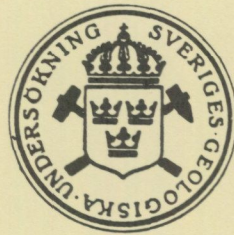


FLORENTIN PARIS  
SVEN LAUFELD AND IVO CHLUPÁČ

CHITINOZOA  
OF THE SILURIAN-DEVONIAN  
BOUNDARY STRATOTYPES IN BOHEMIA

WITH THREE PLATES



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Project  
ECOSTRATIGRAPHY

Addresses:

Florentin Paris  
Laboratoire de Paléontologie et Stratigraphie  
Centre Armoricaïn d'Etude structurale des Socles  
F-35042 Rennes-Cedex, France

Sven Laufeld  
Geological Survey of Sweden, Box 670  
S-751 28 Uppsala, Sweden

Ivo Chlupáč  
Ustřední ústav geologický  
Malostranské nám. 19  
CZ-118 21 Praha 1, Czechoslovakia

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## Abstract

Paris, F., Laufeld, S., and Chlupáč, I., 1981: Chitinozoa of the Silurian-Devonian boundary stratotypes in Bohemia. Sveriges geologiska undersökning, Ser. Ca. No. 51, pp. 1-29, Uppsala 1981.

Closely spaced samples across the Silurian-Devonian boundary in the type sections at Klonk and Karlštejn indicate the usefulness of chitinozoans in defining the boundary. Some chitinozoan associations are restricted to the upper Pridolian. At Klonk *Desmochitina urna* associated with *Linochitina klonkensis* does not range above Bed 20 which represents the top of the Silurian. The two species have a similar distribution in the Karlštejn section. The Pridolian is characterized by

thick-walled forms such as *Eisenackitina* and *Desmochitina*. In contrast, *Ancyrochitina* and *Angochitina*, especially *Angochitina chlupaci*, can be used in defining the basal Devonian (Lochkovian).

Four new species are described, viz. *Angochitina chlupaci*, *Desmochitina? suchomastyensis*, *Eisenackitina krizi*, and *Linochitina klonkensis*.

The possible biological affinity between Chitinozoa and graptolites is discussed and it is concluded that chitinozoans are not related to graptolites.

### Introduction

The interest in using Chitinozoa for dating Early Palaeozoic sedimentary rocks arose fairly late. Largely as a consequence of research by petroleum companies the importance of this group of fossils for detailed stratigraphic work and interbasin correlation was confirmed. However, publications on the occurrence and range of chitinozoans in international stratotypes are virtually nonexistent. Jenkins' (1967) work on Chitinozoa in the type Caradocian is one of the rare exceptions. This lack of studies in critical sections has led to a strange situation. Using Chitinozoa as exclusive evidence, some authors have referred rocks to stages or series in which chitinozoans are poorly known or not even studied. Unfortunately, very few detailed studies (Jenkins 1967; Pichler 1971; Laufeld 1967, 1974) have been made on the occurrence of Chitinozoa in the most important Ordovician-Devonian reference sections in Europe. As we have been involved in the selection of a boundary stratotype in the Barrandian, Bohemia, we have chosen two sections near Prague for a detailed range logging of Chitinozoa. The Klonk section at Suchomasty is the international stratotype and the Karlštejn section is the auxiliary stratotype for the Silurian-Devonian boundary (McLaren 1972; Martinsson 1977).

In addition to establishing which chitinozoan taxa occur in this geographical area and in this stratigraphic interval, we thought it would be of interest to find out whether or not there are any changes in the occurrence

and composition of the chitinozoan fauna in the interval below and above the boundary between the Silurian and Devonian systems. In fact, it would be of particular interest to find out whether the composition of the chitinozoan assemblages – like that of the graptolites – shows a major break at the systemic boundary or a gradual transition where the replacement of species takes place more or less continuously in the interval near the boundary. The answers to these questions are important because if there are few or no similarities in the distribution of chitinozoans and graptolites in these sections, it seems probable that the two groups of organisms are not closely related biologically. The occurrence and variations in composition of chitinozoan assemblages may help to explain the significance of the change in the macrofauna close to the boundary. Chitinozoans could also be of use in refining the correlation of those beds near the boundary which so far have not yielded any of the diagnostic macrofossils. A study of the chitinozoans (and other groups of macrofossils) might even throw some light on the significance of changes in the macrofauna close to the boundary. Was the rapid faunal change at the system boundary caused by an accelerated rate of evolution, by a marked change of ecological conditions or, as suggested by Davies & MacQueen (1977), by sedimentological processes which amassed material of different ages in one bed?

GENERAL PART

By

F. PARIS, S. LAUFELD AND I. CHLUPÁČ

SECTIONS STUDIED

The Silurian-Devonian formations in the Barrandian area (Fig. 1) form the centre of a syncline with gently dipping limbs where the transition from the Pridolian to the Lochkovian can be studied in several exposures.

Southwest of Prague the Lochkovian strata consist of two main facies, the Radotin and Kotys facies. The former is composed of fine-grained limestone intercalated with dark-coloured calcareous mudstone and the

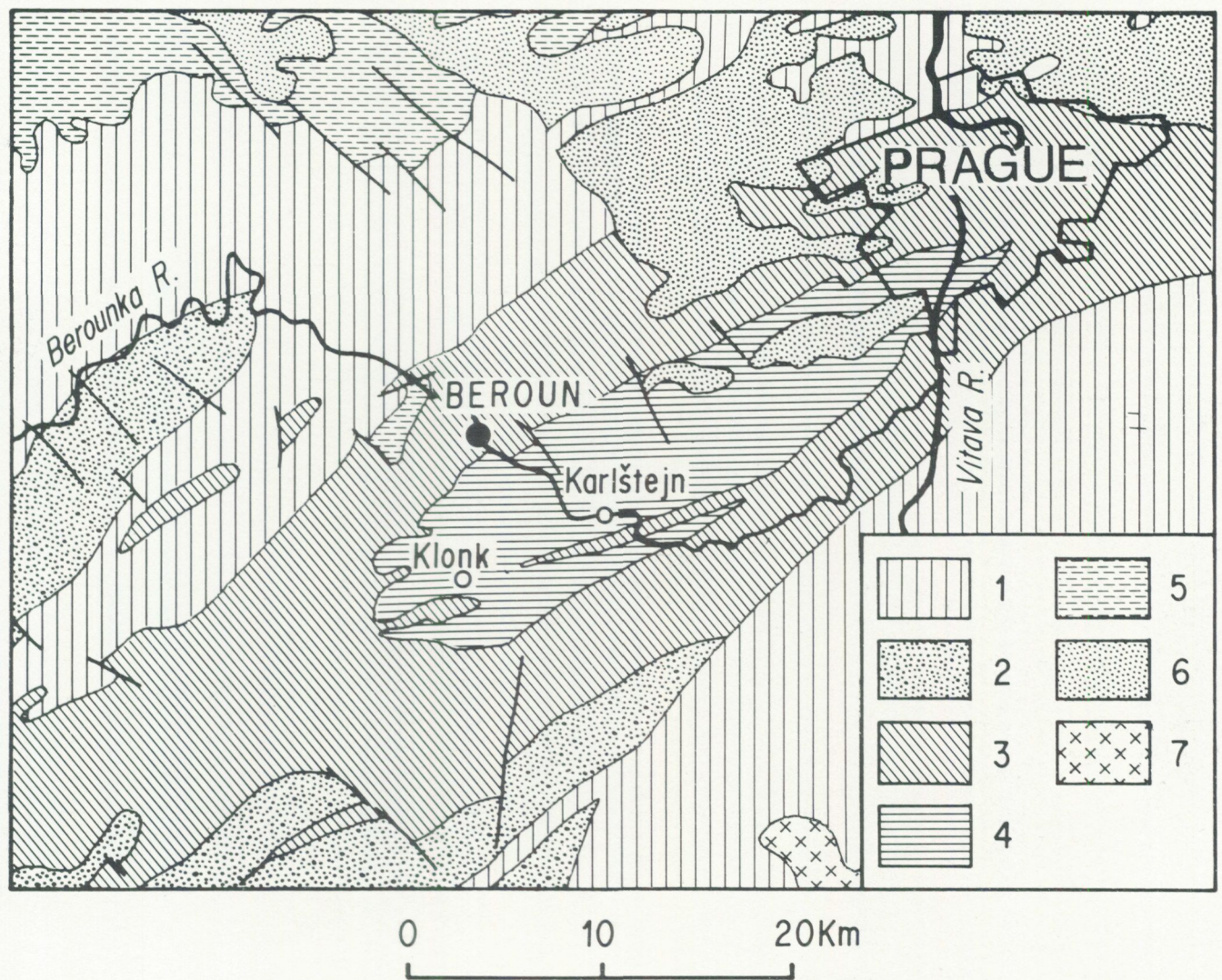


Fig. 1. Geological map of the central part of the Barrandian area showing locations of the Klouk and Karlštejn sections. Modified from Chlupáč 1978.

1 = Precambrian, 2 = Cambrian, 3 = Ordovician, 4 = Silurian and Devonian, 5 = Upper Carboniferous, 6 = Upper Cretaceous and Tertiary, 7 = Granitoids.

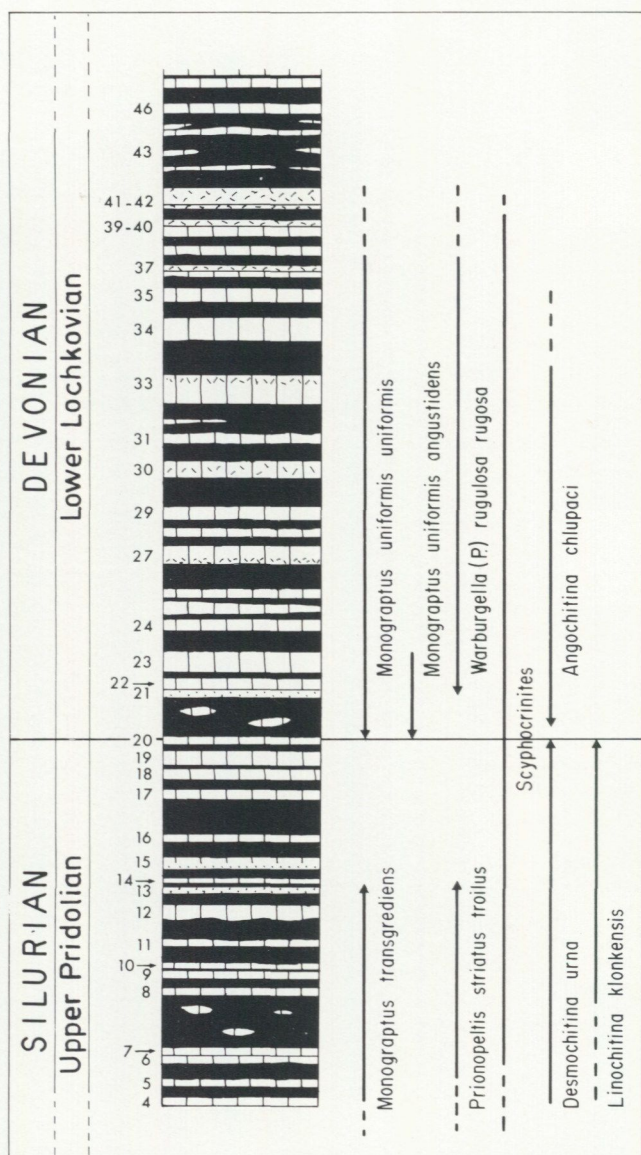


Fig. 2. Lithology of the Klonk section (for details, see Chlupáč *et al.* 1972) with stratigraphic ranges of index chitinozoans compared to those of the standard index graptolites, trilobites and crinoid.

latter of light-coloured bioclastic limestones. The Kotys facies represents sedimentation in well aeriated water that was shallower than that in which the Radotin deposition took place.

After considerations of, among others, size and condition of exposure and number of groups of fossils in the Barrandian sections, Klonk (close to Suchomasty) was selected as the Silurian-Devonian boundary stratotype (McLaren 1972). The Karlštejn section was chosen as an auxiliary stratotype.

A great number of detailed studies of the fossils of these two sections have been completed already (Chlupáč 1977:93). But so far, chitinozoans have been only briefly discussed (Eisenack 1934; Laufeld 1977a). Our preliminary studies indicated that a detailed scrutiny of the occurrence of Chitinozoa in the boundary stratotypes at Klonk and Karlštejn would be most useful for later correlations.

### KLONK

At Klonk, close to Suchomasty southwest of Prague, a hillside facing a river displays an excellent exposure of calcareous mudstones interbedded with dark grey to black limestones of the Radotin facies representing fairly deep water deposition. In this section it is possible

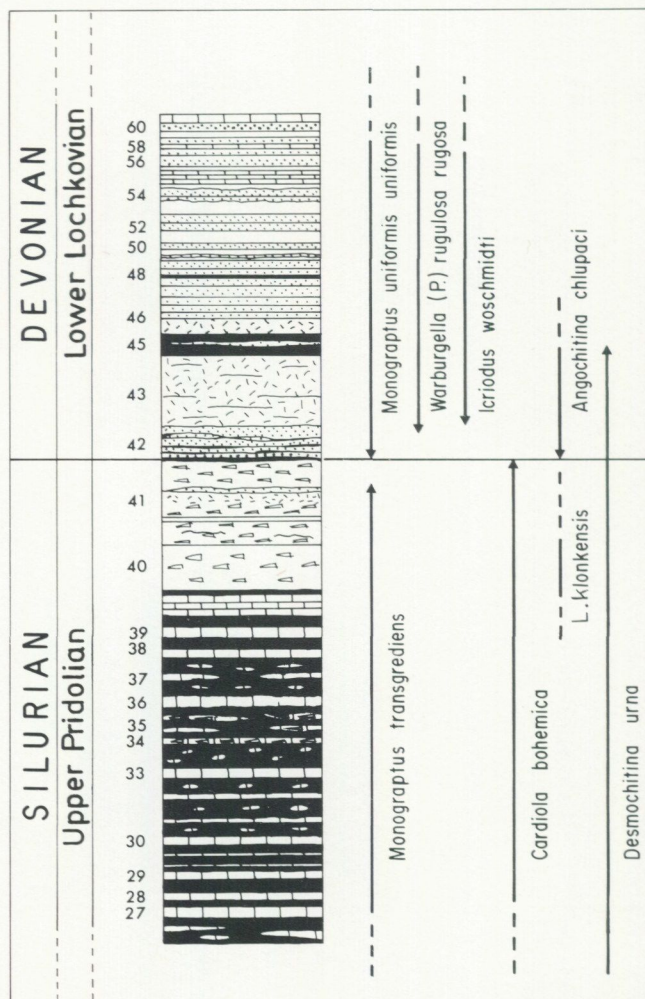


Fig. 3. Lithology of the Karlštejn section (for details, see Chlupáč *et al.* 1972) with stratigraphic ranges of index chitinozoans compared to those of the standard index graptolites, trilobites, conodont, and bivalves.

CHITINOZOA OF THE SILURIAN-DEVONIAN BOUNDARY STRATOTYPES IN BOHEMIA



Fig. 4. Biostratigraphy, relative frequency and abundance of Chitinozoa in the Klonek section. Silurian-Devonian boundary marked by arrow. Hatched areas represent unsampled parts of the section. The black areas mark relative frequency in per cent (full column width = 100%). A relative frequency of less than 3% is marked by a star. ? = Possible occurrence; material poorly preserved. Lithology after Chlupáč *et al.* 1972.

to recognize the Pridolian-Lochkovian boundary only by a scrutiny of the fossils because of the lithological uniformity of the succession (Horný 1955; Chlupáč 1953, 1977; Chlupáč *et al.* 1972).

The most important fossils for recognizing the Pridolian part of the section are the graptolites, particularly *Monograptus transgrediens* Perner, which ranges up to the top of the mudstone of Interbed 13-14 (Fig. 2), brachiopods (*Dayia bohemia* Bouček), and bivalves - *Pterochaenia (Joachymia) falcata* Barrande, *Pterinopecten (Pterinopecten) cybele* (Barrande).

The base of the Lochkovian, and thus Devonian, coincides with the appearance of *Monograptus uniformis* Pribyl. This graptolite proliferates at the top of Bed 20 and ranges upwards into Bed 53. In Bed

21, about 50 cm above the Silurian-Devonian boundary, *Warburgella rugulosa rugosa* (Bouček) makes its debut. This trilobite characterizes the Lower Lochkovian. A number of other stratigraphically important fossils occur in the Lower Lochkovian at Klonek in addition to *M. uniformis* and *W. rugulosa rugosa* (see Chlupáč 1977:106).

At the present time we have not studied the chitinozoans of all the numbered beds and interbeds at Klonek but the samples processed have yielded a rather detailed picture of the stratigraphic distribution of these fossils immediately below and above the Silurian-Devonian boundary. The position of samples at Klonek which have been processed for Chitinozoa are shown on Fig. 4.



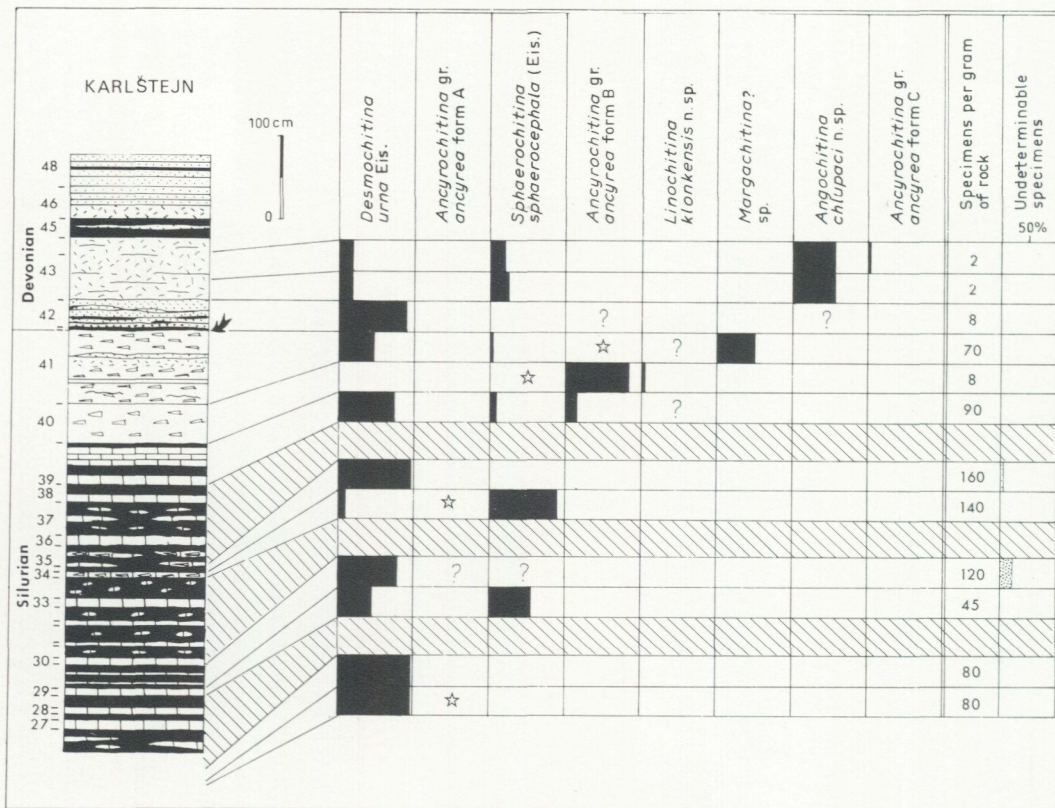


Fig. 5. Biostratigraphy, relative frequency and abundance of Chitinozoa in the Karlštejn section. For explanation, see Fig. 4.

KARLŠTEJN

The Karlštejn-Budnany section, which is well-known to geologists since Barrande's time, is also located at a river and represents the deeper water Radotin facies. The calcareous mudstones and dark limestones have been folded but the tectonic deformation is simple and does not obscure the stratigraphic relationships. The fauna is typically Pridolian up through Bed 41 and consists of, e.g. *Monograptus transgrediens*, *Ceraticaris bohémica*, *Cardiola bohémica*, and *Pterochaenia (Joachymia) falcata*. *Monograptus uniformis uniformis* makes its debut in Interbed 41-42 (Fig. 3). This

indicates the base of the Lochkovian which is located about 30 cm above the last known occurrence of *M. transgrediens* in this section. At Karlštejn the Lower Lochkovian is also characterized by the presence of *Warburgella rugulosa rugosa* and *Icriodus woschmidti*. The latter is a guide fossil for the Lower Lochkovian (Chlupáč *et al.* 1972).

Already in 1934 Eisenack established the occurrence of Chitinozoa in the Karlštejn section but he gave no stratigraphic details. In the present study we will deal with chitinozoans only up through Bed 43 and exclude the overlying part of the Lochkovian (Fig. 5).

## CHITINOZOA

## LABORATORY TECHNIQUES

The processing used is the standard technique for an interbedded mudstone-limestone sequence as described in detail by Paris (1976, 1978b). The standard size of a limestone sample was 25 g which were dissolved in hydrochloric and later hydrofluoric acid, whereas only 10 g of a mudstone sample were dissolved in hydrofluoric acid. After wet-sifting (mesh distance 53  $\mu\text{m}$ ) the Chitinozoa were transferred to water and extracted with a micropipette. The best preserved specimens of each taxon were isolated and prepared for study which was done with a scanning electron microscope according to a technique described earlier by Paris (1978a). Because of the great abundance of specimens (several thousands) in some samples, the remaining chitinozoans were concentrated by the use of a heavy liquid before making standard palynological slides.

All specimens in a sample were classified and counted for computations of the relative frequency of each species and the total frequency of Chitinozoa (expressed as the number of specimens per gram of rock) in the sample. In samples with very abundant Chitinozoa the total frequency was calculated by multiplying the number of specimens in selected and measured areas on the slides by the total area under the cover glass.

The chitinozoans described and illustrated here and the rest of the material are deposited in the collections of the Institute of Geology, University of Rennes, France, and catalogued under the numbers IGR 51301-51366 and 51401-51500.

## TERMINOLOGY

Paris and Laufeld alone are responsible for the descriptions of Chitinozoa. In the descriptions in the systematic part of this paper we have used the following symbols:

L	= Total length of vesicle
lp	= Length of body
lc	= Length of neck
dp	= Maximum diameter of body
dc	= Diameter of neck
db	= Diameter of oral opening
d.coll	= Diameter of collar
l.cop	= Length of copula
d.cop	= Diameter of copula

## STATE OF PRESERVATION

The chitinozoans in the mudstone intercalations are all entirely flattened.

In the limestones chitinozoans with a thick-walled vesicle, e.g. *Desmochitina* and *Eisenackitina*, are generally preserved with original symmetry and in full relief. Thin-walled chitinozoans belonging to the genera *Ancyrochitina*, *Angochitina*, *Linochitina*, and *Sphaerochitina*, however, commonly are wrinkled or flattened or even fragmented.

These latter forms are amber coloured or light brown whereas specimens of, e.g. *Desmochitina* and *Eisenackitina* are black.

In most specimens from both the Klonk and Karlštejn sections the vesicle surface is covered by a sticky organic substance which obscures the sculpture and ornamentation (Pl. 3:22).

## STRATIGRAPHIC DISTRIBUTION OF CHITINOZOA

The present publication is devoted to only a minor part of two sections and it should be kept in mind that our study is restricted to a stratigraphic interval hardly more than 10 m in thickness.

It seems probable that these 10 metres of uppermost

Pridolian – basal Lochkovian limestones and calcareous mudstones represent a short time interval. It is true that the rate of deposition of sediments at Klonk and Karlštejn in this stratigraphic interval is unknown at the present time. On the other hand, the entire Pridolian

Stage, which in itself cannot represent more than a few million years, embraces about 60 metres of limestones and calcareous mudstones very similar to those studied by us. Thus, assuming that the 10 m of sediments studied represent a short span of time we are struck by the very rapid changes in the composition of the chitinozoan assemblages (cf. Figs. 4–5).

#### CHITINOZOA IN THE KLONK SECTION

As can be seen in Fig. 4 the Pridolian part of the Klonk section is characterized by an abundance of *Desmochitina urna*. Except for Bed 17 and Interbed 17–18 this species generally constitutes more than 50% of all identifiable chitinozoan specimens and in Interbed 14–15 it reaches a peak of 80%. The disappearance of *D. urna* at Klonk is abrupt and takes place at the level of the Silurian-Devonian boundary. In Bed 20 *D. urna* makes up more than 50% of all Chitinozoa but in the basal Lochkovian, in Interbed 20–21, it is lacking.

*Linochitina klonkensis* is also restricted to the Pridolian part of the Klonk section. Its relative frequency is less than that of *D. urna* but in Interbed 12–13, Bed 17 and Interbed 17–18 (Fig. 4) it is fairly abundant, inversely to *D. urna*.

The other chitinozoans – *Desmochitina? suchomastyensis* n. sp. and *Eisenackitina? sp. aff. lagenomorpha* (Eisenack) – recorded only in the Pridolian part of the Klonk section (below Interbed 20–21) are less important because of their rarity. On the other hand, specimens here referred to as *Sphaerochitina sphaerocephala* (Eisenack) can be used as complementary indicators of the Silurian-Devonian boundary because specimens of this species are absent above Bed 21.

The appearance at the Silurian-Devonian boundary in the Klonk section of specimens referred to here as *Margachitina? sp.* is of some interest. Their occurrence in Bed 20 and Interbed 20–21 does not seem accidental because this taxon appears in approximately the same stratigraphic position in the Karlštejn section. If it can be demonstrated later that these *Margachitina? sp.* specimens are forerunners of, or even syntaxonomic with, *M. poculum* the occurrence of these specimens is of great interest because *M. poculum* is a cosmopolitan taxon in the lower Devonian (Paris 1976, 1978b). The appearance and sudden increase in abundance of *Margachitina? sp.* probably does not indicate evolution of a new taxon but rather reflects a faunal immigration caused by changes in the marine environment in the Klonk area. Further, it seems probable that the syn-

chronous appearance at Klonk of *Monograptus uniformis uniformis* was caused by the same palaeoecological factors that paved the way for the appearance of *Margachitina? sp.*

At the top of Bed 20 *D. urna* and *Linochitina klonkensis* disappear. Taxa with a smooth vesicle wall (*Desmochitina*, *Eisenackitina*) are replaced by taxa with an ornamented vesicle wall (*Angochitina*, *Gotlandochitina*). *Angochitina chlupaci* is a good example of this in the lowermost Lochkovian (constituting more than 75% of the total number of chitinozoan vesicles in Bed 24 and close to 70% in Interbed 34–35). Among the representatives of the genus *Ancyrochitina* there is no spectacular change at the Silurian-Devonian boundary. It is true that *Ancyrochitina* gr. *ancyrea* "form B" successively replaced "form A" but as mentioned in the descriptions of these forms, the differentiating characters are not very precise and, furthermore, easily obscured by deformation. The relative frequencies of these two forms cannot be used for precise correlation either. Anyway, the co-occurrence of several common taxa in the Upper Pridolian and Lower Lochkovian supports the conclusion that there is no hiatus at the boundary between the Silurian and the Devonian in the Klonk section.

Even though the diversity of Chitinozoa is moderate to low (10 taxa below the top of Bed 20 and 4 above Interbed 20–21), the abundance of specimens is very great, particularly in the uppermost Pridolian where 200 specimens per gram of rock have been recorded. In carbonates such a great number is exceptional. The abundance of Chitinozoa is considerably lower in the Lower Lochkovian than in the Upper Pridolian despite the fact that there is no conspicuous petrographic difference between the rocks above and below the boundary (cf. Fig. 4). Because no major change in sedimentary regime took place at the Silurian-Devonian boundary the decrease in abundance of Chitinozoa in the Lower Lochkovian can be explained by changes in rate of sedimentation and/or the biological production. At the present time our studies of the bathymetric control of the occurrence of different chitinozoan taxa are in their infancy (cf. Laufeld 1974, 1977b, 1979a, 1979b). Hence, we will not discuss a bathymetric control at this time.

#### CHITINOZOA IN THE KARLŠTEJN SECTION

As is the case in the Klonk section, *Desmochitina urna* is the dominant chitinozoan in the lower part of the

Karlštejn section (Fig. 5). In the sequence studied *D. urna* is most abundant in the uppermost part of the Pridolian. In contrast to its occurrence at Klonk *D. urna* remains an important faunal element also after the appearance of *Monograptus uniformis uniformis* in Interbed 41–42 at Karlštejn. Our data indicate that *D. urna* disappears approximately one metre above the base of the Devonian in the Karlštejn section. Even though the disappearance of the most abundant chitinozoan, *D. urna*, does not coincide precisely with the debut of *M. uniformis uniformis*, one of the rare chitinozoan taxa, viz. *Linochitina klonkensis*, does not range into *M. uniformis uniformis*-bearing beds. The *D. urna* – *L. klonkensis* association is of great value for distinguishing the uppermost Pridolian, particularly because *D. urna* specimens in Bed 42 are poorly preserved and do not occur as chains (it cannot be excluded that this was caused by small-scale redeposition).

*Sphaerochitina sphaerocephala* ranges across the

Silurian-Devonian boundary at Karlštejn as well as at Klonk. At Karlštejn *Margachitina?* sp. is restricted to the uppermost Pridolian bed (No. 41), where it dominates the fauna (constituting 50% of all specimens encountered).

Obviously, the basal Lochkovian can also be distinguished by means of Chitinozoa at Karlštejn because *Angochitina chlupaci*, which constitutes 70% of the chitinozoan vesicles in Bed 43 and probably occurs in Bed 42 (a few poorly preserved specimens, cf. Fig. 5), does not occur in the Silurian part of the section which we studied.

In agreement with the occurrence at Klonk, Chitinozoa are much more abundant (c. 20 times) in the Pridolian than in the Lochkovian at Karlštejn. On the other hand, there is a fairly conspicuous facies change in the Karlštejn section close to the Pridolian-Lochkovian boundary and it seems reasonable to explain the decrease in abundance of Chitinozoa there by an increased rate of deposition in early Lochkovian time.

#### RELATIONSHIP BETWEEN CHITINOZOANS AND GRAPTOLITES

In several publications it has been suggested that Chitinozoa show a biological affinity with graptolites. We have argued against such an interpretation repeatedly in the past (e.g. Laufeld 1974). If chitinozoans were pre-metascicula stages of graptolites it seems most probable that certain graptolite species and genera should have stratigraphic ranges identical or extremely similar to those of certain chitinozoan species and genera. Such a covariance has not been demonstrated so far. The main obstacle for micropalaeontologists to test ideas of this and related kinds is the almost complete ignorance among macropalaeontologists even trying to quantify abundance or frequency of macrofossils in their studies. A prerequisite for a detailed non-morphological comparison between Chitinozoa and, e.g. graptolites would be bed by bed sampling and quantification. The organic material of the body wall in both groups is so similar in composition that their resistance against biological and mechanical degradation can be looked upon as identical. Hence, a comparison between the abundance/frequency of chitinozoans and graptolites in the same beds of a series of strata would yield definitive proof for or against a close

biological relationship between the two groups. Such a study is under way in the Silurian of Gotland. However, we felt it is worth discussing the data at hand in the Klonk section. We will restrict our comparison between Chitinozoa and graptolites to the 160–170 cm thick interval in which diagnostic graptolites are entirely lacking. In this interval – between Interbeds 14–15 and 19–20 – not a single specimen of the "Pridolian" *Monograptus transgrediens* or the "Lochkovian" *Monograptus uniformis uniformis* and *M. uniformis augustidens* has been recorded despite the extremely thorough studies made by leading graptolite specialists as part of the work for defining the Silurian-Devonian boundary. A quick glance at Fig. 4 reveals that 6 chitinozoan species have been recorded in this interval. Three of those species occur also in the beds below that yield *M. transgrediens*. One of the other chitinozoan species is diagnostic for and occurs exclusively in this interval. The remaining two chitinozoan species in this interval range upwards well into the Lochkovian and if any of the two latter would be related to *M. uniformis* one would expect that specimens of *M. uniformis* would occur in this interval, the more so since Interbed 14–15

yields 130 specimens of Chitinozoa per gram of rock. This great abundance of Chitinozoa is second only to that of Bed 20 (200/g), where *M. uniformis* occurs in great abundance.

In summing up, it is evident that the graptolite and chitinozoan data at hand from the Klonek section do not

support the interpretation that the two groups are closely related. When quantitative data become available on the abundance/frequencies of graptolites in the Klonek and Karlštejn sections the ecological relationships between the two groups can be elucidated.

### CONCLUSIONS

According to our data and interpretation thereof, we conclude:

(1) There is no demonstration of a biological relationship between the chitinozoans and the graptolites.

(2) In spite of the fact that this is a comparatively detailed chitinozoan study, the purpose of which is to demonstrate that Chitinozoa are useful biostratigraphic tools, we would like to emphasize that denser sampling would yield an even more refined picture.

(3) Far too often microfossils are neglected by palaeontologists and stratigraphers. A fourth of the number of chitinozoan species described in this paper are new to science despite the fact that the Silurian-Devonian stratotypes are classical sections which have been studied palaeontologically for more than a century.

(4) Fully aware of the inadequacy of our data due to non-continuous sampling and realizing the importance of ecological factors we conclude that the *Desmochitina urna* - *Linochitina klonekensis* assemblage can be used

to recognize the uppermost part of the Pridolian and thus latest Silurian.

(5) The debut of *Angochitina chlupaci* indicates Lower Lochkovian and thus by definition earliest Devonian.

(6) Chitinozoa offer a great potential for refining the correlation of rocks of Pridolian and Lochkovian age and for correlating the Silurian-Devonian boundary in Bohemia, Podolia, Thuringia, the Armorican Massif, the Carnic Alps, the Central Pyrenees, Catalonia, Sardinia, and Morocco.

(7) Our study of Chitinozoa in the Silurian-Devonian boundary stratotypes, where graptolites and conodonts are common, could be used to correlate the Rhenish facies types where these are holomarine but devoid of graptolites and conodonts.

(8) Quantitative data on abundance, relative frequency and diversity of Chitinozoa are very useful and should be included in all future studies.

SYSTEMATIC PART

By

F. PARIS AND S. LAUFELD

**Genus *Ancyrochitina* Eisenack, 1955**

Type species *Conochitina ancyrea* Eisenack, 1931

*Ancyrochitina* group *ancyrea* (Eisenack, 1931)

In the present material the genus *Ancyrochitina* commonly is represented by poorly preserved specimens with broken appendices. The overall shape of the best preserved specimens causes us to assign these specimens to *Ancyrochitina ancyrea* s. l. This species or group of species/forms shows a wide morphological variation. As pointed out by Laufeld (1974:39), a comprehensive biometrical study of well preserved material of this complex of taxa must be carried out before its taxonomical and stratigraphic significance can be evaluated. For that reason we refer all *Ancyrochitina* specimens from Klonk and Karlštejn to "group *ancyrea*". The wide variation in length and ornamentation of the neck in our material, however, induced us to distinguish three different morphological types, designated informally as forms A, B and C. We do not consider these forms of any taxonomical value but used them in an effort to find out whether any of these forms shows a preferred distribution. The informal character of our forms does not make compiling lists of synonyms for them meaningful.

*Ancyrochitina* group *ancyrea* form A

**MATERIAL** – About one hundred poorly preserved specimens from Klonk and less than 10 specimens from Karlštejn.

**DESCRIPTION** – *Ancyrochitina* specimens with relatively short neck and few appendices that are poorly branched.

**OCCURRENCE AND RELATIVE FREQUENCY** – Base of the Klonk section (see Figs. 4–5): rare, but constituting 30% of the chitinozoan specimens in Bed 17. It is doubtful whether it occurs above Bed 20.

*Ancyrochitina* group *ancyrea* form B  
Pl. 3:7, 19

**MATERIAL** – Almost 400 commonly fragmented specimens from Klonk and close to 200 specimens from the Karlštejn section.

**DESCRIPTION** – This form is characterized by the development of its neck which can be as much as three times as long as the body (Pl. 3:7). In its oralmost part the neck carries a few short spines. The body is conical and the base is flat. Wide and long appendices are attached to the aboral edge. In most cases, there are 4–6 appendices which are branched distally (Pl. 3:19).

**OCCURRENCE AND RELATIVE FREQUENCY** – Specimens of form B are common in Beds 14, 17, 20, 21, and 24 at Klonk where up to 70% (in Bed 21) of the number of chitinozoans consists of this form. Form B appears fairly close to the Silurian-Devonian boundary but cannot be used in the precise correlation of the boundary.

In the Karlštejn section *A. gr. ancyrea* form B occurs in Beds 39, 40 (almost 80% of the total number of chitinozoan specimens), 41, and 42.

*Ancyrochitina* group *ancyrea* form C

**MATERIAL** – About 60 specimens from Bed 40 at Klonk and some doubtful, poorly preserved specimens from Bed 43 at Karlštejn.

**DESCRIPTION** – This form is similar to *A. ancyrea* and can be distinguished from form A and B by its short neck with well-developed ornamentation:

**OCCURRENCE AND RELATIVE FREQUENCY** – At Klonk this form is restricted to Bed 40 where it constitutes 65% of all chitinozoan specimens. At Karlštejn it is restricted to, and rare in, Bed 43.

**Genus *Angochitina* Eisenack, 1931**

Type species *Angochitina echinata* Eisenack, 1931

*Angochitina chlupaci* Paris & Laufeld n. sp.  
Pl. 3:9–10, 13–14, 16, 18, 20–22

DERIVATIO NOMINIS – In honour of our coauthor Ivo Chlupáč, for his outstanding contributions to the understanding of the Barrandian geology and palaeontology, especially that of the Silurian-Devonian boundary.

HOLOTYPE – Pl. 3:9, IGR 51366 (P.41). Type and figured specimens are deposited at the Institute of Geology, University of Rennes, France, under IGR numbers. The letter and figures in parenthesis give the position of the specimen and refer to an England finder.

TYPE LOCALITY – Klouk section, close to Suchomasty, Czechoslovakia (Chlupáč *et al.* 1972).

TYPE STRATUM – Bed 24 in the Klouk section, lowermost Lochkovian (Devonian).

PARATYPES – Pl. 3:13, IGR 51366(R. 38.1); 3:14, IGR 51363(N. 36); 3:18, IGR 51363(P. 42); 3:20, IGR 51363(N. 41); and 3:21, IGR 51363 (O. 39.1).

MATERIAL – Two entirely flattened specimens from the mudstone in Interbed 21–22 at Klouk and 267 slightly deformed specimens from Bed 24 and 55 specimens from the mudstone in Interbed 33–34 at the same locality.

Furthermore, about 30 specimens from Bed 43 at Karlštejn.

DIAGNOSIS – *Angochitina* species with ovoid vesicle and an elongated neck. Shoulder absent and flexure inconspicuous. The ornamentation consists of short spines which are sparsely set and covers the vesicle in its entirety.

DESCRIPTION – *Ancyrochitina chlupaci* has an ovoid body (like a Rugby football) which is rather elongated ( $dp/lp = 0.75$ ) with a maximum diameter at its middle part. The body passes without any shoulder into a fairly narrow neck with parallel walls. In some specimens it looks like the neck is widened in its oralmost part but this is primarily due to flattening of parts of the neck. The neck is relatively long, and, when complete, reaches the same length as the body ( $lc/lp=1$ ). The ornamentation consists of thin spines scattered over the

vesicle (Pl. 3:10). Apparently, the spines, which are hollow, are formed by an eversion of the outermost layer (periderm) of the vesicle wall. On the neck the ornamentation is less conspicuous. The middle part of the neck is provided with a well-developed prosome. We have not been able to study internal structures.

DIMENSIONS – Measurements are given in micrometers (cf. Fig. 6):

	L	dp	lp	dc	l spine	lp/lc
Holotype	>195	60	107	30	5	<1.2
Mean established on 20 fairly well preserved specimens	210	≈75	108.5	30	7	≈1
Range of variation	182–260	58–93.5	93.5–130	27–39	5–11	0.78–1.33

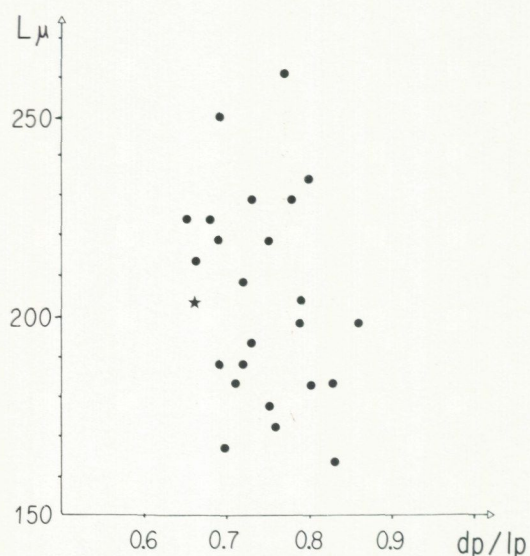


Fig. 6. Diagram showing variation in *Angochitina chlupaci* n. sp. (25 measurements). L = length of vesicle,  $dp/lp$  = diameter of body/length of body, \* = values for holotype.

REMARKS – Commonly the oralmost part of the neck is fragmentary or damaged and the mean value of length obtained too small. On the other hand, some specimens are partly flattened (neck only) which requires a coefficient of correlation for obtaining correct values.

DISCUSSION – *Angochitina chlupaci* is morphologically close to *A. echinata* Eisenack, 1931 in its overall shape of vesicle. The new species, however, has a more ovoid body and its ornamentation is less dense and not as conspicuous as that of *A. echinata*. *Angochitina*

*chlupaci* has an elongated body similar to that of *A. elongata* Eisenack, 1931 but it can be distinguished from the latter species by the shape of its neck and ornamentation. Our new species is also very similar to *A. comosa* Taugourdeau & Jekhowsky, 1960. The range of variation of ornamentation is very wide in *A. comosa* and our new species falls within that range. The Saharan species, however, has a more conspicuous flexure and its body has its maximum width in its aboral part as opposed to the middle part as it is in *A. chlupaci*.

**OCCURRENCE AND RELATIVE FREQUENCY** – *A. chlupaci* makes its appearance above the Pridolian-Lochkovian boundary in the two sections studied. The frequency of the species varies considerably and can reach 80% of the total number of chitinozoan specimens. We have been unable to establish safely the occurrence of *A. chlupaci* in some beds in the Lower Lochkovian at Klonk due to the poor state of preservation of Chitinozoa in those beds.

#### Genus *Desmochitina* Eisenack, 1931

Type species *Desmochitina nodosa* Eisenack, 1931

*Desmochitina urna* Eisenack, 1934  
Pl. 1:1–11, 16; Pl. 3:6

Synonymy: See Paris in Degardin & Paris 1978

1973 *Desmochitina urna* Eisenack; Obut 1973, Pl. 14:6–8, Pl. 15:5–9  
1979 *Bursachitina urna* (Eisenack); Rahmani 1978:137–138, Pl. 3:1–4  
(In MS)

**MATERIAL** – 1250 specimens from both lithologies in the Beds 24 through 43 at Karlštejn. 1130 specimens from limestone and mudstone in the beds below Bed 20 (inclusive) at Klink. In addition to isolated vesicles, chains of 3–8 specimens were recorded.

**REMARKS** – The great abundance and fine state of preservation of our specimens warrant some additional remarks to Eisenack's (1934) original description of *Desmochitina urna*.

It should be stressed that the intraspecific variation is very great in this species (see Pl. 3:6). The total length and maximum width of vesicles can vary by as much as a factor of 2 (Pl. 1:2, 4 and 9). Obviously, the general vesicle shape of *D. urna* is so variable that it is not possible to identify the species by a single vesicle. (It can never be overemphasized that safe identifications of chitinozoans have to be made on populations and

never on single specimens.) In some beds (e.g. Bed 39 at Karlštejn) all specimens of *D. urna* have a very conspicuous ornamentation (Pl. 1:4) consisting of small, closely spaced tubercles. The same specimens have a copula which is exceptionally widened in the aboral direction (Pl. 1:9–10).

The connections between the vesicles in chains are secured primarily because the copula is attached to the surface of the operculum of the adjacent vesicle by its strongly expanded aboral part (Pl. 1:16). The connection between the oralmost part (e.g. the neck) of one vesicle and the base of the adjacent one is of lesser importance for the preservation of a chain and it is common that the contact between vesicles is only restricted to the copula (Pl. 1:1).

**DIMENSIONS** – Measurements are given in micrometres:

	L	dp	db	dc
Mean based on 100 undeformed specimens from limestones	127	77	50	45
Range variation	88–192	57–104	36–68	34–60

	L.cop.	d.cop.	lb/dp
Mean based on 100 undeformed specimens from limestones	10.2	15	0.65
Range of variation	5–15	10–20	0.54–0.77

When plotted (Fig. 7) it becomes evident that the numerical values of the dimensions are fairly well clustered. As is the case in chitinozoans from the Pyrenees described by Degardin & Paris (1978), there are only a few rare specimens whose dimensions deviate considerably from the norm. We have not tried to separate such forms from typical specimens of *Desmochitina urna*.

**OCCURRENCE AND RELATIVE FREQUENCY** – Eisenack (1934) described *D. urna* from Bohemia and established its occurrence in Pridolian limestones from Karlštejn and Dworetz. It is also abundant in the following areas:

- (1) Spain, in the uppermost part of the San Pedro Formation (Cramer 1964, 1967);
- (2) Morocco, in the Pridolian part of the Bou Regreg section outside Rabat (Rahmani 1978);
- (3) U.S.S.R. (Obut 1973);
- (4) France, in the central Pyrenees (Degardin & Paris 1978).
- (5) Italy, on Sardinia and in the Carnic Alps (Laufeld, unpublished).



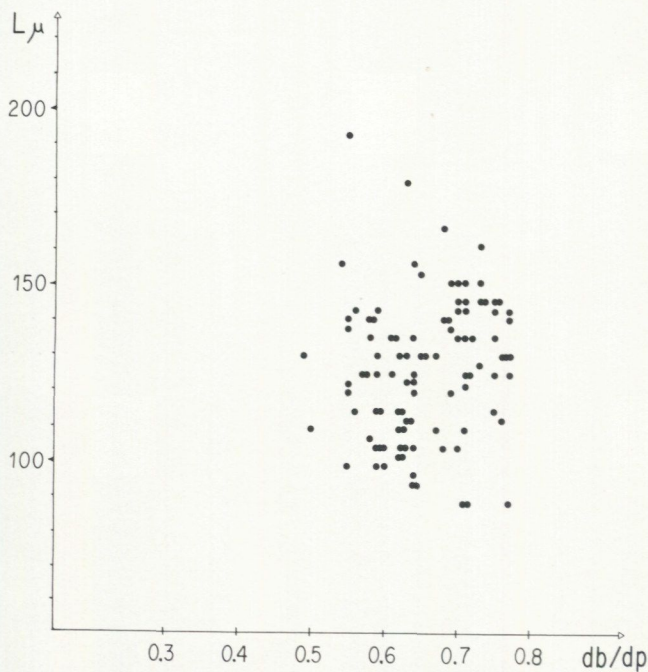


Fig. 7. Diagram showing variation in *Desmochitina urna* (Eisenack, 1934) (100 measurements). L = length of vesicle, dp/lp = diameter of body/length of body.

If *D. urna* and *D. sulcata* Taugourdeau & Jekhowsky, 1960 are regarded as conspecific (see Degardin & Paris 1978), *D. urna* occurs also in Sahara (Taugourdeau & Jekhowsky 1960; Magloire 1967; Jardiné & Yapaudjan 1968) and in a number of geographically dispersed areas where the ages of rocks are under debate (Goldstein, Cramer & Andress 1969; Paris in Deunff *et al.* 1971; Robardet & Taugourdeau 1971).

In the Klouk section *D. urna* is very abundant in the lowermost bed (No. 5) analysed and ranges through the Upper Pridolian just to disappear at the top of Bed 20 at the base of the Lochkovian (Fig. 4).

*D. urna* is also abundant in the lower part of the Karlštejn section but becomes rare in the uppermost bed (No. 43) analysed (Fig. 5).

Its disappearance seems to coincide with the appearance of *Monograptus uniformis uniformis*, precisely so at Klouk and within a few decimetres at Karlštejn.

*Desmochitina? suchomastyensis* Paris & Laufeld n. sp.  
Pl. 2:1-5

DERIVATION OF NAME – Named after the famous geological locality "Suchomasty", not very far from the Klouk section.

HOLOTYPE – Specimen on Pl. 2:1, IGR 51360 (M.38.2).

PARATYPES – The specimens on Pl. 2:3, IGR 51329 (T.43.2) and Pl. 2:5, IGR 51360(N.39).

TYPE LOCALITY – The Klouk section, close to Suchomasty, Barrandian, Czechoslovakia.

TYPE STRATUM – Bed 14 at Klouk, Upper Pridolian, latest Silurian.

MATERIAL – 10 specimens from Bed 14 at Klouk.

DIAGNOSIS – Chitinozoan with very stocky vesicle, the length (L) of which is conspicuously less than its maximum width (dp). The strongly curved flanks are constricted in oralward direction. The oral opening is surrounded by a very short tubular collar and the aboral edge of vesicle is sharp. The flat or slightly concave base has a protruding annular mucro in its central part. The operculum is disklike and the thick vesicle wall carries a conspicuous ornamentation of short cones and tubercles and a secondary incomplete network of crests. Chains are unknown at the present time.

DESCRIPTION – *D.? suchomastyensis* has a very characteristic silhouette where the flat base and strongly curved flanks form a hemisphere (Pl. 2:5) or cut sphere (Pl. 2:1). The vesicle has a fairly narrow oral aperture ( $db/dp < 0.4$ ). This aperture carries the tubular (Pl. 2:2) or slightly widened (Pl. 2:5) collar in which the organic wall becomes progressively thinner. The flat operculum is located at the base of the collar, thus hermetically sealing the interior of the vesicle. Scars on the opercular surface indicate that the operculum also acts as a connecting device between two vesicles. Inside the short, ring-shaped mucro in the central part of the base (Pl. 2:2) the vesicle wall is much thinner than outside. The ornamentation is distributed evenly on the flanks where the vesicle wall is very thick. The cones or wide tubercles decrease in size and density on the collar but are sometimes united to crests forming a more or less irregular network (Pl. 2:4). In stocky specimens (e.g. Pl. 2:1) the base almost lacks ornamentation. In all other specimens the ornamentation decreases in size and density in aboral direction from the basal edge (Pl. 2:2). It seems most probable that *D.? suchomastyensis* occurs in chains, although we have not observed chains as yet.

DIMENSIONS – Measurements are given in micrometres:

	L	dp	d.coll.	db/dp
Holotype	96	135	55	0.4
Mean established on 5 undeformed specimens	103	150	53.5	0.36
Range of variation	90-110	130-180	45-65	0.3-0.4

DISCUSSION – *D.?* *suchomastyensis* is easily distinguished from all other chitinozoans described so far. A new, undescribed species from the Upper Siegenian of Brittany has a rather similar overall silhouette (Paris, in preparation).

The generic assignment is tentative because species of the genus *Desmochitina* should have a conspicuous copula (as the type species). A possible solution would be to create a new genus embracing forms with a hemispherical vesicle.

OCCURRENCE AND RELATIVE FREQUENCY – The new species is very rare (less than 1% of total number of chitinozoans) in Bed 14 in the Klouk section, its only known occurrence.

#### Genus *Eisenackitina* Jansonius, 1964

Type species *Eisenackitina castor* Jansonius, 1964

The genus *Eisenackitina* is used here in its original definition. We share Jansonius' (1970) opinion that *Bursachitina* Taugourdeau, 1966 is a junior synonym.

*Eisenackitina krizi* Paris & Laufeld n. sp.  
Pl. 1:12-15, 17-19, 21

DERIVATION OF NAME – In honour of our friend Dr. Jiří Kříž for his contributions to the knowledge of the Silurian fossils in the Barrandian.

HOLOTYPE – The specimens on Pl. 1:12, IGR 51359 (M.36).

PARATYPES – The specimens on Pl. 1:13, IGR 51325; Pl. 1:14, IGR 51359(N.33.4); Pl. 1:15, IGR 51359 (0.35.4); Pl. 1:18, IGR 51359(0.34).

TYPE LOCALITY – The Klouk section, close to Suchomasty, Barrandian, Czechoslovakia.

TYPE STRATUM – Bed 5 at Klouk, Upper Pridolian, latest Silurian.

MATERIAL – 350 specimens from Bed 5 at Klouk.

DIAGNOSIS – *Eisenackitina* species with small vesicle in which the flanks are subparallel and slightly curved.

Collar present but short. The basal edge is rounded. Copula lacking. Disklike operculum. The ornamentation consists of small tubercles that are most abundant and well developed at the aboral edge. The base is flat or slightly concave. Chains occur.

DESCRIPTION – *Eisenackitina krizi* which sometimes occurs as twins and more rarely as chains of 3-4 specimens, is characterized by its stocky shape (dp is slightly smaller than L). Commonly the flanks are subparallel but in some specimens there is a slight convexity in the aboral half of vesicle. The aboral edge is always rounded. The collar is membranous and commonly short and the operculum is flat or slightly convex. In twins and chains both operculum and collar form the connection between the vesicles. The collar is attached to the aboral edge of the adjacent vesicle and the operculum is attached to the central part of the base of its neighbor. When desegregation of individuals in a chain has taken place, the thin central part of a vesicle is missing and on the operculum of the vesicle immediately aboral of the first there are small membranous processes, remains of the central part of the neighbor's base. The ornamentation, consisting of tubercles which in some cases are fused to short crests (Pl. 1:17), is well developed at the aboral margin, occurs also on the flanks, but almost disappears on the base (Pl. 1:21). The collar is almost smooth (Pl. 1:14).

DIMENSIONS – Measurements are given in micrometres:

	L	dp	db	d.coll.	d.coll/dp
Holotype	90	72	56	63	0.87
Mean, based on 25 slightly deformed specimens	100	73	53.5	60	0.83
Range of variation	78-117	62.5-78	44-60	52-68	0.71-0.96

When the values are plotted (Fig. 8) it becomes evident that the range of variation is in agreement with that of a normal population.

DISCUSSION – In some respects *Eisenackitina krizi* is similar to *E. lagenomorpha*. The latter species, however, has a distinctly more conical vesicle. *Conochitina oelandica silurica* Taugourdeau, 1963, is also morphologically close to *E. krizi* in its overall vesicle shape but can be distinguished by its lack of ornamentation and its well-developed collar.

OCCURRENCE AND RELATIVE FREQUENCY – At present *E. krizi* is known only from Bed 5 in the Klouk section where it constitutes about 60% of the chitinozoan specimens recorded (cf. Fig. 4).

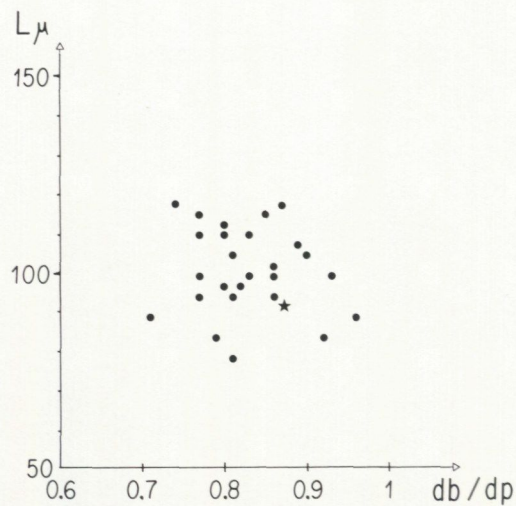


Fig. 8. Diagram showing variation in *Eisenackitina krizi* n. sp. (26 measurements). L = length of vesicle, dp/lp = diameter of body/length of body, \* = values for holotype.

*Eisenackitina* sp. aff. *E. lagenomorpha* (Eisenack, 1931)  
Pl. 1:20

**MATERIAL** – Some 30 specimens from Beds 10 and 12 at Klonek.

**DESCRIPTION** – This species has concavely curved flanks which tend to obscure the presence of a collar. The shoulder and flexure are poorly differentiated. The conical body has a flat base. The relatively thick test wall becomes progressively thinner in aboral direction. The disklike operculum is located fairly deep in the oral tube which in some specimens looks like a true collar (Pl. 1:20). The ornamentation consists of sparsely set, short and slender spines which cover the entire vesicle except for its oralmost part. As can be seen in the figured specimen (Pl. 1:20) a sticky organic coating sometimes covers the ornamentation. At the inconspicuous basal edge, where the ornamentation is best developed, the sticky organic substance may form a pseudocarina.

**DIMENSIONS** – Measurements are given in micrometres:

	L	dp	lp	d.coll.	dp/L
Mean based on 15 specimens	99.5	68	64	35	0.6
Range of variation	78–114	60–83	41–78	31–49	0.44–0.73

**DISCUSSION** – The present specimens may possibly represent a new taxon distinguished from *E. lagenomorpha* by their oral tube and less dense ornamentation.

**OCCURRENCE AND RELATIVE FREQUENCY** – *E.* sp. aff. *E. lagenomorpha* is known only from the lower part of the Klonek section where it constitutes 6% and 14.5% of the total number of chitinozoan vesicles in the late pridolian Beds 10 and 12, respectively (see Figs. 4 and 5).

#### Genus *Gotlandochitina* Laufeld, 1974

Type species *Gotlandochitina martinssoni* Laufeld, 1974

*Gotlandochitina* sp.  
Pl. 3:17

**MATERIAL** – Very few, poorly preserved specimens from the top bed of Bed 43 at Karlštejn. Some poorly preserved and not easily classified specimens from Beds 24 and 40 in the Klonek section may belong to this taxon.

**DESCRIPTION** – Due to the poor state of preservation it is only possible to note that the ornamentation is sparse. There are only 3 or 4 major (and distally branching) spines in each longitudinal series. The neck carries verrucae but the shoulder and flexure lack such ornamentation.

**OCCURRENCE AND RELATIVE FREQUENCY** – *Gotlandochitina* sp. constitutes 5% of the chitinozoans in the upper part of Bed 43 at Karlštejn. It is possible that it occurs also in Bed 24 at Klonek (cf. Figs. 4–5).

#### Genus *Linochitina* Eisenack, 1968

Type species *Desmochitina erratica* Eisenack, 1931

*Linochitina klonekensis* Paris & Laufeld n. sp.  
Pl. 2:6–9, 11,13,17

- 1960 *Desmochitina erratica* Eisenack; Taugourdeau and Jekhowsky 1960, Pl. 8:95  
 ?1967 *Desmochitina erratica* Eisenack; Magloire 1967, Pl. 4:21, 29; 5:20, 36  
 ?1975 *Linochitina erratica* (Eisenack); Rauscher and Robardet 1975, Pl. 9:17  
 ?1976 *Linochitina erratica* (Eisenack); Eisenack 1976, Fig. 12

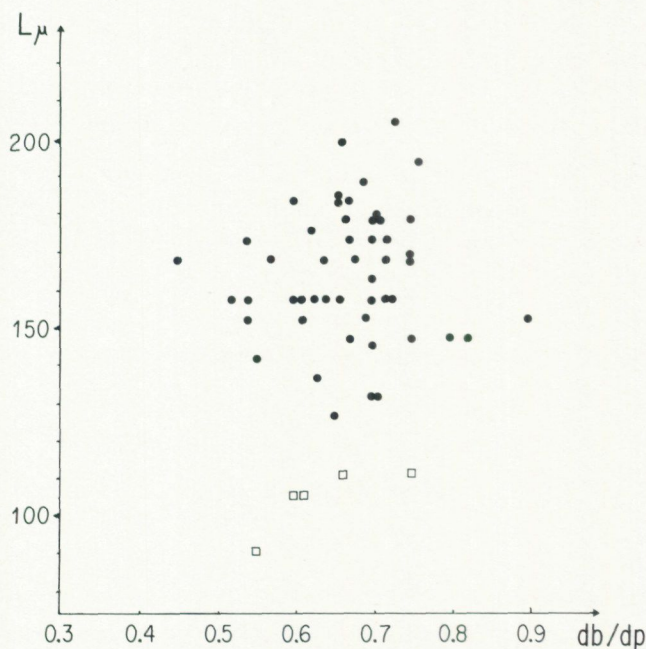


Fig. 9. Diagram showing variation in *Linochitina klonkensis* n. sp. (54 measurements). L = length of vesicle, dp/lp = diameter of body/length of body, \* = values for holotype, □ = values for the neotype of *Linochitina erratica* (Eisenack, 1931).

DERIVATION OF NAME – From Klonk, close to Suchomasty, Czechoslovakia.

HOLOTYPE – Pl. 2:11, IGR 51328(M.41.1).

PARATYPES – Pl. 2:6, IGR 51361(N.39.2); Pl. 2:9, IGR 51361(0.46.4); Pl. 2:13, IGR 51361(N.41.4); Pl. 2:17, IGR 51361(P.47).

TYPE LOCALITY – The Klonk section at Suchomasty in Czechoslovakia.

TYPE STRATUM – Bed 12 at Klonk, upper Pridolian, uppermost Silurian.

MATERIAL – 180 more or less deformed specimens from the limestone beds at Klonk and Karlštejn and 90 flattened specimens from mudstones intercalated with the limestone beds in these sections.

DIAGNOSIS – *Linochitina* species with fairly large subtubular vesicle and convex base. The glossy vesicle has an inconspicuous collar and a well developed tube-formed copula. The operculum is sleeve-shaped and becomes wider in aboral direction.

DESCRIPTION – The new species, which is abundant in some beds in the Klonk section, is characterized by its large vesicle where length far surpasses width (L/dp

>3). There is no conspicuous constriction in the oral part of vesicle. In typical specimens the fairly thin vesicle wall has a glossy, smooth exterior (Pl. 2:7, 13). The diameter of the aperture is close to the largest width of the vesicle (db/dp c. 0.7). We have recorded strong deviations from this value but they are insignificant and due to deformation (Pl. 2:17). The aboral pole is convex and this is accentuated in flattened specimens. The thin-walled tubular copula is attached to the centre of the aboral pole (Pl. 2:8–9). In chains the vesicles are held firmly together by the attachment of this copula to the central part of the operculum of the next vesicle and by the attachment of the oralmost part of the collar to the peribasal part of the next vesicle (Pl. 2:7). A carina has not been noticed and the aboral edge is broadly rounded and perfectly smooth. The disklike operculum carries an aboral skirtlike tubular flange that is widened in its aboralmost part that seals the vesicle interior at a fair distance from the oral aperture.

DIMENSIONS – Measurements are given in micrometres (cf. Fig. 9):

	L	dp	db	db/dp
Mean based on 25 slightly deformed specimens from limestones	156	53.5	34	0.64
Mean based on 25 flattened specimens from mudstones	169	69.1	48.5	0.70
Corrected values (coefficient for restoring original volume = 0.70)	c. 160	48.3	33.6	–
Range of variation	130–203	36.4–58	26–40	–
Holotype	160	55	40	0.72

REMARKS – The mean length of the flattened specimens from mudstones exceeds the mean length of the specimens extracted from limestones. This is due to the extrusion of the convex base in the flattened specimens.

DISCUSSION – *Linochitina klonkensis* shows similarities to *Linochitina erratica* (Eisenack, 1931) and previously the two forms have not been distinguished from another. The holotype, paratypes and neotype of *L. erratica* described by Eisenack (1931, 1962, 1968) have a constriction close to the oralmost part of the vesicle and a widened collar. These details make it possible to distinguish between the two species. *Linochitina klonkensis* can be distinguished from *L. erratica* also by its L/dp ratio which amounts to 3 compared to 2 in the latter

species. Eisenack's descriptions, redescrptions and emendations (1931, 1934, 1962, 1968, etc.) are not detailed enough to allow a close comparison. On the other hand, if one accepts Laufeld's (1974:99-100) populations of *L. erratica* from the Silurian of Gotland as characteristic, *L. klonkensis* can be distinguished from *L. erratica* by its lack of a sharp basal edge (cf. Laufeld 1974, Fig. 59).

*L. odiosa* Laufeld, 1974 is also similar to our new species but is not as long as *L. klonkensis* and has curved flanks. Both species lack a carina and a sharp basal edge.

OCCURRENCE AND RELATIVE FREQUENCY - See Figs. 4 and 5.

*L. klonkensis* is restricted to the Pridolian in the Klonk and Karlštejn sections. It is rare at Karlštejn, where it constitutes 5% of all chitinozoan specimens in Bed 40, but fairly abundant at Klonk. In the latter section *L. klonkensis* constitutes 75% of the Chitinozoa in Interbed 12-13. In Klonk it also occurs (2%) in Bed 5 and Bed 20 where it represents 10% of the chitinozoans but it has not been recorded above Bed 20.

*Linochitina* sp. aff. *ervensis* Paris, 1979  
Pl. 3:5, 8

MATERIAL - A single chain consisting of 4 vesicles (and possibly a few isolated vesicles) in Bed 14 at Klonk.

DESCRIPTION - This species has a short vesicle (c. 100µm) elongate conical in shape. A well developed carina (Pl. 3:8) is attached to the aboral edge. The straight flanks are similar to those of *L. ervensis* described from the Pridolian of northwestern France by Paris (in Babin *et al.* 1979). For the time being we do not consider these forms conspecific due to differences in the size of the carina.

*Linochitina* sp.  
Pl. 3:1

MATERIAL - A dozen specimens from Bed 14 in the Klonk section.

DESCRIPTION - This fairly large (L c. 140 µm) chitinozoan is very similar to *Linochitina klonkensis* n. sp. However, a carinalike structure is attached to the aboral edge of vesicle. A detailed scrutiny of this

structure was made in a SEM under high magnification but it did not reveal whether the structure is a remnant of the collar of an adjacent specimen or an "embryonic" carina. Hence, we keep such specimens under open nomenclature.

**Genus *Margachitina* Eisenack, 1968**

Type species *Desmochitina margaritana* Eisenack, 1937

*Margachitina?* sp.  
Pl. 2:12, 18 and 19

MATERIAL - 51 specimens from Bed 20 and 90 from Interbed 21-22 at the Klonk section and an additional 60 specimens from Bed 41 at Karlštejn.

DESCRIPTION - Secondary flattening has accentuated the disklike or lenticular shape of the vesicles studied. Before deformation the vesicle was not spheroidal because, as revealed by a special study, the flattening shows a preferred orientation along the longitudinal axis (which happens to be the shortest axis). There are 4 or 5 ringlike thickenings in the vesicle wall perpendicular to the longitudinal axis and obviously the flattening of the vesicle was guided by these structures.

The slightly convex operculum has a short membranous peripheral part and seals tightly the interior of the vesicle. Collar is lacking but there is a slight ring-shaped perioral thickening of the vesicle. In *Margachitina?* sp. there is no scar from the copula (Pl. 2:12).

DIMENSIONS - Measurements are given in micrometres:

	dp	db	dp/db
Mean based on 15 flattened specimens	80	36.5	0.45
Range of variation	73-93.5	31-41.5	0.4-0.5

DISCUSSION - Generally, flattened *Margachitina* specimens display scars from the intervesicular copula both at the aboral pole and in the centre of the operculum (cf. Paris 1976, Pl. 22:6; 1978a, Pl. 1:14). This and the fact that our taxon shows several similarities to, e.g., *Desmochitina acollaris* Eisenack, 1959 and *Desmochitina hemsiensis* Laufeld, 1974 necessitates a question mark in our generic designation. We

have referred it tentatively to *Margachitina* because of its similarity in overall vesicle shape to *M. poculum* Collinson and Schwalb, 1955. The latter species is known from the Lochkovian and basalmost Pragian (Paris 1976, 1978a, 1978b). Future studies will reveal whether the taxa discussed should be excluded from *Margachitina* and *Desmochitina* and placed in a new genus.

**OCCURRENCE AND RELATIVE FREQUENCY** – As can be seen in Figs. 4 and 5 *Margachitina?* sp. has a peculiar range restricted to the beds in the immediate vicinity of the Silurian-Devonian boundary at Klouk and Karlštejn. The species constitutes more than 10% of the total number of chitinozoan vesicles in Bed 20 at Klouk and about 30% in Interbed 21–22. In the Karlštejn section it is very abundant in Bed 41 with a relative frequency of 50% but has not been recorded in any other bed sampled.

**Genus *Sphaerochitina* Eisenack, 1955**

Type species *Lagenochitina sphaerocephala* Eisenack, 1931

The original concept of the genus is accepted which means that only forms with a spheroidal body and lacking or having a low (short) ornamentation are included. We regret that several authors do not follow the original description but instead include in *Sphaerochitina* a number of taxa whose bodies are not spheroidal or subspheroidal.

*Sphaerochitina sphaerocephala* (Eisenack, 1931)  
Pl. 2:10, 14–16; Pl. 3:3

**SYNONYMY** – See Eisenack (1972) and Laufeld (1974).

**MATERIAL** – About 90 specimens from the interval between Bed 14 and Interbed 20–21 (inclusive) from the Klouk section. From the Karlštejn section we recorded more than 1000 specimens in Beds 29 through 43.

**REMARKS** – As stressed earlier by Laufeld (1974) several authors have used *S. sphaerocephala* as a "waste-basket taxon". However, *S. sphaerocephala* should embrace only specimens with a spheroidal body and a cylindrical neck and having a minute and

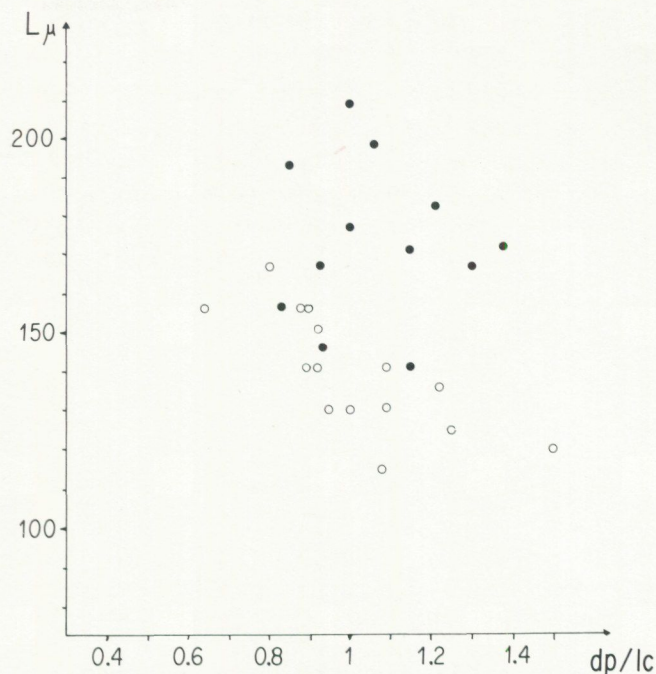


Fig. 10. Diagram showing intraspecific variation of *Sphaerochitina sphaerocephala* (Eisenack, 1931) (27 measurements). L = length of vesicle, dp/lp = diameter of body/length of body. ● = values from specimens from Bed 17 in the Klouk section, ○ = values from specimens from Beds 27 and 34 in the Karlštejn section.

inconspicuous ornamentation of microcones or microverrucae. As pointed out by Eisenack (1972) some of the members in a *S. sphaerocephala* population seem to be transitional to *Angochitina echinata* but identification of *S. sphaerocephala* is easy when a population is at hand.

In our Klouk and Karlštejn material different populations have different vesicle size. Some beds, e.g., 29 and 34 at Karlštejn, have yielded forms which are smaller than those from other beds (Fig. 10). In some beds forms with a less convex base are common but this is probably due to deformation. Some of the deformed specimens have a silhouette similar to that of *Sphaerochitina impia* Laufeld, 1974 or *S. acanthifera* Eisenack, 1955 (Pl. 2:10).

**DIMENSIONS** – All measurements are in micrometres:

	L	dp	lp	dc
Mean based on 12 specimens from Klouk 17	173	84	80	31.5
Range of variation	140–208	73–93.5	67.5–104	26–36.5
Mean based on 15 specimens from Karlštejn 29 and 34	139.5	64	65	23.5
Range of variation	120–166.5	57–67.5	41.5–88.5	21–26

OCCURRENCE AND RELATIVE FREQUENCY – See Figs. 4 and 5.

In the Klonk section *S. sphaerocephala* is represented by more than 20% of all specimens of Chitinozoa in Bed 17, by less than 2% in Bed 20 and by about 15% in Interbed 20–21. The species disappears above Bed 21.

At Karlštejn *S. sphaerocephala* ranges from Bed 29 (50%) to the top of Bed 43 (c. 20%) and is most abundant in Bed 34 where it constitutes 90% of all chitinozoan vesicles.

**Chitinozoa indet., n. gen.?, n. sp.**

Pl. 3:4, 11–12, 15

MATERIAL – Four specimens from Bed 39 and the top of Bed 43 at Karlštejn.

DESCRIPTION – The vesicle has the form of a compressed sphere with evenly curved flanks. The wide oral opening is surrounded by a multilayered, long and membranous collar (Pl. 3–12, 15). A disklike operculum is located at the transition between collar and body. In addition to its strange collar the taxon is characterized by its peculiar ornamentation which con-

sists of discontinuous, membranous flanges arranged longitudinally and perpendicular to the vesicle wall. The erect flanges radiate from the collar, becoming progressively lower and smaller towards the equatorial part of the vesicle (Pl. 3:11–12, 15). The twins in Pl. 3:4 are so poorly preserved that a direct comparison of them with the two other, single specimens (Pl. 3:11–12, 15) is of restricted value. Tentatively, however, we regard all four specimens as syntaxonomic.

DIMENSIONS – The measurements are in micrometers:

	L	dp	db	l.coll.	db/dp
Mean based on 3 specimens	c. 45	85	45	c. 15	0.53

DISCUSSION – Our new taxon shows greatest similarity to the genus *Desmochitina*, particularly *D. lenticularis* (Bouché, 1965) and *D. muldiensis* Laufeld, 1974. The descriptions of the genera *Desmochitina* Eisenack, 1931 and *Hoegisphaera* Staplin, 1961 do not cover forms having an ornamentation of radiating membranous flanges even though such forms previously have been referred to those genera. The future will show whether forms with such an ornamentation deserve to be separated from *Desmochitina* and *Hoegisphaera* and referred to a new genus.

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## PLATE 1

figs. 1–11 and 16: *Desmochitina urna* Eisenack, 1934.

1. Chain of six closely similar vesicles. Karlštejn section, Bed 29, IGR 51365(0.35),  $\times 200$ .
2. Note the ornamentation in this typical specimen. Klonek section, Bed 5, IGR 51359(M.34.3),  $\times 300$ .
3. Specimen showing wide copula and operculum. Karlštejn section, Bed 29, IGR 51365(N.33.2),  $\times 300$ .
4. Exceptionally elongate and slender specimen. Karlštejn section, Bed 29, IGR 51365(J.34.2),  $\times 300$ .
5. Flattened specimen with operculum in place. Klonek section, Interbed 5–6, IGR 51326(N.40.2),  $\times 300$ .
6. Detail of aboral pole of the specimen in fig. 2 showing the hollow copula. Note the lack of a pore (lumen) to the interior of the vesicle. Klonek section, Bed 5,  $\times 1000$ .
7. Detail of oral pole showing operculum in situ. Note traces of the copula of the adjacent vesicle attached to the operculum. Karlštejn section, Bed 29, IGR 51365(Q.34.2),  $\times 1000$ .
8. Flattened specimen showing a fold in the aboral part of the vesicle wall indicating plastic deformation during compaction. Klonek section, Interbed 10–11, IGR 51324(T.39),  $\times 300$ .
9. Specimen in lateral view, Karlštejn section, Bed 29, IGR 51354(P.40.3),  $\times 300$ .
10. Specimen with relatively wide copula as compared to the diameter of vesicle. Karlštejn section, Bed 29, IGR 51365(L.32),  $\times 300$ .

11. Detail of copula of the specimen in fig. 3.  $\times 1000$ .

16. Detail showing connections in a chain. Karlštejn section, Bed 29, IGR 51365(0.33),  $\times 500$ .

figs. 12–15, 17–19 and 21: *Eisenackitina krizi* Paris & Laufeld n. sp. All specimens from Bed 5 in the Klonek section.

12. Holotype. IGR 51359(M.36),  $\times 300$ .

13. Twins. IGR 51325,  $\times 300$ .

14. Paratype with well developed collar. IGR 51359(N.33.4),  $\times 300$ .

15. Paratype with deformed oral part. IGR 51359(0.35.4),  $\times 300$ .

17. Ornamentation of aboral part and edge of the specimen in fig. 14.  $\times 1000$ .

18. Paratype. IGR 51359(0.34),  $\times 300$ .

19. Oblique oral view of the specimen in fig. 18 showing operculum in place.  $\times 1000$ .

21. Detail of aboral pole of the specimen in fig. 15. Note lack of copula and lack of ornamentation of the base.

fig. 20: *Eisenackitina* sp. aff. *E. lagenomorpha* (Eisenack, 1931).

The pseudoornamentation of this vesicle consists of an amorphous organic matter. The phenomenon is common in the chitinozoans from the Klonek and Karlštejn sections. Klonek section, Bed 12, IGR 51328(L.41.4),  $\times 300$ .

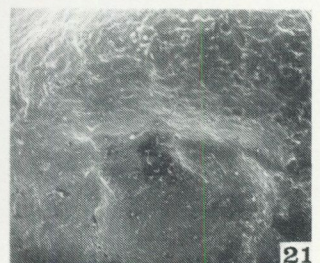
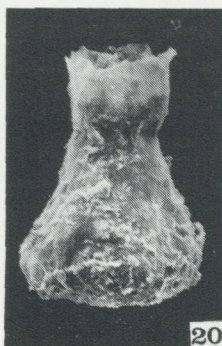
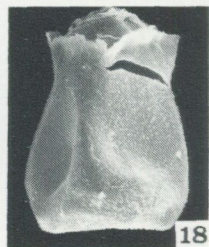
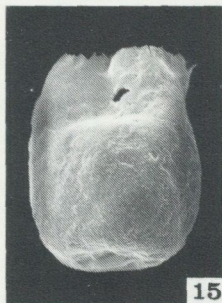
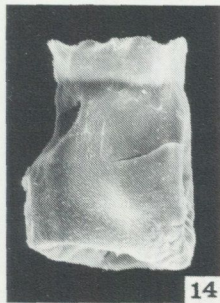
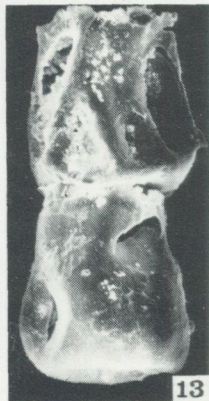
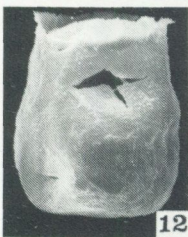
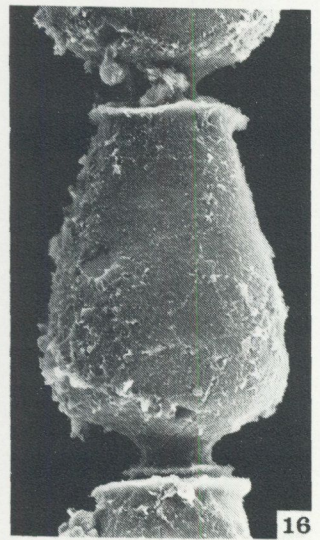
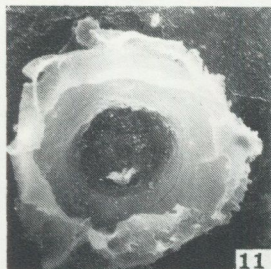
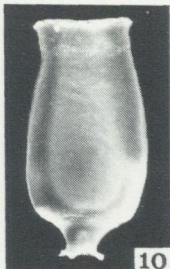
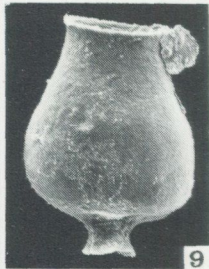
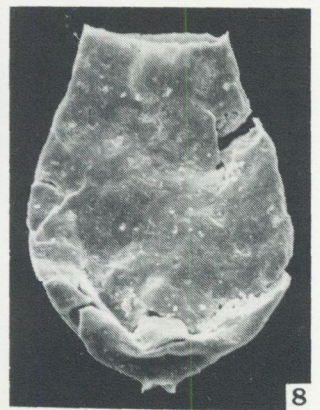
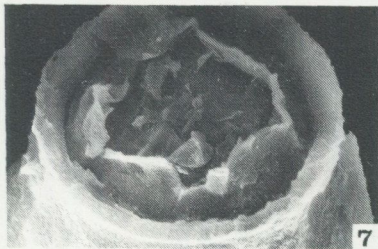
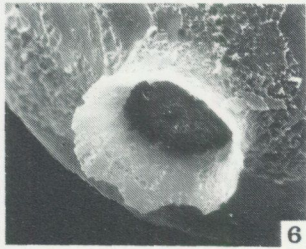
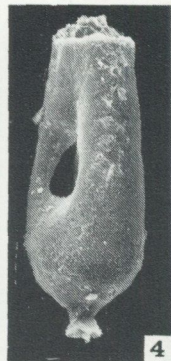
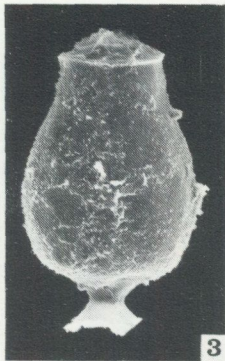
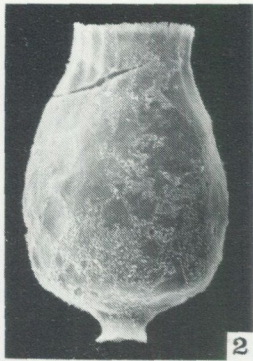
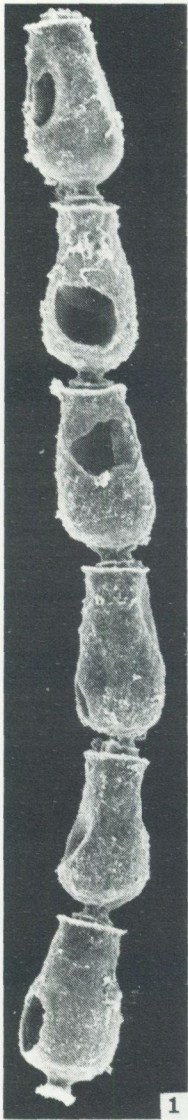


PLATE 2

figs. 1–5. *Desmochitina? suchomastyensis* n. sp., Klonk section, Bed 14.

1. Holotype in lateral view. IGR 51360(M.38.2), ×300.
2. Aboral view of specimen in fig. 1 showing an annular mucro, ×300.
3. Paratype in oral view. IGR 51329(T.43.2), ×300.
4. Detail in fig. 3 showing vesicle ornamentation, ×750.
5. Paratype in oblique oral view. Large specimen. IGR 51360(N.39), ×300.

figs. 6–9, 11, 13, and 17. *Linochitina klonkensis* n. sp., Klonk section.

6. Paratypes consisting of flattened twin. Bed 17. IGR 51361(N.39.2), ×300.
7. Detail in fig. 6 showing the connection between the vesicles and lack of carina. ×1000.
8. Detail of aboral pole in oblique aboral view showing copula. The granulation of vesicle surface is an artifact. Bed 17. IGR 51361(P.40), ×1000.
9. Twins. The lower vesicle shows copula. Note that the oral part of the neck of this vesicle has cracked and partly is firmly attached to the base of the upper vesicle. Bed 20. IGR 51362(O.46.4), ×200.
11. Holotype, slightly deformed, showing subparallel flanks

and scar of copula. Note pseudoornamentation of organic matter. Bed 12. IGR 51328(M.41.1), ×300.

13. Long and slender specimen with deformed oral and aboral end. Bed 17. IGR 51361(N.41.4), ×300.
17. Paratypes consisting of deformed twin. Folds of vesicle wall in the lower part of neck give a false impression of constriction. Bed 20. IGR 51362(P.47), ×300.

figs. 10 and 14–16. *Sphaerochitina sphaerocephala* (Eisenack, 1931).

10. Specimen with prosome squeezed out of the neck. Klonk section, Bed 17. IGR 51361(L.39), ×300.
14. Note ornamentation and pseudoornamentation. Karlštejn section, Bed 29. IGR 51365(M.37.3), ×300.
15. Deformed specimen. Klonk section, Bed 17. IGR 51361(N.39), ×300.
16. Detail in fig. 15 showing vesicle ornamentation. ×1500.

figs. 12, 18 and 19. *Margachitina?* sp., Klonk section, Bed 20.

12. Detail of oral pole showing the operculum. IGR 51362(N.48.1), ×1000.
18. Oral view showing slightly displaced operculum. IGR 51323(P.39), ×400.
19. Oblique lateral view showing annular "ridges". IGR 51323(N.37.2), ×400.

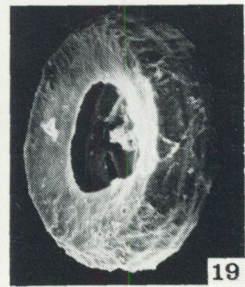
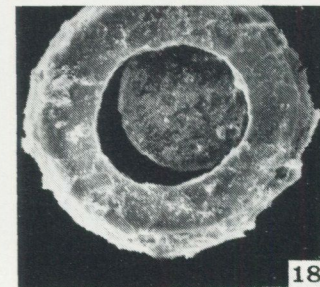
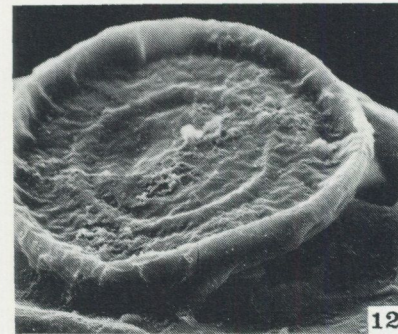
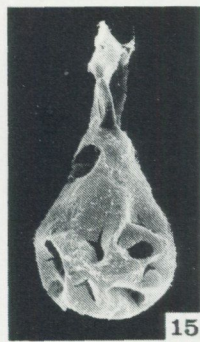
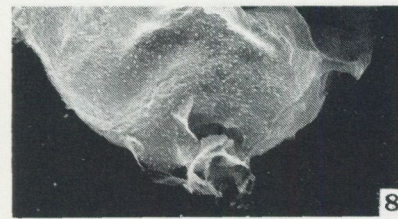
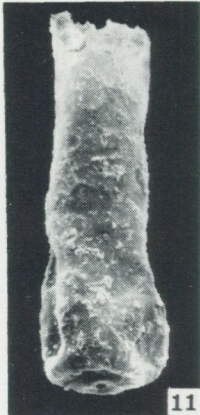
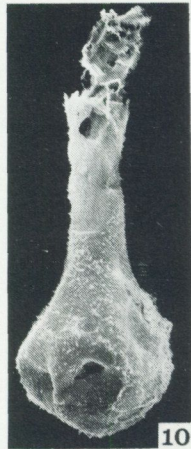
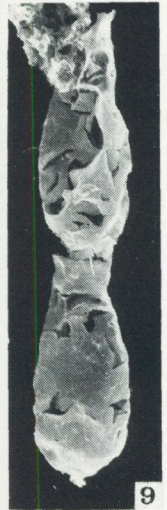
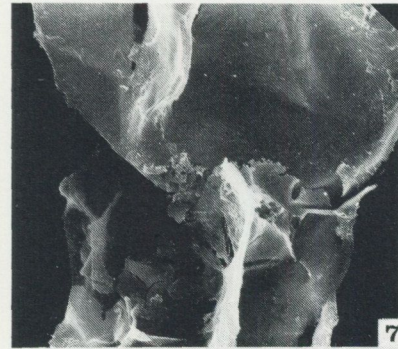
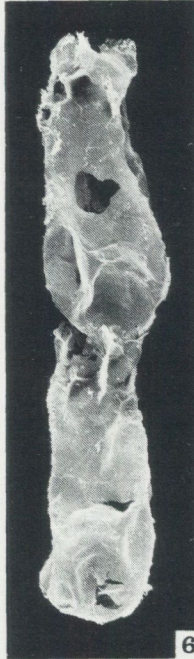
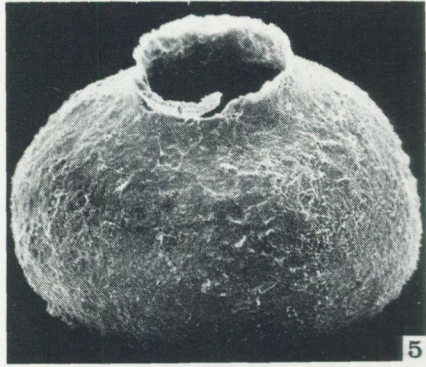
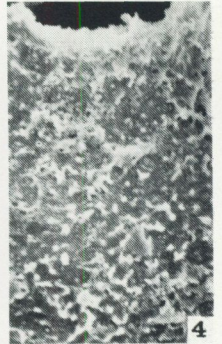
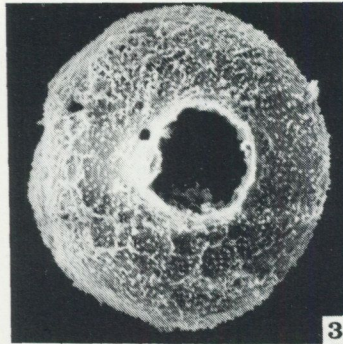
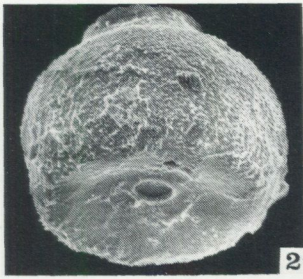
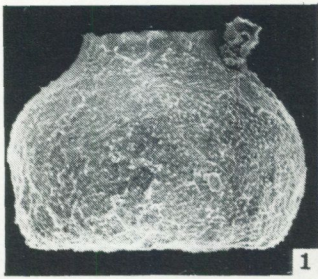
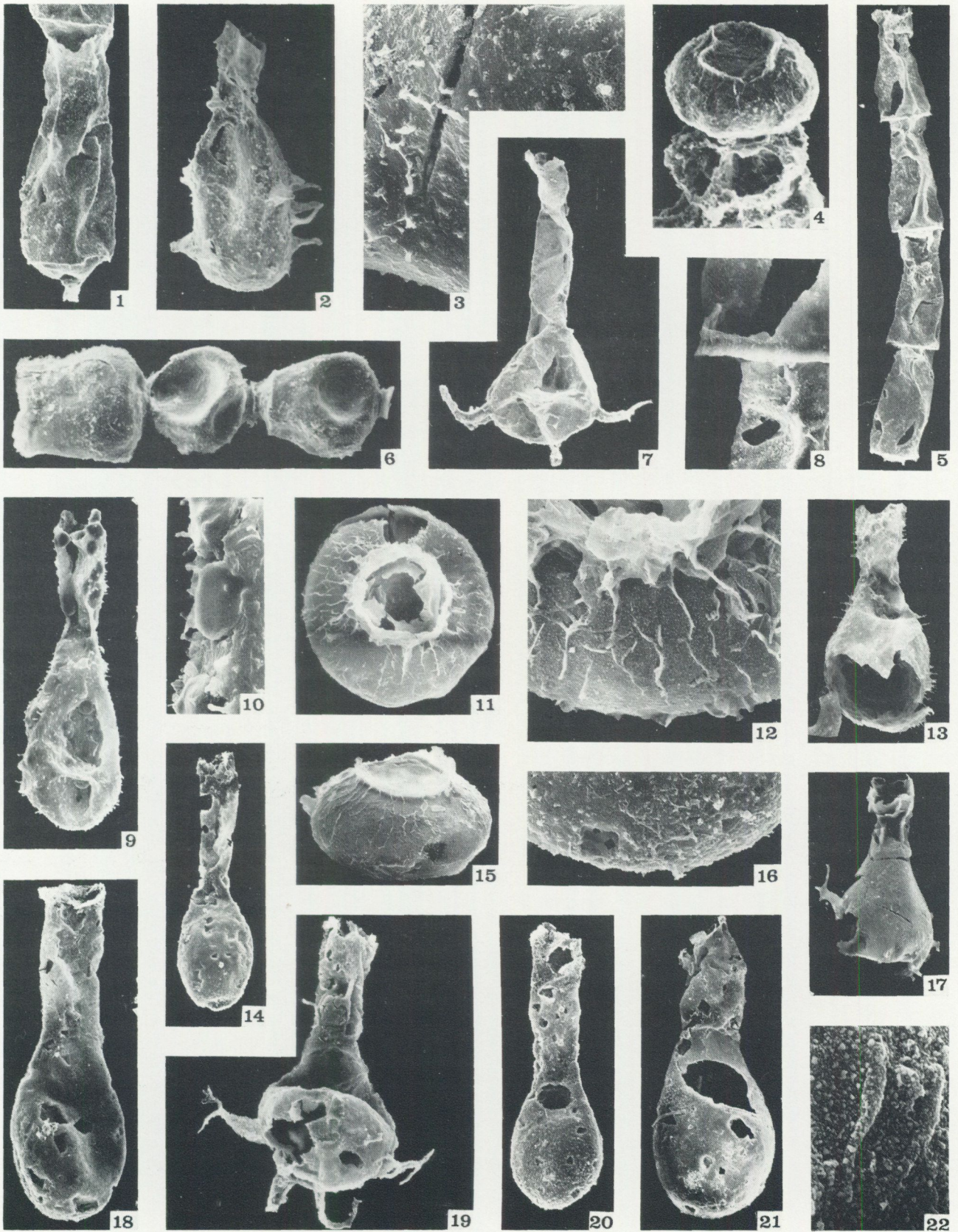


PLATE 3

- fig. 1. *Linochitina* sp. Specimen having a short carina. Klonek section, Bed 14. IGR 51360(M.39.4),  $\times 300$ .
- fig. 2. *Cylindrochitina?* sp. Unique specimen. Klonek section, Bed 14. IGR 51329(S.43.2),  $\times 250$ .
- fig. 3. *Sphaerochitina sphaerocephala* (Eisenack, 1931). Detail of cracked vesicle wall showing thickness of wall and ornamentation. Karlštejn section, Bed 29.  $\times 2000$ .
- fig. 4. Chitinozoa indet. n. gen.? n. sp. Chain in which the uppermost specimen is the only one which has not deteriorated. Karlštejn section, Bed 39. IGR 51357(N.41.2),  $\times 300$ .
- figs. 5 and 8. *Linochitina* sp. aff. *ervensis* Paris, 1979. Klonek section, Bed 14. IGR 51360(J.39).
5. Chain of four more or less flattened vesicles.  $\times 200$ .
8. Detail of carina of uppermost specimen in fig. 5.  $\times 1000$ .
- fig. 6. *Desmochitina urna* Eisenack, 1934. Chain of three specimens of which two are monstrose forms. Karlštejn section, Bed 39. IGR 51357(M.41.3),  $\times 300$ .
- fig. 7. *Ancyrochitina* group *ancyrea* (Eisenack, 1931) "form B" showing elongated neck. Klonek section, Bed 14. IGR 51360(M.37.4),  $\times 300$ .
- figs. 9–10, 13–14, 16, 18, and 20–22. *Angochitina chlupaci* n. sp.
9. Holotype. Karlštejn section, top of Bed 43. IGR 51366(P.41),  $\times 300$ .
10. Same specimen showing detail of ornamentation.  $\times 1000$ .
13. Paratype. Comparatively short specimen with well developed ornamentation. Karlštejn section, top of Bed 43. IGR 51366(R.38.1),  $\times 300$ .
14. Paratype in lateral view. Klonek section, Bed 24. IGR 51363(N.36),  $\times 200$ .
16. Detail of aboral pole of the specimen in fig. 20 showing softening of vesicle surface.  $\times 750$ .
18. Partly flattened paratype. Note organic matter sticking to the vesicle surface. Klonek section, Bed 24. IGR 51363(P.42),  $\times 300$ .
20. Paratype in lateral view. Klonek section, Bed 24. IGR 51363(N.41),  $\times 200$ .
21. Paratype in oblique lateral view. Klonek section, Bed 24. IGR 51363(O.39.1),  $\times 300$ .
22. Detail of ornamentation of the specimen in fig. 21. The spines are sitting in organic matter enveloping the vesicle.
- figs. 11–12 and 15. Chitinozoa indet. n. gen.?, n. sp., Karlštejn section, top of Bed 43.
11. Oral view. IGR 51366(S.37.4),  $\times 400$ .
12. Detail in fig. 11 in oblique lateral view showing membranous flanges radiating from the collar.  $\times 1500$ .
15. Specimen in oblique lateral view showing collar and radiating membranous flanges. IGR 51366(P.37.3),  $\times 400$ .
- fig. 17. *Gotlandochitina* sp. The poorly preserved specimen shows scars from longitudinal rows of spines. Karlštejn section, top of Bed 43. IGR 51366(T.39).
- fig. 19. *Ancyrochitina* group *ancyrea* (Eisenack, 1931), "form B". Klonek section, Bed 24. IGR 51363(N.40).



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