2) to the Ashgillian Lyckholm Formation (F_1).

D. m. grandicolla, relatively large, body chamber elliptical to cylindrical, $l_3 \geq l_1$; psilate to slightly granulate; Glaukonitkalk to the Llandeilian Vaginatenskalk (B_3).

D. m. elongata, relatively large, elongately elliptical, $l_3 < l_1$, psilate; Glaukonitkalk (B_3).

Desmochitina minor, in EISENACK, 1962 — EISENACK continues the subdivision of the *Desmochitina minor* s. l. taxon in smaller units. Beside *D. m. typica*, *D. m. grandicolla*, and *D. m. elongata*, also are described and illustrated:

D. m. erinacea, generally larger than *D. m. typica*, ellipsoidal to slightly spherical, $l_3 < l_1$, echinate.

D. m. cocca, oval to spherical.

D. m. amphorea, oval, $l_3 < l_1$.

D. m. rugosa, relatively large, ellipsoidal to oval, copula often funnel shaped.; vesicle surface scabrate to rugose.

D. m. ovulum, relatively large, ellipsoidal to oval, copula generally funnel shaped, and often situated at an angle with the longitudinal axis.

The large variability of the taxon is stressed and thoroughly illustrated. The occurrences of the individual subspecies in the Ordovician of Estland is diagrammatically illustrated.

Desmochitina minor, in TAUGOURDEAU, 1965 — *D. m. typica*, *D. m. cocca* and *D. m. ovulum* are reported from Ordovician sediments in Oklahoma and Iowa. Four specimens figured and compared with the corresponding European forms.

***Desmochitina sulcata*?** TAUGOURDEAU and DE JEKHOWSKY, 1960.

The species is a rare constituent of some assemblages of the lower part of the Formigoso Formation.

Previous records. — *Desmochitina sulcata*, in TAUGOURDEAU and DE JEKHOWSKY, 1960 — Holotype described and illustrated. The species is reported to be very variable. It occurs in the upper part of the Silurian in two wells in the Sahara.

Desmochitina urna EISENACK, 1934.

(Plate III, figure 83.)

The specimens found in the study region are very similar to the forms figured by EISENACK (1934) from the Upper Silurian of Bohemia. As far as could be distinguished from the outline of the only specimen figured by BENOIT and TAUGOURDEAU in figure 2 of their 1961 paper on Ordovician chitinozoans from the Sahara, the Sahara forms have a less pronounced constriction at the oral pole of the vesicle and miss the remnant of the copula at the aboral pole.

Previous records, comments. — *Desmochitina urna*, in EISENACK, 1934 — Holotype and six additional specimens figured and described from the Silurian of Bohemia: ea of Dworetz (Wenlockian) and the lower part of the Ludlovian (eß of Karlstein).

Desmochitina cf. *urna*, in BENOIT and TAUGOURDEAU, 1961 — reported from sandstones and silty shales in which a graptolite, *Didymograptus extensis*, characteristic of the Arenigian, has been found.

Desmochitina urna, in BENOIT and TAUGOURDEAU, 1961 — Occurs in the Hamra Quartzite Formation, attributed to the Lower Arenigian because of the presence of a pygidium of *Niobe*.

Desmochitina urna, in CRAMER, 1964 — Six specimens figured from the Ludlovian to basal Lower Gedinnian San Pedro Formation of NW Spain.

F. — Formgenus **Pterochitina** EISENACK, 1955.

« Chitinozoans of which the body length equals or is smaller than the maximum diameter, and which have a cingulum. »

Type species of the genus: *P. perivelata* (EISENACK, 1937).

Remarks. — The presence of the cingulum differentiates *Pterochitina* from *Hoegisphaera*.

Pterochitina perivelata ? (EISENACK, 1937).

(Plate III, figures 79 and 85.)

All specimens found in the study region are compressed to thin and flat discs. Consequently no other measurements than l_1 could be made. However, the direction and form of the fold in the cingulum suggest an original shape of the vesicle similar to that of *P. perivelata* (in EISENACK, 1937: plate 3:9). Since no traces of a pronounced oral structure were found, and the size of l_1 is in the right order of magnitude, the present taxon is tentatively attributed to *P. perivelata*.

The cingulum is formed by the periderre and is double near its attachment to the body chamber.

Previous records. — *Bion perivelatum*, in EISENACK, 1937 — See below.

Pterochitina perivelata, in EISENACK, 1955 — Neotype and two additional specimens described and illustrated; l_1 of two specimens: 78 μ and 81 μ . The species appears to be restricted to the Upper Ludlovian Beyrichia Limestone in the Baltic region. EISENACK postulates as homologous the cingula of *Cyathochitina* (e.g. *C. kukersiana* or *C. campanulaeformis*) and of *Pterochitina*.

Pterochitina perivelata, in BACHMANN, SCHMID and PREY, 1964 — One very small specimen (l_1 approximately 30 μ) illustrated from Silurian sediments in Austria.

Pterochitina deichaii TAUGOURDEAU, 1963.

(Plate III, figure 84.)

The frequently poorly preserved specimens found in the study region are quite similar to those described by TAUGOURDEAU except for the marked absence of colonial forms.

Previous records. — *Desmochitina* sp., in TAUGOURDEAU, 1962 — One colonial specimen illustrated from Middle or Upper Llandoveryan sediments of some wells in the Sahara.

Pterochitina deichaii, in TAUGOURDEAU, 1963 — Holotype and three additional colonial specimens figured and described from Middle and Upper Llandoveryan sediments of some wells in the Sahara.

G. — Formgenus **Hoegisphaera** STAPLIN, 1961.

Definition of the genus as given by JANSONIUS (1964):

« Vesicle lenticular to spherical, length not exceeding width; basal edge, shoulder and flexure not differentiated; aperture circular, simple, usually bordered by an annular thickening, rarely by a narrow lip, operculum external, of same structure as in *Desmochitina densa*, often detached and separated; no basal callus or other basal structures; cuticle usually single layered and smooth, sometimes roughened or wrinkled when rudimentary outer layer is present; chain formation never observed. »

Type species of the genus: *H. glabra* STAPLIN, 1961.

Hoegisphaera acollare (EISENACK, 1959).

(Plate III, figures 76 thru 78.)

L, not observable; $l_1=70-95 \mu$ (80 μ); $l_3=40-55 \mu$ (50 μ).

Previous records. — *Desmochitina?* *acollare*, in EISENACK, 1959 — Holotype described and figured. Middle Gotland Formation (Wenlockian), Gotland.

Desmochitina acollare, in EISENACK, 1964 — The species is recorded in the Upper Llandoveryan Visby Marl and in one sample of the Wenlockian Slite Formation, Gotland.

Hoegisphaera acollare, in JANSONIUS, 1964 — The species is placed in *Hoegisphaera*.

H. — Formgenus **Lagenochitina** EISENACK, 1931

emend. Proc. C.I.M.P., 1964

(1965, supplement 4: TAUGOURDEAU, 1965 — thesis).

« Col cylindrique assez long ($\neq 0.5$ L), panse en forme de bouteille (une portion plus ou moins longue est cylindrique), passant à cylindro-conique; pas de poils, mais parfois de très petits tubercules (rarement). »

Lagenochitina vitrea (TAUGOURDEAU, 1962).

(Plate II, figure 47; plate III, figures 67, 73, 80, 81 and 86.)

The present taxon is a colonial form, although it occurs in the very great majority of cases as single units. On rare occasions up to eight units (average, three) have been found, though individually detached, still arranged in a chain configuration. Prosome and other structures similar to these described by Taugourdeau and Magloire (1966) for *Desmochitina* (= *Eremochitina* according to the 1964 C.I.M.P. Proceedings, supplement 4) *erratica* may be observed in *L. vitrea*. In samples which have been subjected to a slightly greater amount of metamorphism, less transparent specimens occur together with transparent *L. vitrea*. These translucent to opaque specimens are slightly smaller in size, but show not other differentiation characteristics. Whether these differences in size have stratigraphic use or not, could not be determined at this stage of the investigation. The pseudostome of the Spanish *L. vitrea* is smooth and straight, not serrate.

L. vitrea as it occurs in NW Spain, is larger and on the average, more beer bottle shaped than *D. erratica* as shown in TAUGOURDEAU and MAGLOIRE (1966).

Previous records, comments. — *Sphaerochitina vitrea*, in TAUGOURDEAU, 1962 — Holotype and one additional specimen figured and described from Middle and Upper Llandoveryan sediments of some wells in the Sahara. The Spanish specimens are most similar to the forms described from the Sahara and appear to have the same geological range. They apparently occur in a similar type of assemblages of chitinozoans with, among others, *C. edjelensis* (s.l.), *C. edjelensis elongata*, *P. deichaii*, *P. combazii*.

Sphaerochitina vitrea, in TAUGOURDEAU, 1963 — Two specimens illustrated from Middle or Upper Llandoveryan sediments of some

wells in the Sahara. TAUGOURDEAU discusses the value of transparency of the vesicle wall to differentiate *L. vitrea* from other taxa, and concludes that the transparency of the vesicle wall is an essential and not an accidental characteristic.

Sphaerochitina vitrea, in CRAMER, 1964 — Four specimens illustrated from the upper part of the Formigoso Formation and the lower part of the San Pedro Formation, NW Spain. (The present paper shows that *L. vitrea* occurs throughout the Formigoso Formation, but is rare or absent in the basal part of the San Pedro Formation.)

Lagenochitina sp. cf. **L. ? macrostoma** TAUGOURDEAU and DE JEKHOWSKY, 1960, in: Béju and Danet 1962, plate II: 15.

(Plate II, figure 60.)

The present taxon is a rare constituent of Formigoso assemblages. Dimensions: $L = \pm 170 \mu$; $l_1 = \pm 95 \mu$; $l_2 = \pm 40 \mu$; $l_3 = \pm 60 \mu$; l_2 situated $\pm 40 \mu$ below pseudostome. The taxon differs from *L. macrostoma* by having a smooth, non-tuberculate, vesicle wall and by its smaller dimensions.

Tentative comparison. — *Lagenochitina draaensis* GRIGNANI and MAGLOIRE, 1964 — Upper Devonian, Morocco. l_3 relatively narrow, L shorter than in *L. ? macrostoma*.

Lagenochitina macrostoma TAUGOURDEAU and DE JEKHOWSKY, 1960 — Famennian of two wells in the Sahara. $L = 220 \mu$; $l_1 = 100 \mu$ (holotype). Outline similar to the present taxon.

Sphaerochitina sphaerocephala macrostoma, in BÉJU and DANET, 1962 — Silurian, Moldavian bassin. The Spanish taxon has a relatively shorter vesicle length, a narrower neck, and a smaller pseudostome diameter.

Desmochitina cf. *sommeri* LANGE, in TAUGOURDEAU and DE JEKHOWSKY, 1960 — Silurian, post-Llandoveryan in some wells in the Sahara. The specimens illustrated are in many respects similar to the Spanish forms, but have a relatively wider pseudostome.

J. — Formgenus **Angochitina** EISENACK, 1931
emend. Proc. C.I.M.P. 1964

(1965, supplement 4, TAUGOURDEAU, 1965 — thesis), emend.

« Col cylindrique, jamais réduit au pseudostome, variable; collette souvent présente; pseudostome le plus souvent indifférencié;

panse sphérique, ellipsoïdale, piriforme; corps entièrement couvert de poils ou d'épines, le plus souvent ramifiés, fourchus, parfois bipèdes, le plus souvent à profil aigu. »

Fungochitina TAUGOURDEAU, 1965, in Proc. C.I.M.P., 1964,
(1965, supplement 4).

« Ce genre correspond plus au moins à la conception originale de *Sphaerochitina*, mais ne peut garder ce nom, le génotype en étant exclu. En effet, nous groupons dans notre genre les formes à col bien développé (en moyenne supérieur à 0.5 L), à panse aplatie (en champignon ou en soupape d'automobile). La surface est entièrement couverte de petits tubercules dont la hauteur est voisine de la largeur. »

Macrostromachitina TAUGOURDEAU, 1965, in Proc. C.I.M.P., 1964
(1965, supplement 4).

« Genre caractérisé par la possession d'une panse (0.5 L) généralement sphérique surmontée par un col large dès son origine et régulièrement évasée vers l'ouverture qui présente une largeur égale à celle de la panse. La surface est généralement couverte de petits tubercules comme dans le genre *Fungochitina*. »

The author does not see clearly how TAUGOURDEAU's classification will work practically, because in assemblages of some tens of specimens numerous transitional forms occur with characteristics intermediate between *Angochitina* (sensu TAUGOURDEAU), *Fungochitina*, and *Macrostromachitina*. Let us compare *Angochitina* and *Fungochitina*. After subtracting from the total bodies of both definitions the factors which they have in common, the differences between both genera are reduced to: *Angochitina*, body chamber elongate to spherical, sculptural elements filose or spinose, that is, longer than wide; *Fungochitina*, body chamber mushroom shaped, sculptural elements small, shorter than wide (tubercules). These generic differences are, to say the least, rather arbitrary, considering the notoriously wide variability observed in most chitinozoan « species ». For example, TAUGOURDEAU and DE JEKHOWSKY show in plate I, figures 2 thru 7 of their 1964 paper, six specimens of *Angochitina longicolla* — a species which, after the revision of many

genera and species during the C.I.M.P. meeting in November 1964, remains attributed to *Angochitina*. Of these six specimens, one is psilate, four have sculptural elements with a length smaller than or equal to the width, and the sixth is spinate. The general vesicle outline is that of an *Angochitina*, however the sculpture is that of *Fungochitina* for five of the six specimens figured. It is possible, though not probable, that an assemblage occurs which consists of nearly psilate « *Angochitina* » *longicolla* exclusively. Will these specimens then be classified as *Fungochitina*?

As to the outline of the body chamber, the other major means of differentiation between both genera: it is obvious that the original, three dimensional, outline of the body chamber is subjected to great changes during the fossilization process. Now, it is quite conceivable that in some originally more or less spherical species the body chamber outline changes during compression to elongate or to more or less mushroom shaped or to both. Naturally, forms with an originally mushroom shaped body chamber, will retain most of the original outline when compressed; the crucial point is that many chitinozoans have a subspherical body chamber, and that a sphere changes its outline to some kind of ellips when it is compressed to form a flat body. The orientation of the resulting ellips with respect to the neck of the specimen is quite at random, which can be seen by examining taxa with relatively stable appendix configurations such as *Plectochitina rosendae*, *P. carminae*, *Ancyrochitina primitiva*, *P. (?) pseudoagglutinans*. All these species show body chamber outlines ranging from elongate to mushroom shaped.

It is therefore proposed here that the genus *Fungochitina* be abandoned, and that its species be placed in *Angochitina*, which then will accommodate species corresponding to this definition:

« Body chamber elongate, piriform, mushroom shaped, spherical, clearly differentiated from the neck by a pronounced flexure. A shoulder may be developed, but not necessarily so; the same holds for the basal edge of the body chamber. Neck conical to cylindrical; a collar is often present. Pseudostome periphery straight to serrate or crenulate. No appendices, such as those which are found in *Ancyrochitina* or *Plectochitina*, are present. The vesicle sculpture, which is formed by the periderre, the ectoderre or both wall layers, is psilate, granulate, echinate, filose, spinate. Larger elements may be present, however these are not situated in a configuration similar to that found in *Ancyrochitina* (e. g. *A. primitiva*) at the aboral pole of the vesicle. »

This definition would also attribute to *Angochitina* most species of *Macrostomachitina* and *Sphaerochitina*, because of essentially the same reasons as set forth above.

***Angochitina berneseae* n. sp.**

(Plate IV, figures 90* and 91.)

Body chamber pistilliform to, rarely, funnel shaped with a flat to concave bottom; neck and collar cylindrical to slightly conical with wide pseudostome; pseudostome periphery straight; opisthosome and prosome often present; no aboral callus; sculpture echinate, sculptural elements $0.5\ \mu$ wide, up to $6\ \mu$ high (average: 1 to $3\ \mu$), evenly distributed over the entire body; majority of tips of echinae point towards the oral pole of the specimens; the echinae are simple, not bipede and do not bifurcate. $L=115-130\ \mu$; $l_1=80-90\ \mu$; $l_2=35-45\ \mu$; $l_3=40-50\ \mu$. Holotype: 0913-A-14, 110.1×27.9 from section El Tueiro.

Comparisons. — *Sphaerochitina acanthifera* EISENACK, 1955 — This species has a similar sculpture, but is distinguished from *A. berneseae* by the rhomboidal outline of the body chamber.

Ancyrochitina aculeata TAUGOURDEAU and DE JEKHOWSKY, 1960 — This species has a similar general outline and sculpture, but is distinguished from *A. berneseae* by its aboral appendices.

Angochitina capillata EISENACK, 1937 — Body chamber clearly piriform, with a sculpture of longer sculptural elements, which are concentrated on the body chamber.

Angochitina cf. *capillata*, in GRIGNANI and MAGLOIRE, (1964) — This taxon has few and large echinae and a piriform body chamber. It differs from *A. capillata* by having longer and fewer echinae than the type specimen figured by EISENACK, G. and M.'s specimens have a narrower neck and a more concave body chamber bottom.

Angochitina cf. *capillata*, in BÉJU and DANET, 1962 — This taxon has a vesicle outline similar to that of *A. berneseae*, but the illustration does not permit a nearer comparison, especially as no description is given. This taxon is reported in the Silurian of the Moldavian basin.

Angochitina capillata, in DUNN, 1959 — This taxon is quite different from the type specimen of *A. capillata* figured by EISENACK. Its outline is similar to that of *A. berneseae*, but the illustration does not permit a nearer comparison. The ranges of both taxa are quite different.

Angochitina comosa TAUGOURDEAU and DE JEKHOWSKY, 1960 — Body chamber spherical to ovoidal with a more slender and longer neck than that of *A. berneseae*. Sculptural elements often bipede.

Angochitina echinata EISENACK, 1931 — This species has a more piriform body chamber, a thinner and more slender neck and a sculpture of fewer and larger echinae. The sculpture shows a size differentiation not found in *A. berneseae*.

Angochitina fungiformis (EISENACK, 1931) — This species has an outline similar to that of *A. berneseae*, but is psilate.

Angochitina longicolla EISENACK, 1959 — This species has a different outline and a sculpture of cones rather than slender echinae.

Angochitina oklahomensis TAUGOURDEAU, 1965 — The outline of the body chamber of this species is cylindro-spherical; it has a shorter neck, and a sculpture of echinae which are larger than those of *A. berneseae*.

Angochitina pistilliformis (EISENACK, 1931) — This species has an outline similar to that of *A. berneseae*, but is distinguished from it by its sculpture which is less pronounced and is restricted to the neck, and by its serrate to crenulate pseudostome periphery. *A. pistilliformis* is apparently a taxon morphographically closely related to *A. berneseae*, and has been reported from Middle and Upper Llandoveryan sediments of some wells in the Sahara (TAUGOURDEAU, 1962; 1965 - thesis).

Angochitina valentini and *A. valentini aspera* CRAMER, 1964 — Body chamber of both taxa piriform to oval, relatively longer than that of *A. berneseae*; the taxa are also differentiated by their sculpture: psilate to echinate with sculptural elements that are widely spaced and are short.

***Angochitina calandrai* n. sp.**

(Plate III, figures 88 and 89*.)

Body chamber piriform with a round bottom; basal edge absent; flexure pronounced. Neck short (0.3 of body chamber length), collar reduced or absent. Pseudostome periphery straight. A prosome is present in most specimens, no other internal structures were found. Vesicle wall smooth. Periderris surrounds most of the vesicle, and is often present in the form of a structure which strongly resembles the « post-collar » of *Plectochitina* (?) *pseudoagglutinans* (compare TAUGOURDEAU, 1963). The vesicle wall is thin

and frequently wrinkled. $L=135-150\ \mu$ ($140\ \mu$); $l_1=80-90\ \mu$; $l_2=l_3=40-45\ \mu$. Holotype: 0910-A-13: 118.3×33.5 , from section El Tueiro.

Comparison. — No described taxa resemble the present species closely enough to present problems with identification.

Angochitina eisenacki BACHMANN, SCHMID and PREY, 1964.

(Plate IV, figures 87 and 93.)

Body chamber oval to piriform; neck cylindrical with a slightly widened mouth, grades into collar; pseudostome periphery serrate to crenulate. Collar and upper part of neck transparent, lower part of neck and body chamber opaque to, rarely, translucent. The ratio of length of neck to length of body chamber is approximately 1. No internal structures seen. The sculpture of branching filose ornaments is most pronounced and largest at the body chamber, but although the sculpture decreases in importance towards the collar, no forms with a psilate collar were found. The species is a very rare constituent of San Pedro assemblages.

Previous records, comments. — *Angochitina eisenacki*, in BACHMANN, SCHMID and PREY, 1964 — Holotype and an additional specimen figured and described from the Silurian Hochwipfel Formation, Austria. The specimens found in the San Pedro Formation are quite similar to the specimen illustrated in the line drawing of plate IV: 35 in BACHMANN, SCHMID and PREY'S paper.

Angochitina elongata EISENACK, 1931.

A rare constituent in assemblages with *A. longicolla* and related forms, *A. elongata* is apparently an extreme in this formgroup of morphologically related taxa. It is so rare that it is practically useless for correlation purposes in the region studied.

Previous records. — *Angochitina elongata*, in EISENACK, 1931 — Holotype and an additional specimen figured and described from an erratic pebble of the Baltic Silurian.

Angochitina elongata, in EISENACK, 1964 — Neotype figured; occurrence reported in the Lower Ludlovian Hemse Formation (western facies), Baltic region.

Angochitina filosa EISENACK, 1955.

(Plate IV, figures 98, 99 and 101.)

The specimens found in the study region show a less pronounced sculpture of filose elements (especially at the neck of the specimens), than the specimens recorded by EISENACK from the Baltic region. No trend could be established for the changes in number and size of sculptural elements. Although the upper part of the neck is less opaque than the lower parts of the vesicle, no internal structures could be seen. The pseudostome periphery is serrate to crenulate in well preserved specimens. The sculptural elements originate in the opaque ectoderre. No periderre was observed.

Previous records, comments. — *Angochitina filosa*, in EISENACK, 1955 — Holotype and two additional specimens figured and described. The specimens were prepared from an erratic pebble supposedly derived from the Upper Ludlovian Beyrichia Limestone in the Baltic region. The three specimens figured show a more pronounced cover of sculptural elements than the great majority of the specimens found in Spanish sediments. The size range indicated by EISENACK for the Baltic forms is similar to that of the Spanish, however, large forms dominate in the Spanish assemblages.

Angochitina filosa, in TAUGOURDEAU, 1961 — Occurrence of the species reported in sediments of Silurian age in SW France.

Angochitina cf. *filosa*, in EISENACK, 1964 — One specimen figured, apparently from the Lower Ludlovian Hemse Group; it has a greater similarity to the Spanish forms than the type specimen of the species.

Angochitina filosa, in CRAMER, 1964 — Two specimens figured; the specimens have a lower number of sculptural elements than the type specimen of the species. Reported from upper part of the Formigoso Formation and the lower part of the San Pedro Formation, Wenlockian (not: Tremadocian), part, to Ludlovian, part, NW Spain.

Angochitina cf. **longicolla** complex
of morphographically related forms.

In this formgroup are placed the numerous specimens which occur over great horizontal distances, but with a fairly short vertical range. The group comprises a morphographically graded series of forms with characteristics transitional between *Angochitina longi-*

colla, *Angochitina elongata*, *Angochitina (Sphaerochitina) sphaerocephala* sensu lato, *Angochitina (Sphaerochitina) longicollis*, *Angochitina filosa*, *Angochitina valentini*, *Angochitina valentini aspera*. The characteristics of the species placed in this complex are discussed under their taxonomic identifications.

It is remarkable that all the above mentioned taxa have been reported from sediments of roughly the same age (Middle or Upper Llandoveryan to approximately Lower Wenlockian) of largely distant regions.

***Angochitina longicollis* EISENACK, 1959.**

[Plate IV, figures 100, 102, 106, and 111 (?).]

As was illustrated previously TAUGOURDEAU and DE JEKHOWSKY, *A. longicollis* and related forms (Llandoveryan, Sahara) show a great variability of vesicle sculpture. Most any sculpture type from psilate to densely spinose by slightly echinate or spinose, may be found. The same sculpture variety was met with in the Spanish forms, but a dominance of psilate or lightly sculptured forms over densely covered specimens was observed. The outline of the body chamber was found to range from nearly spherical to elongately piriform, with a slight numerical dominance of the more spherical forms over the elongate ones. The recorded variations appear to be without use for stratigraphic purposes.

Previous records, comments. — *Angochitina longicollis*, in EISENACK, 1959 — Holotype and an additional specimen figured and described from the Upper Llandoveryan Upper Visby Marl, Gotland. *A. longicollis* differs from *A. elongata* by the length of the neck which is greater than the body chamber length in *A. longicollis*, and shorter than the body chamber length in *A. elongata*. The average sculpture is the more pronounced in *A. longicollis* populations. (This does not hold true for the Spanish assemblages-F.H.C.)

Angochitina longicollis, in TAUGOURDEAU and DE JEKHOWSKY, 1960 — Five specimens figured and briefly described. They illustrate the wide variability of body chamber form, body chamber length to neck length ratio, and sculpture form and density, of specimens recorded from (Upper) Llandoveryan sediments in some wells in the Sahara.

Angochitina longicollis, in EISENACK, 1964 — One specimen figured; occurrence reported: Llandoveryan Visby Marl, Gotland.

Angochitina longicolla, in CRAMER, 1964 — One specimen figured; range indicated not correct, the correct range is: lower part of the San Pedro Formation.

Angochitina longicolla, in BACHMANN, SCHMID and PREY, 1964 — Two specimens figured and extensively described from a very small Silurian faunule in Austria.

Angochitina cf. *longicolla*, in TAUGOURDEAU, (1965 - thesis) — One specimen figured from the Llandoveryan in Gotland. This specimen is most similar to the majority of the NW Spanish forms.

Angochitina (Sphaerochitina) longicollis
(TAUGOURDEAU and DE JEKHOWSKY, 1960).

(Plate IV, figures 97, 103, 107 and 108.)

This taxon occurs in assemblages with, among others, *A. (S.) sphaerocephala*, and is morphographically linked to this species by a series of transitional forms. However, *A. longicollis* (with a ratio of neck length to the body chamber length which is more than 4) is more common in the lower part of the San Pedro Formation and the upper part of the Formigoso Formation than in the over and underlying parts of the sequence. Although *A. sphaerocephala* is fairly common in the uppermost part of the San Pedro Formation, no specimens of *A. longicollis* s. s. were identified.

The body chamber is predominantly spherical, rarely piriform or oval; due to compression, forms with a flat, or even convex bottom occur also. The neck and collar are cylindrical to slightly conical with a somewhat expanded mouth. The pseudostome periphery is crenulate in well-preserved specimens. A prosome which often occupies the entire length of the neck, was found in most transparent and translucent specimens. The wall is psilate to finely granulate (sculptural elements up to 1 μ in height and basal diameter). Forms with an increasingly pronounced sculpture can be placed in a graded series of morphographically related specimens which links *A. longicollis* with *A. longicolla*. However, forms with a more pronounced sculpture have a relatively shorter neck (ratio neck to body chamber length approximately 3 or less) and usually have a somewhat more piriform body chamber. The width of the neck is slightly larger in *A. longicolla* and related forms.

Previous records, comments. — *Sphaerochitina longicollis*, in TAUGOURDEAU and DE JEKHOWSKY, 1960 — Holotype

figured and described from sediments of Llandoveryian age in two wells in the Sahara. The central invagination of the body chamber which is reported by T. and J. might be due to the compression of the specimens during the fossilization. This structure has not been found in Spanish specimens.

Sphaerochitina longicollis, in TAUGOURDEAU, 1962 — One specimen figured from Middle or Upper Llandoveryian sediments in some wells in the Sahara. The specimen has a broader and shorter body chamber than the forms from the Spanish Silurian.

Sphaerochitina longicollis, in CRAMER, 1964 — One specimen figured. This specimen has an incomplete body chamber. The occurrence indicated is not correct, the true occurrence is: upper part of the Formigoso Formation, lower part of the San Pedro Formation.

Angochitina (Sphaerochitina) sphaerocephala (EISENACK, 1931).

(Plate IV, figure 113.)

In the Spanish assemblages two formgroups of similar outline but different size are distinguished. One taxon is quite similar to the type specimen of the species; this taxon is plotted as *A. sphaerocephala*. The size and outline of the Spanish forms correspond well with the characteristics indicated by EISENACK in 1931 and 1934.

The other taxon is of identical outline as the previous but it is considerably larger (L-up to 300 μ). It might be conspecific with *Angochitina (Sphaerochitina) sphaerocephala magna*.

Previous records of the taxa pertinent to the present study. — *Sphaerochitina sphaerocephala*, in EISENACK, 1964 — Forms with morphographic characteristics transitional to *Angochitina (Sphaerochitina) acantifera* and *Angochitina ceratophora* are recorded. Occurrences cited in this and previous records: Silurian, E₂, in Bohemia; Moldavian basin, Silurian; Eke Formation (Middle Ludlovian) and Hemse Formation (Lower Ludlovian), Gotland.

Sphaerochitina sphaerocephala magna, in TAUGOURDEAU and DE JEKHOWSKY, 1960 — Holotype illustrated and briefly described. Occurrence: Devonian, pre-Siegenian, in a well in the Sahara.

Angochitina spinosa (EISENACK, 1932).

A few specimens, tentatively attributed to *A. spinosa*, were found in the San Pedro Formation. These specimens are similar to the specimen figured in plate II, figure 2, of EISENACK's 1959 paper.

Previous records. — *Conochitina spinosa*, in EISENACK, 1932 — Holotype and two additional specimens figured and described from Silurian erratic pebbles.

Ancyrochitina spinosa, in DUNN, 1959 — Five specimens figured and described from the Devonian Cedar Valley Limestone, Solon Member, Iowa.

Ancyrochitina spinosa, in EISENACK, 1959 — Neotype and an additional specimen figured and briefly described. $L=109-155\ \mu$. *A. spinosa* is similar to *A. ancyrea* and obviously related to this species in that the aboral pole possesses a flat to invaginate body chamber. However, if the body chamber bottom is inflated, which also is found in *A. ancyrea*, and if the sculpture is excessively developed, the specimens become similar to *A. devonica*. The species occurs in the Wenlockian Slite Marl and Slite Limestone, Gotland, and perhaps also in the Upper Ludlovian Beyrichia Limestone in Gotland. (Compare *A. sp. aff. spinosa*, in EISENACK, 1955 — where a form intermediate between *A. echinata* and *A. spinosa* is reported).

Angochitina spinosa, in CRAMER, 1964 — The species is reported from the Siegenian to Emsian in NW Spain. The specimen figured has an inconspicuous sculpture.

Ancyrochitina spinosa, in GRIGNANI and MANTOVANI, 1964 — The specimens figured are reported to be identical to those described and illustrated by EISENACK in his 1932 paper. In Morocco, the species occurs in the Upper Devonian of some wells.

Angochitina (Sphaerochitina) valentini CRAMER, 1964,
and **Angochitina valentini aspera** CRAMER, 1964.

(Plate IV, figures 104, 105, 112, 114, 115, and 119.)

Both taxa show a wide variability in vesicle outline and sculpture, ranging from psilate to densely echinate. They are placed in the same complex of morphographically related taxa as *A. longicolla*, *A. elongata*, *A. filosa*, *A. sphaerocephala*, *A. longicollis*.

Both *A. valentini* and *A. valentini aspera* show a similar variability in outline, ratio of length of neck to body chamber length, etc. They are extremes of a complex of closely related taxa, however, whether they belong to one single species (as is suggested by the fact that they have ranges and a lateral distribution which precisely coincide) will be determined by a statistical study of the above mentioned complexes only.

Previous records. — *Angochitina valentini*, *Angochitina valentini aspera*, in CRAMER, 1964 — Holotypes and five additional specimens figured and described. The illustrations show the great variability in form found in the taxa. The ranges indicated are incorrect, compare figures 1 thru 4 of the present paper.

Angochitina form. I.

(Plate IV, figures 116 thru 118.)

Body chamber subspherical; flexure pronounced. Neck and collar reduced; pseudostome periphery straight. No internal structures observed. Although the taxon is common in some scattered samples, the establishment of a formal species for this form seems premature because of the lack of characteristic, distinctive features and its rather great variability.

Angochitina form. II.

(Plate IV, figures 109 and 110.)

Chitinozoans in size and outline similar to *Angochitina sphaerocephala* (EISENACK, 1931) occur in the Formigoso Formation. They differ from this species by having a tuberculate vesicle wall. Because no more than some ten specimens were recorded, no attempt was made to establish a new species for these forms.

K. — Formgenus *Ancyrochitina* EISENACK, 1955.

« Chitinozoen mit nahezu zylindrischem Unterteil ($\frac{1}{3}$ - $\frac{2}{3}$ der Gesämlänge) und umgekehrt kegelförmigen, seltener kugligem Oberteil. Polfläche \pm eben, schwach eingedellt oder ausgebaucht. Rand der Polfläche mit verhältnismässig wenigen (etwa 4-10, meist 5-8) kräftigen, \pm langen, einfachen, bzw. gegabelten oder auch recht unregelmässig verästelten Armen besetzt. Grösse zwischen 0,1-0,3 mm. »

Type species of the genus: *A. ancyrea* (EISENACK, 1931).

Ancyrochitina ancyrea complex of morphographically related forms.

In the present study the system of Eisenack in dealing with this complex of forms is followed (EISENACK, 1964, page 322,).

Ancyrochitina ancyrea (EISENACK, 1931).

[Plate V, figures 125 and 126 (cf.).]

Forms similar to the figured specimen occur in the San Pedro Formation, together with representatives of the *A. desmea*, *A. tumida*, *A. fragilis* s.s. group of morphographically related taxa. This complex is characterised by six to twelve (average, ten) relatively simply branched appendices situated at the aboral pole of the body chamber. The ectoderme is smooth; a prosome is often present; the collar has a slightly serrate periphery. The forms found in the San Pedro Formation are most similar to those reported by EISENACK (1955, plate II, figures 7, 8, 9) from the Upper Ludlovian Beyrichia Limestone in the Baltic region.

Previous records, comments. — *Conochitina ancyrea*, in EISENACK, 1931 — Holotype and four additional specimens described and figured from an erratic pebble (Silurian, Baltic region). The specimens figured are quite similar to those found in the San Pedro Formation.

Conochitina metancyrea, in EISENACK, 1934 — Four specimens described and figured from an erratic pebble (Silurian, Baltic region). The figured specimens are similar to those found in the San Pedro Formation.

Conochitina protancyrea, in EISENACK, 1937 — Five specimens figured and described from erratic pebbles of approximately Upper Silurian age from the Baltic region. The forms figured have shorter and more simple, thinner appendices than specimens from the San Pedro Formation.

Ancyrochitina ancyrea, in EISENACK, 1955 — Five specimens figured and described from the Upper Ludlovian Beyrichia Limestone. Additional comments on the variability of the taxon are given. The specimens found in the San Pedro Formation are similar to those figured in plate II, figures 7, 8, 9. Forms like the one figured in plate II, figure 15 have not been found in the Spanish assemblages.

Ancyrochitina ancyrea, in TAUGOURDEAU and DE JEKHOWSKY, 1960 — Seven specimens figured from Llandoveryan to Emsian sediments of some wells in the Sahara. Additional comments on the variability of the taxon are given. Specimens found in the San Pedro Formation are similar to those figured in plate I, figure 3, of Ordovician age (related to *A. desmea*, hic), plate I, figures 4, 5, of Silurian age (related to *A. desmea*, hic).

Ancyrochitina ancyrea, in TAUGOURDEAU, 1962 — The species is reported from Middle and Upper Llandoveryan sediments in some wells in the Sahara.

Ancyrochitina ancyrea, in BÉJU and DANET, 1962 — Nine specimens figured and briefly described from Silurian sediments in the Moldavian basin. Except for the specimen figured in plate I, figure 7, all B. and D.'s forms were also found in the San Pedro Formation.

Ancyrochitina ancyrea, in EISENACK, 1964 — Five specimens figured together with numerous specimens placed in the formgroup of taxa morphographically related to *A. ancyrea*. The great variability of the constituents of the formgroup is illustrated. Specimens found in the San Pedro Formation are similar to those figured in plate XXVII, figure 7 and plate XXIX, figure 4.

Ancyrochitina ancyrea, in CRAMER, 1964 — Reported from Llandoveryan to Emsian sediments in NW Spain. The specimens figured in plate XX, figures 25, 26, are from the upper part of the San Pedro Formation.

Ancyrochitina tumida, in CRAMER, 1964 — The specimen figured in plate XX, figure 9, is similar to *A. ancyrea* in EISENACK 1955, plate II, figure 7.

Ancyrochitina ancyrea, in SOMMER and VAN BOEKEL, 1964 — One specimen figured and described from Lower Devonian sediments in Brasil. This specimen is quite unlike any of the forms found in the San Pedro Formation. It differs from the San Pedro specimens by having two long appendices and a conical neck with wide pseudostome.

Ancyrochitina desmea EISENACK, 1964.

(Plate V, figure 124.)

Numerous forms were found in the middle and lower parts of the San Pedro Formation which are quite similar to the type specimen of the species. A great number of forms with characteristics transitional to those of *A. fragilis* and *A. tumida* were found in addition to *A. desmea*. The « pure » forms are characterised by six to twelve (average, ten) highly branched, stout appendices, situated at the aboral part of the body chamber, and by highly branched processes and spines on the neck. The collar is spinose. Most major appendices are hollow and originate in the body chamber ectoderre (which is generally opaque and black to dark brown in the San Pedro specimens). In a few specimens, the collar and upper part of the neck is transparent to translucent and shows traces of a prosome. No other internal structures were found. The root parts of the appendices and of the major processes are covered by the transparent periderre in some specimens. It could not be determined if the complete sculptural elements are covered, at least originally, by the periderre, nor could it be confirmed if the complete vesicle is covered by the periderre. *A. desmea* and its relatives are more common in the middle part of the San Pedro Formation than in older layers of the formation; they are absent in the Formigoso Formation.

Previous records, comments. — *Ancyrochitina desmea*, in EISENACK, 1964 — Holotype and five additional specimens figured and described from the Lower Ludlovian Hemse Formation (western facies) at Snoders, Baltic region. Forms similar to those figured by Eisenack occur in Spanish Ludlovian sediments.

Ancyrochitina fragilis EISENACK, 1955.

(Plate V, figure 133.)

The species is found in the San Pedro Formation together with other representatives of the *A. ancyrea* formgroup.

Previous records. — *Ancyrochitina fragilis*, in EISENACK, 1955 — Holotype and five additional specimens figured. $L=181-214\ \mu$. (The Spanish specimens are smaller). Occurrence reported in the Silurian Crinoid Limestone and in the Upper Ludlovian Beyrichia Limestone.

Ancyrochitina fragilis, in TAUGOURDEAU and DE JEKHOWSKY, 1960 — The variability of the species is discussed and the species is split in *A. fragilis*, *A. f. brevis*, *A. f. harpago*, *A. f. regularis*. Numerous figures accompany the discussion. The species is reported from Llandoveryan to pre-Emsian sediments in several wells in the Sahara.

Ancyrochitina fragilis, in BÉJU and DANET, 1962 — Three specimens described and figured from the Silurian of the Moldavian basin. The forms differ from some of those described by TAUGOURDEAU and DE JEKHOWSKY, (1960) by having a less rounded, piriform body chamber.

Ancyrochitina fragilis, in TAUGOURDEAU, 1962 — The species is reported from the Middle and Upper Llandoveryan of a well in the Sahara.

Ancyrochitina cf. *fragilis*, in TAUGOURDEAU, (1965 - thesis) — The form figured is from the Ludlovian in the Sahara.

***Ancyrochitina fragilis* (EISENACK, 1955) *regularis* TAUGOURDEAU and DE JEKHOWSKY, 1960, *Ancyrochitina fragilis* (EISENACK, 1955) *brevis* TAUGOURDEAU and DE JEKHOWSKY, 1960.**

(Plate V, figures 142 and 143.)

A graded series of forms transitional between *A. f. regularis* and *A. f. brevis* (cf. figure 12, in TAUGOURDEAU and DE JEKHOWSKY, 1960), occurs in assemblages recovered from sediments in the study region. The *regularis* variety is by far more abundant than the *brevis* variety. No difference in lateral or vertical ranges of both taxa was detected. If the complete *A. f. brevis* complex (as illustrated by T. and J. 1960) is to be included in the present taxon, it apparently has a far more restricted vertical extension in the Cantabrian Mountains than in the Sahara.

The appendices are hollow, and are continuous with the body ectoderre; a prosome is often present. The differences in outline of the vesicle have no stratigraphic use in the study region, and all forms between spherical and very elongately piriform body chambers have been found. The neck is cylindrical to conical with a wide oral opening; the pseudostome periphery is serrate to crenulate. The periderre is often still present on part of the body chamber and the root parts of the appendices.

Previous records, comments. — *Ancyrochitina fragilis regularis*, *Ancyrochitina fragilis brevis*, in TAUGOURDEAU and

DE JEKHOWSKY, 1960 — Holotype and some additional specimens figured and described from the Sahara. *A. f. regularis* extends through the basal Lower Devonian (pre-Siegenian). *A. f. brevis* (cf. T. and J.'s figure 12) is recorded in Llandoveryian thru pre-Siegenian sediments in four wells in the Sahara (compare TAUGOUR-DEAU, 1962).

Ancyrochitina fragilis brevis, in CRAMER, 1964 — Three specimens figured, from the Ludlovian to basal Lower Gedinnian San Pedro Formation in NW Spain.

***Ancyrochitina moldavica* BÉJU and DANET, 1962.**

(Plate V, figure 137.)

Body chamber oval to funnel shaped with round bottom; flexure prominent; shoulder inconspicuous or absent, basal edge rounded, and in well preserved specimens, not distinguishable in the vesicle outline. Neck cylindrical or slightly widened towards the oral pole. Collar inconspicuous with straight pseudostome periphery. Prosome and opisthosome present in many specimens. The body chamber bottom of some transparent to translucent specimens shows a set of darker lineations concentric to the aboral callus. The appendices are continuous with the vesicle wall and are solid. They are simple or may, to a minor extent, bifurcate. Length of the appendices, up to $0.5 l_1$ in the Moldavian specimens, but in the Spanish forms the length is usually less. Vesicle wall smooth. $L=140-170 \mu$; $l_1=70-90 \mu$; $l_2=30-40 \mu$; $l_3=40-55 \mu$.

Previous records, differences. — *Ancyrochitina moldavica*, in BÉJU and DANET, 1962 — Holotype and two additional specimens illustrated and described from the Silurian of the Moldavian basin. The authors differentiate *A. moldavica* from *A. fragilis* by its more delicate overall aspect; they differentiate *A. moldavica* from *A. tomentosa* by the absence of echinae on the vesicle wall, and from *A. tumida* by its oval chamber. The Spanish forms are quite similar to the holotype, but have a slightly longer neck and shorter appendices; they are morphographically nearer to *A. tumida* than the Moldavian forms.

Ancyrochitina cf. **pilosa** TAUGOURDEAU and DE JEKHOWSKY, 1960.

[Plate V, figure 130 (cf.)]

In assemblages with the *A. ancyrea*, *A. desmea*, *A. primitiva* complex, a few specimens similar to *A. pilosa* (cf. T. and J. 1960, plate II, figure 23) occur. The Spanish forms have a less pronounced filose sculpture on the upper part of the neck; they are very variable and distinguished with difficulty from *A. tumida*.

Previous records, comments. — *Ancyrochitina pilosa*, in TAUGOURDEAU and DE JEKHOWSKY, 1960 — Holotype and an additional specimen figured and described. The species has been recorded from two wells in the Sahara, in post-Llandoveryan to pre-Siegenian sediments.

Ancyrochitina pilosa curta, in TAUGOURDEAU, 1962 — Holotype and two additional specimens figured and described from Frasnian sediments in the Sahara. The specimens found in the Silurian San Pedro Formation have a slender oval to piriform body chamber, contrasted with the stout, flat-bottomed, funnel shaped body chamber of the Upper Devonian Sahara forms. The ratio neck length to body chamber length is larger in the Spanish forms. The sculpture on the upper part of the neck is more pronounced in the Sahara forms.

Ancyrochitina primitiva EISENACK, 1964.

(Plate V, figures 132, and 134 thru 136.)

Body chamber piriform to oval; two to twelve appendices present. The appendices are irregularly distributed near the aboral pole of the body. The form of the appendices ranges from simple and unbranched to branched as in *A. ancyrea*. A graded series of forms transitional between *A. ancyrea*, *A. spinosa*, *A. pilosa*, occurs together with *A. primitiva* in the study region.

The appendices are hollow and their wall is continuous with the body chamber wall. No diaphragm was seen. The ectoderme of appendices and body is structurally undifferentiated. No internal structures were found, although numerous perfectly transparent specimens were examined.

Previous records. — *Ancyrochitina primitiva*, in EISENACK, 1964 — Holotype and fifteen additional specimens figured and described. The great variability of the present taxon is stressed.

Occurrences : Visby Marl (Llandoveryan); Höglint Formation (Wenlockian); Halla Limestone (Wenlockian); Mulde Marl (Wenlockian), Gotland.

Ancyrochitina tumida TAUGOURDEAU and DE JEKHOWSKY, 1960.

(Plate V, figures 127 thru 129.)

The present species is apparently an extreme unit in a graded series of forms related to *A. demea*, *A. ancyrea* and *A. pilosa*. The form of the body chamber varies from conical with a flat aboreal part to piriform, or rarely, oval. The length of the neck varies from $\frac{1}{6}$ to $\frac{1}{2}$ of the vesicle length. Form number and size of appendices, variable, however, in most specimens six or more appendices are present.

The sculpture of the upper part of the vesicle is psilate to sparsely covered with filose elements.

Previous records, comments. — *Ancyrochitina tumida*, in TAUGOURDEAU and DE JEKHOWSKY, 1960 — Holotype and an additional specimen figured and described from Llandoveryan to Emsian sediments of two wells in the Sahara. The forms found in the San Pedro Formation are similar to the specimen figured in plate II, figure 31 (Silurian) of T. and J.'s 1960 paper.

Ancyrochitina tumida, in CRAMER, 1964, plate XX, figure 9 — The specimen shown should be attributed to *A. ancyrea*, rather than to *A. tumida*, since of the form of the appendices is different, and the collar and upper part of the neck are psilate.

Ancyrochitina tumida, in GRIGNANI and MAGLOIRE, 1964 — One specimen figured; range indicated as Silurian to Devonian in some wells in Morocco.

Ancyrochitina* (?) *vanoyenii n. sp.

(Plate IV, figures 94 and 95*.)

Body chamber piriform with a round bottom; basal edge absent; flexure pronounced. Neck short (up to $\frac{1}{3}$ of the body chamber length); collar reduced or absent. Pseudostome periphery straight. A prosome is present in most specimens, but no other internal structures were observed. Vesicle wall smooth. A ring of relatively long appendices is present near the aboral pole; these appendices are hollow and apparently are continuous with the vesicle wall,

but no lumen connecting the body cavity the central of the processes was found. The appendices seem to be composed of « spongy tissue », similar to that which is found in *Plectochitina carminae*. The vesicle wall is thin and frequently wrinkled. $L=135-150\ \mu$; $l_1=80-90\ \mu$; $l_2=l_3=40-50\ \mu$. Holotype : 0913-A-14, 118.6×31.8 , section El Tueiro.

The species is a rare constituent of basal Formigoso Formation assemblages. As it has a wide lateral distribution it may be useful for stratigraphic purposes despite its rarity.

L. — Formgenus **Plectochitina** CRAMER, 1964, emend. CRAMER, 1966.

« General outline flask shaped; appendices situated at aboral pole only, distally connected, often anastomosing. Collar transparent, with straight to crenulate pseudostome periphery; no prosome or other internal structures observed in the species described till date; neck subcylindrical to tapered towards body chamber; body chamber fungiform to flask shaped. Appendices may be solid at the base and spongy towards the distal parts. »

Remarks. — The appendices of many specimens are composed of two types of tissue : 1) at the root of the appendices, a hollow opaque to translucent part, and 2) the spongy tissue of the distal and often anastomosing parts of the appendices. Both tissue type show gradual transitions. It appears that the spongy tissue is continuous with the periderre, and that the opaque to translucent hollow part of the appendices is continuous with the body chamber ectoderre. In a few specimens of *P. carminae* which are broken just in the right places, it can be seen that the body cavity continues into the roots of the appendices.

Type species of the genus : *P. carminae* CRAMER, 1964.

Plectochitina carminae CRAMER, 1964.

(Plate V, figures 145 and 146.)

The proximal part (root) of the appendices is hollow and is continuous with the body cavity. The body chamber ectoderre is continuous with the opaque to translucent root part of the appendices; towards the distal part the appendices gradually change into spongy tissue. The spongy tissue is continuous with the appendix periderre, at least in some specimens. The configuration of the

anastomosing parts of the appendices may vary somewhat from specimen to specimen, but the species is clearly distinguished from the unnamed taxon shown by POU MOT and VAN OYEN on the range chart of the Proc. C.I.M.P., 1964 (1965): « répartition des chitinozoaires typiques. proposition pour séminaires », etc. In fact, no forms transitional to this taxon have been found in the study region.

Previous records, comments. — ?*Clathrochitina* sp. I, in TAUGOURDEAU and DE JEKHOWSKY, 1960, figure 32 — One damaged specimen figured from the uppermost Silurian of a well in the Sahara.

Plectochitina carminae, in CRAMER, 1964 — Holotype and an additional specimen figured from the upper part of the San Pedro Formation. (The species has been identified also in the Furada Formation in Asturias.)

Plectochitina carminae, in CRAMER, 1966 — One specimen figured; the generic definition is emended.

***Plectochitina combazii* n. sp.**

(Plate IV, figures 144, 148* and 149.)

Body chamber piriform, ovoidal to funnel shaped, with concave to flat bottom; flexure pronounced; neck cylindrical, grading into collar; collar diameter increases toward pseudostome; pseudostome periphery straight to serrate; opisthosome and prosome often present; no operculum found. At the basal edge of the body chamber two to three sets of simply anastomosing appendices are present. If two sets present, these are made up of approximately twelve individual appendices each, if three sets are present they are formed by four to eight appendices each. A concentric annular structure connects the appendices of each set distally. Except for the root part in some specimens, the appendices are entirely made up of spongy tissue. The spongy tissue is apparently continuous with the body periderre. Periderre psilate to slightly granulate (sculptural elements less than $1\ \mu$ wide and high); ectoderre often absent, but if present, opaque to translucent, smooth. $L=120-150\ \mu$; $l_1=60-70\ \mu$; $l_2=30-40\ \mu$; $l_3=30-40\ \mu$; length of appendices approximately $20\ \mu$. Holotype: 0911-H-14, 113.9×49.7 , section El Tueiro.

Comparisons. — *Plectochitina carminae*, CRAMER, 1964 — Appendices arranged in a greatly complex anastomosing pattern. The structure that connects the distal parts of the appendices is

continuous and, in well preserved specimens, has a starlike general outline.

Ancyrochitina saharica TAUGOURDEAU, 1962 — As far as could be judged from the photographs and the description of the holotype, this species has long, non-anastomosing appendices.

Remark. — A specimen with appendices similar to, but longer than those of *P. combazii* is figured as taxon number 55 of POU MOT and VAN OYEN's above mentioned « répartition des chitinozoaires typiques ». The range of this taxon indicated as basal Silurian to basal Lower Devonian. This range is longer than that of *P. combazii*.

***Plectochitina rosendae* CRAMER, 1964.**

(Plate V, figure 139.)

The root part of the appendices is hollow and grades into the spongy tissue of the distal part of the appendices; at the connection point of the appendices an irregularly shaped thickening is often present. This structure is also formed by spongy tissue, but the tiny elements that compose it are distinguished from the rest of the spongy tissue by their slightly thicker walls. No internal structures observed in the vesicles; no periderme found.

Previous records. — *Plectochitina rosendae*, in CRAMER, 1964 — One specimen figured and described from the upper part of the San Pedro Formation.

Plectochitina rosendae, in CRAMER, 1966 — One specimen figured.

The following species are tentatively attributed to *Plectochitina*, rather than to *Ancyrochitina*, on the assumption that the spongy tissue of the appendices is an essential and differentiating characteristic that can be used to effectively reduce the size of the genus *Ancyrochitina*.

***Plectochitina* (?) *pseudoagglutinans* (TAUGOURDEAU, 1963).**

(Plate V, figures 140, 141 and 147.)

Body chamber funnel shaped to piriform; shoulder pronounced; bottom concave to flat; basal edge rounded but conspicuous. Neck cylindrical or with increasing diameter towards pseudostome. Col- lar transparent, pseudostome periphery straight. Opisthosome and

prosome present in many specimens. In a few specimens a detached operculum was found in the upper part of neck or collar. The specimens which show this feature are apparently restricted to the basal part of the Formigoso Formation, and differ from the specimens that occur in the San Pedro Formation, by their larger size, thicker appendices, and a more funnel shaped body chamber. The older specimens also show a greater tendency to occur in configurations that suggest a colonial habitus of two or three units together. Of the San Pedro specimens, the appendices are few in number and the root part is continuous with the body chamber wall. Except for the very root part, the appendices are completely composed of spongy tissue. As the appendices are very fragile, many specimens are found without appendices at all. However, judging from the location of the remainder of the partially damaged appendices, 4 to 8 appendices were originally present. $L=90-180\ \mu$ (average $160\ \mu$); $l_1=70-110\ \mu$ (average $90\ \mu$); $l_2=30-40\ \mu$; $l_3=40-60\ \mu$. Ectoderre and periderre psilate to slightly granulate (elements less than $1\ \mu$ high and wide).

Previous records, comments. — *Ancyrochitina fragilis pseudoagglutinans*, in TAUGOURDEAU, 1963 — Holotype and five additional specimens figured and described. They are found in the Middle and Upper Ludlovian in some wells in the Sahara. The Spanish specimens have, on the average, a shorter neck, and a less rigid appearance than the Sahara forms, but this may be a result of fossilization or may be due to the preparation method applied. In none of the Spanish forms a « post-collar » structure was found, neither were forms with a subspherical to oval body chamber observed. (cf. TAUGOURDEAU, 1963, plate I, figures 5, 6.)

Ancyrochitina ancyrea, in TAUGOURDEAU and DE JEKHOWSKY, 1960 — Reattributed to *A. f. pseudoagglutinans* by TAUGOURDEAU in 1963. Same remarks as for the above entry.

Ancyrochitina sp., in TAUGOURDEAU, 1963 — Middle and Upper Llandoveryan of a well in the Sahara. Three specimens illustrated. The specimen shown in plate II, figure 20, is quite similar to the Spanish forms.

Plectochitina pseudoagglutinans, in CRAMER, 1964 — One specimen figured from the upper part of the San Pedro Formation. The specimen figured is fairly representative for the specimens found in this part of the column. It differs from the older forms, found in the Formigoso Formation, by its more rigid appendices with tiny expansions or knobs at the distal parts. However, these features

might represent merely variations and both forms may belong to the same taxon. Yet, the forms do not occur together in the upper part of the Formigoso Formation or in the basal part of the San Pedro Formation where one would expect representatives of both forms, if they were merely varieties.

***Plectochitina* (?) *taugourdeau* n. sp.**

(Plate IV, figures 92 and 96*.)

Body chamber elongately piriform, occasionally oval, no shoulder developed. Specimens with a piriform body chamber have a gradual transition to the neck, but in specimens with an oval body chamber a distinct flexure is present. Body chamber bottom round, basal edge inconspicuous, round. The neck is long and grades into the collar which has a slightly increased diameter at the pseudostome. Pseudostome periphery straight to serrate. Two to seven thick, but fragile appendices are situated at the edge of the body chamber. The appendices are entirely composed of spongy tissue, which is continuous with the body chamber periderre. No lumen found in ectoderre. The exact form of the appendices is unknown at this date because all specimens found have broken appendices. A prosome is present in many specimens and an aboral darkening, which might be an opisthosome, is present in some. Both periderre and ectoderre are smooth.

The taxon is rather variable in size: $L=180-295\ \mu$; $l_1=80-100\ \mu$; $l_2=35-45\ \mu$, $l_3=40-50\ \mu$; dimensions of holotype: $L=270\ \mu$; $l_1=95\ \mu$; $l_2=40\ \mu$; $l_3=45\ \mu$. Holotype: 0909-A-2, 118.7×26.7 , from section El Tueiro.

Comparison. — *Plectochitina* (?) *longicornis* (TAUGOURDEAU and DE JEKHOWSKY, 1960) — Two or three appendices situated on or near the aboral pole. Body chamber oval, flexure clearly developed. $L=200\ \mu$; $l_1=70\ \mu$.

Plectochitina (?) *pseudoagglutinans* (TAUGOURDEAU, 1963) — Body chamber of different outline. $L=190\ \mu$; $l_1=100\ \mu$. Appendices of type specimen shorter and thinner.

Plectochitina (?) *nodosa* (TAUGOURDEAU and DE JEKHOWSKY, (1960) — $L=180\ \mu$; $l_1=60\ \mu$. Structure of appendices different. Flexure well developed, body chamber of different outline.

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b) SYSTEMATIC TAXONOMIC PART.

In lieu of listing the 63 references to papers published before 1963 which were consulted during preparation of this report, the reader is referred to the extensive annotated bibliography by Taugourdeau and Bouché:

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Manuscript received, May 1966.

PLATE I

EXPLANATION OF PLATE I.

(Scale units are 50 μ , unless otherwise stated.)

1. *Cyathochitina campanulaeformis* (EISENACK, 1931).
2. *Cyathochitina campanulaeformis* (EISENACK, 1931).
3. *Cyathochitina campanulaeformis* (EISENACK, 1931).
4. Detached body chamber bottom and cingulum of *Cyathochitina campanulaeformis* (EISENACK, 1931).
5. *Cyathochitina campanulaeformis* (EISENACK, 1931).
6. *Cyathochitina campanulaeformis* (EISENACK, 1931).
7. *Cyathochitina* cf. *dispar* BENOIT and TAUGOURDEAU, 1961.
8. *Cyathochitina* cf. *dispar* BENOIT and TAUGOURDEAU, 1961.
9. *Cyathochitina alata* TAUGOURDEAU and DE JEKHOWSKY, 1960.
10. *Cyathochitina elenitae* CRAMER, 1964.
11. *Cyathochitina elenitae* CRAMER, 1964.
12. *Cyathochitina clathrata* (EISENACK, 1959).
13. *Cyathochitina clathrata* (EISENACK, 1959).
14. *Cyathochitina clathrata* (EISENACK, 1959).
15. *Ambitisporites avitus* HOFFMEISTER, 1959 (scale units are 17 μ).
16. *Amocosporites miserabilis* CRAMER, 1966 (scale units are 17 μ).
17. *Cyathochitina clathrata* (EISENACK, 1959).
18. Detached body chamber bottom and cingulum of *Cyathochitina clathrata* (EISENACK, 1959).
19. Detached body chamber bottom and cingulum of *Cyathochitina clathrata* (EISENACK, 1959).
20. Sporomorph of unknown affinity (scale units are 17 μ).

All spores and sporomorphs shown on this plate and on plate III are from the San Pedro Formation.

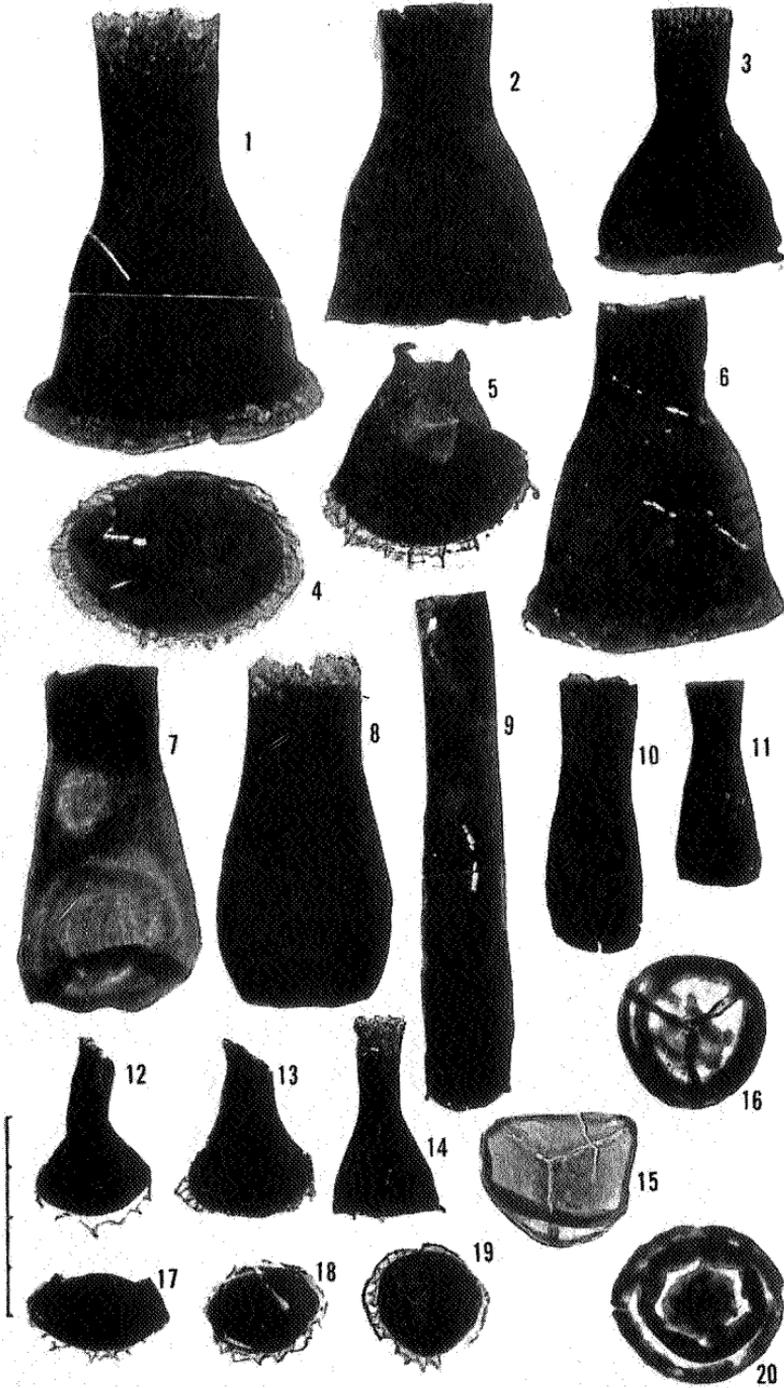


PLATE II

EXPLANATION OF PLATE II.

(Scale units are 50 μ .)

21. *Conochitina gordonensis* CRAMER, 1964.
 22. *Conochitina gordonensis* CRAMER, 1964.
 23. *Conochitina brevis* TAUGOURDEAU and DE JEKHOWSKY, 1960.
 24. *Conochitina brevis* TAUGOURDEAU and DE JEKHOWSKY, 1960.
 25. *Conochitina gordonensis* CRAMER, 1964.
 26. *Conochitina parvidecipiens* n. sp.
 27. *Conochitina parvidecipiens* n. sp.
 28. *Conochitina lagenoforma* n. sp.
 29. *Conochitina lagenoforma* n. sp.
 30. *Conochitina lagenoforma* n. sp.
 31. *Conochitina* sp. intermediate between *C. oelandica silurica* TAUGOURDEAU, 1963 and *C. edjelensis* TAUGOURDEAU, 1963.
 32. *Conochitina* sp. intermediate between *C. elenitae* CRAMER, 1964 and *C. parvidecipiens* n. sp.
 33. *Conochitina* cf. *edjelensis* TAUGOURDEAU, 1963.
 34. *Conochitina* cf. *edjelensis* TAUGOURDEAU, 1963.
 35. *Conochitina lagenoforma* n. sp.
 36. *Conochitina lagenoforma* n. sp.
 37. *Conochitina oelandica silurica* TAUGOURDEAU, 1963.
 38. *Conochitina oelandica silurica* TAUGOURDEAU, 1963.
 39. *Conochitina* cf. *elenitae* CRAMER, 1964.
 40. *Conochitina* cf. *edjelensis* TAUGOURDEAU, 1963.
 41. *Conochitina intermedia* EISENACK, 1955.
 42. *Conochitina oelandica silurica* TAUGOURDEAU, 1963.
 43. *Conochitina* sp. intermediate between *C. oelandica silurica* TAUGOURDEAU, 1963 and *C. edjelensis* TAUGOURDEAU, 1963.
 44. *Conochitina oelandica silurica* TAUGOURDEAU, 1963.
 45. *Conochitina* (?) *lagenomorpha* EISENACK, 1931.
 46. *Conochitina intermedia* EISENACK, 1955.
 47. *Lagenochitina vitrea* TAUGOURDEAU, 1962.
 48. *Conochitina edjelensis elongata* TAUGOURDEAU, 1963.
 49. *Conochitina edjelensis elongata* TAUGOURDEAU, 1963.
 50. *Conochitina edjelensis alargada* n. var.
 51. *Conochitina edjelensis* TAUGOURDEAU, 1963.
 52. *Conochitina oelandica silurica* TAUGOURDEAU, 1963.
 53. *Conochitina* sp. (Formigoso Formation).
 54. *Conochitina edjelensis* TAUGOURDEAU, 1963, ind. var.
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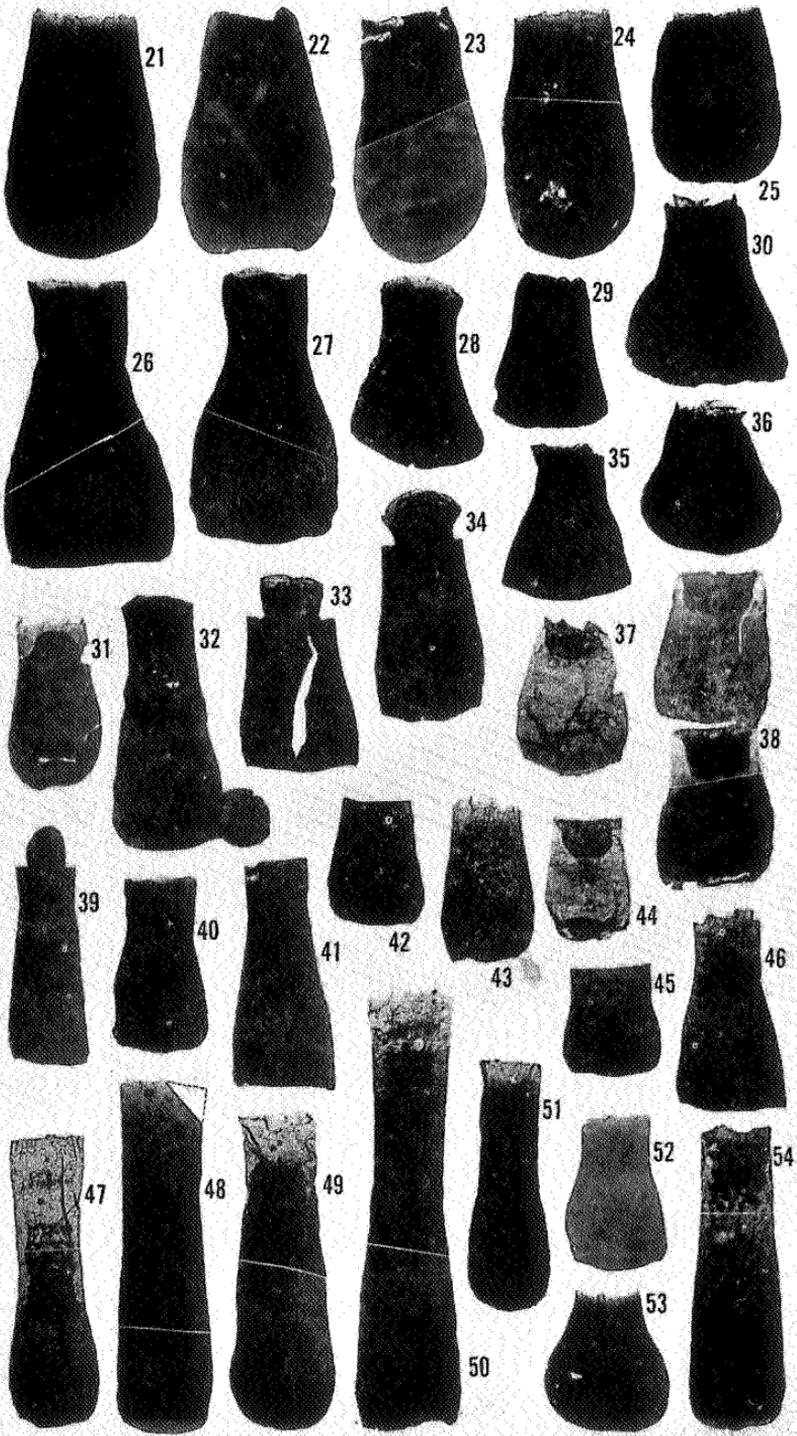


PLATE III

EXPLANATION OF PLATE III.

(Scale units are 50 μ , unless otherwise indicated.)

55. *Conochitina edjelensis alargada* n. var.
 56. *Conochitina gordonensis* CRAMER, 1964.
 57. *Sporomorph* of indeterminate affinity (scale units are 17 μ).
 58. *Pterospermopsis* sp. (scale units are 17 μ).
 59. *Conochitina elenitae* CRAMER, 1964.
 60. *Lagenochitina* sp. cf. *L. (?) macrostoma* TAUGOURDEAU and DE JEKHOWSKY, 1960, in: BÉJU and DANET, 1962, plate II, figure 15.
 61. *Pseudoclathrochitina carmenchuae* (CRAMER, 1964).
 62. *Conochitina brevis* TAUGOURDEAU and DE JEKHOWSKY, 1960.
 63. *Desmochitina elegans* TAUGOURDEAU and DE JEKHOWSKY, 1960.
 64. *Desmochitina elegans* TAUGOURDEAU and DE JEKHOWSKY, 1960.
 65. *Desmochitina* sp. intermediate between *D. elegans* TAUGOURDEAU and DE JEKHOWSKY, 1960 and *D. leonensis* CRAMER, 1964.
 66. *Pseudoclathrochitina carmenchuae* (CRAMER, 1964).
 67. *Lagenochitina vitrea* TAUGOURDEAU, 1962.
 68. *Desmochitina elegans* TAUGOURDEAU and DE JEKHOWSKY, 1960, form 1.
 69. *Desmochitina densa* EISENACK, 1962.
 70. *Desmochitina leonensis* CRAMER, 1964.
 71. *Eremochitina cingulata* (EISENACK, 1937).
 72. *Eremochitina cingulata* (EISENACK, 1937).
 73. *Lagenochitina vitrea* (TAUGOURDEAU, 1962) (scale units are 40 μ).
 74. *Desmochitina leonensis* CRAMER, 1964.
 75. *Desmochitina leonensis* CRAMER, 1964.
 76. *Hoegisphaera acollare* (EISENACK, 1959).
 77. *Hoegisphaera acollare* (EISENACK, 1959).
 78. *Hoegisphaera acollare* (EISENACK, 1959).
 79. *Pterochitina perivelata*? (EISENACK, 1937).
 80. *Lagenochitina vitrea* (TAUGOURDEAU, 1962).
 81. *Lagenochitina vitrea* (TAUGOURDEAU, 1962).
 82. *Desmochitina margaritana* EISENACK, 1937.
 83. *Desmochitina urna* EISENACK, 1934.
 84. *Pterochitina deichaii* TAUGOURDEAU, 1963.
 85. *Pterochitina perivelata*? (EISENACK, 1937) (scale units are 24 μ).
 86. *Lagenochitina vitrea* (TAUGOURDEAU, 1962).
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PLATE IV

EXPLANATION OF PLATE IV.

(Scale units are 50 μ .)

87. *Angochitina eisenacki* BACHMANN, SCHMID and PREY, 1964.
88. *Angochitina calandrai* n. sp.
89. *Angochitina calandrai* n. sp.
90. *Angochitina berneseae* n. sp.
91. *Angochitina berneseae* n. sp.
92. (?) *Plectochitina taugourdeauii* n. sp.
93. Fragment of *Angochitina eisenacki* BACHMANN, SCHMID and PREY, 1964.
94. (?) *Ancyrochitina vanoyenii* n. sp.
95. (?) *Ancyrochitina vanoyenii* n. sp.
96. (?) *Plectochitina taugourdeauii* n. sp.
97. *Angochitina longicollis* (TAUGOURDEAU and DE JEKHOWSKY, 1960*).
98. *Angochitina filosa* EISENACK, 1955*.
99. *Angochitina filosa* (?) EISENACK, 1955*.
100. *Angochitina longicolla* EISENACK, 1959*.
101. *Angochitina filosa* EISENACK, 1955*.
102. *Angochitina longicolla* EISENACK, 1959*.
103. *Angochitina longicollis* (TAUGOURDEAU and DE JEKHOWSKY, 1960*).
104. *Angochitina valentini aspera* CRAMER, 1964*.
105. *Angochitina valentini aspera* CRAMER, 1964*.
106. *Angochitina longicolla* EISENACK, 1959*.
107. *Angochitina longicollis* (TAUGOURDEAU and DE JEKHOWSKY, 1960*).
108. *Angochitina longicollis* (TAUGOURDEAU and DE JEKHOWSKY, 1960*).
109. *Angochitina* form II.
110. *Angochitina* form II.
111. *Angochitina longicolla* (?) EISENACK, 1959*.
112. *Angochitina valentii aspera* CRAMER, 1964*.
113. *Angochitina sphaerocephala* (EISENACK, 1931*).
114. *Angochitina valentini* CRAMER, 1964*.
115. *Angochitina valentini* CRAMER, 1964*.
116. *Angochitina* form I.
117. *Angochitina* form I.
118. *Angochitina* form I.
119. *Angochitina valentini* CRAMER, 1964*.
120. *Angochitina* sp. from the upper part of the San Pedro Formation at Los Barrios de Luna.

All specimens marked with an asterisk (*) are members of the *Angochitina* cf. *longicolla* complex of morphographically graded series of forms with characteristics transitional between *Angochitina longicolla*, *Angochitina elongata*, *Angochitina sphaerocephala* sensu lato, *Angochitina filosa*, *Angochitina longicollis*, *Angochitina valentini*, *Angochitina valentini aspera*. The specimens are identified to the nearest characteristic taxon.

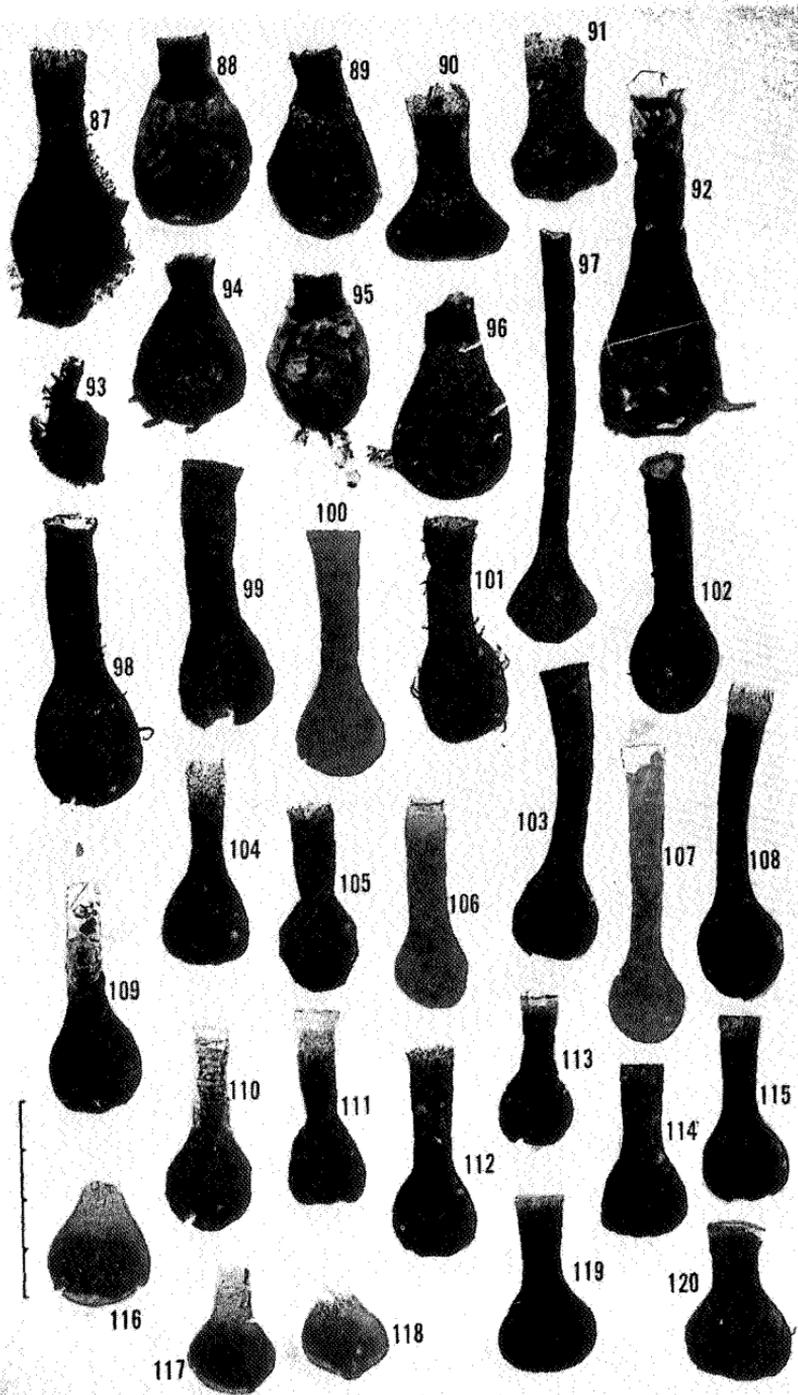


PLATE V

EXPLANATION OF PLATE V.

(Scale units are 50 μ , unless otherwise indicated.)

- 121 through 136. The *Ancyrochitina ancyrea* complex.
 137. *Ancyrochitina moldavica* BÉJU and DANET, 1962.
 138. *Ancyrochitina* sp. Formigoso Formation.
 139. *Plectochitina rosendae* CRAMER, 1964.
 140. (?) *Plectochitina pseudoagglutinans* (TAUGOURDEAU, 1963), Formigoso Formation.
 141. (?) *Plectochitina pseudoagglutinans* (TAUGOURDEAU, 1963), Formigoso Formation.
 142. *Ancyrochitina fragilis brevis* TAUGOURDEAU and DE JEKHOWSKY, 1960.
 143. *Ancyrochitina fragilis brevis* TAUGOURDEAU and DE JEKHOWSKY, 1960.
 144. *Plectochitina combazii* n. sp.
 145. *Plectochitina carminae* CRAMER, 1964. A redeposited specimen found in the (?) Upper Devonian Naranco Formation.
 146. *Plectochitina carminae* CRAMER, 1964.
 147. (?) *Plectochitina pseudoagglutinans* (TAUGOURDEAU, 1963), Formigoso Formation. Notice the operculum in the upper part of the neck and collar. Scale units are approximately 30 μ .
 148. *Plectochitina combazii* n. sp.
 149. *Plectochitina combazii* n. sp.
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