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THE SILURIAN CHITINOZOA OF THE MEHAIGNE AREA

(BRABANT MASSIF, BELGIUM)

by
JACQUES VERNIERS

Laboratorium voor Paléontologie - Rijksuniversiteit Gent

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Summary

The author gives a detailed inventory of Silurian Chitinozoa form the Mehaigne area in the eastern part of the Brabant Massif. Of the 102 samples analysed, 78 contain 39 taxa of Chitinozoa. They belong to ten genera and 38 species, of which 18 are left under open nomenclature. The poor state of preservation does not allow the definition of new species. Eleven informal Chitinozoa assemblages are recognized in the sedimentary sequence which is about 2100 m thick and of a flysch facies. Only the middle section contains early and middle Wenlockian graptolites. The succession of Chitinozoa assemblage zones and subzones indicates ages from middle Llandoverian to early and possibly middle Ludlovian for the entire sequence. At the base, the lowest section may possibly be from the late Ordovician. The assemblage zones allow a detailed correlation with Great-Britain, Gotland (Sweden), the Armorican Massif (France), the Iberian peninsula and North Africa.

Paleoecological interpretation of the genera and species of Chitinozoa found and other features(see VERNIERS, 1982a) suggest that during the Silurian, the Mehaigne area was characterized by bathyal conditions (a continental slope or a geosynclinal trough). Sediments and microfossils previously deposited on the deep outer shelf were brought into the Mehaigne area by turbidity currents. The Chitinozoa assemblages also suggest that the Mehaigne area was in open communication with the Anglo-Welsh area (G.B.), the Baltic region and the Eastern European platform. There was much less contact with the Armorican Massif (France) and other areas to the south.

Korte inhoud

De auteur geeft een gedetailleerde inventaris van de Silurische Chitinozoa uit het Mehaigne-gebied in het oostelijk deel van het Massief van Brabant. Van de 102 onderzochte monsters bevatten 78 monsters in totaal 39 Chitinozoa taxa. Ze behoren tot tien geslachten en 38 soorten waarvan er 18 onder open nomenklatuur gehouden werden. De slechte bewaringstoestand laat niet toe nieuwe species te definiëren. Elf informele Chitinozoa assemblages werden herkend in de sedimentaire sekwentie die ongeveer 2100 m dik is en van het flysch-type. In deze sekwentie werden enkel in het middenste deel vroeg en midden Wenlockiaan-graptolieten gevonden. De opeenvolging van de Chitinozoa assemblagezones en subzones liet toe de volledige sekwentie te dateren als midden Llandoveriaan tot vroeg of misschien midden Ludloviaan. Aan de basis evenwel zou het oudste profiel een boven Ordoviciaan ouderdom hebben. Deze assemblagezones laten een gedetailleerde korrelatie toe met Groot-Brittannië, Gotland (Zweden), het Armorikaans Massief (Frankrijk), het Iberisch schiereiland en Noord-Afrika.

De paleoekologische interpretatie van de gevonden geslachten en soorten van Chitinozoa en andere kenmerken(zie VERNIERS, 1982a) suggereren dat tijdens het Siluur het Mehaigne-gebied gekenmerkt was door bathyale omstandigheden (kontinentale helling of geosinklinaal trog). De sedimenten en mikrofossielen die eerst afgezet waren op een diepe shelf ver van de kust, werden in het Mehaigne-gebied binnengebracht door troebelingsstromen. De Chitinozoa-samenstelling geeft ook aan dat het Mehaigne-gebied in open verbinding stond met het Anglo-Welsh gebied (G.B.), met het Baltisch gebied en het Oosteuropees platform. Er was veel minder kontakt met het Armorikaans massief (Frankrijk) en andere gebieden meer naar het zuiden.

Sommaire

L'auteur donne un inventaire détaillé des Chitinozoaires siluriens de la région de la Méhaigne dans la partie orientale du Massif du Brabant. Des 102 échantillons examinés, 78 contiennent 39 taxa de Chitinozoaires. Ils appartiennent à dix genres et 38 espèces dont 18 restent sous nomenclature ouverte. La préservation médiocre ne permet pas de définir de nouvelles espèces. Onze assemblages informels de Chitinozoa ont été reconnus dans la séquence qui est épaisse de quelque 2100 m et du facies flysch. Seule la partie moyenne contient des graptolites du Wenlockien inférieur et moyen. La succession des zones et sous-zones d'assemblage des Chitinozoaires indique un âge du Llandovérien moyen jusqu'au Ludlovien inférieur ou peut-être moyen pour toute la séquence. A la base, la section la plus basse date peut-être de l'Ordovicien supérieur. Ces zones d'assemblage permettent une correlation détaillée avec la Grande Bretagne, le Gotland (Suède), le massif armoricain (France), le peninsule ibérique et l'Afrique du Nord.

L'interprétation paléoécologique des genres et espèces de chitinozoaires trouvés et d'autres caractères (VERNIERS, 1982a) suggèrent que pendant le Silurien la région de la Mehaigne était caracterisée par des conditions bathyales (pente continentale ou fosse géosynclinale). Les sédiments et les microfossiles deposés dans une première étape sur un shelf profond et éloigné de la côte étaient dans une seconde étape entrainés par des courants de turbidité vers la région de la Mehaigne. La composition des Chitinozoaires suggère aussi que la région de la Mehaigne était en communication ouverte avec la région Anglo-Galloise, la région Baltique et la plate-forme Est-européenne. Il y avait beaucoup moins de contact avec le Massif Armoricain (France) et les régions plus au sud.

Acknowledgements

During the eight years of research, published partially in this work, I received help of many people and it is impossible to thank them all personally here.

Prof. Dr. J. de HEINZELIN, head of the Laboratorium voor Paleontologie (R.U.G.), the promotor of my M.A. and Ph. D. dissertation proposed me the subject in 1970 and followed my research with much interest and critical, metodological recommendations. Dr. J. DECONINCK and Dr. A. GAUTIER of the staff of the same laboratorium taught me a lot in the beginning about (micro-) paleontological methods and investigations. They followed this research the whole time through, and revised several versions of this publication.

Dr. F. MARTIN from the Institut Royal de Sciences Naturelles de Belgique (Brussels) introduced me to chitinozoan studies and gently followed the different steps of this delicate research. She made the final revision of this work and her recommendations improved a lot the last draft.

A visit in november 1973 to the laboratory of Prof. Dr. C. DOWNIE at the University of Sheffield (U.K.) and the filter technique demonstrated by Dr. S. LAUFELD to Dr. J. DECONINCK from our laboratory during his visit to the University of Lund (Sweden) helped us considerably in improving our preparation techniques.

My special thanks go also to all members of the laboratory staff who assisted me during the preparation of this manuscript for publication : Mr. T. TEMMERMAN (photographs), Mr. D. BAVAY and Mrs. J. BAETENS (drafts), Mrs. V. VAN SCHOORISSE, Mrs. N. REYNAERT (dactylography) and Mrs. V. SEMEESE who typed the final version. The Laboratorium voor Elektronenmicroscopie (R.U.G.) and especially Mr. W. BOHYN and Mr. A. BIELEN were very helpful in preparing the S.E.M. photographs. Mrs. K. PITULA (Canada) kindly revised my English. I also want to thank my wife and friends who supported me a lot throughout this work, even at the stage when chitinozoans were the only possible topic of communication.

The first two years (1971-1973) of this research were made possible by a specialisation grant of the I.W.O.N.L. The following years I worked as an assistant in the Laboratorium voor Paleontologie, R.U.G. Hence I also owe a lot to various official educational organisations and indirectly to the Belgian taxpayer.

A. INTRODUCTION.

This work presents the systematics, the stratigraphical distribution, and the paleoecological and paleogeographical interpretation of the Chitinozoa in the Silurian sediments of the Mehaigne area. This area is situated in the eastern part of the Brabant Massif, a Caledonian folded Lower Paleozoic chain completely eroded and now mostly found in the subsurface of middle and northern Belgium. The studied outcrops are along the valleys of the Mehaigne river and its tributary, the Burdinale.

The sedimentological features of the flysch-type sediments were analized in detail (VERNIERS, 1982a) and allow tracing of single turbidite beds over several kilometers and accurate correlation of different sections even though the area has been considerably folded and faulted. On the basis of these correlations, a composite lithostratigraphic column more than 2100 m thick has been established, from which approximately 700 m of sediments are described in detail. The palynological samples are taken from these 700 m. Nine informal formations numbered MB1 to MB9 have been defined, several divided into subunits. The sedimentology of the flysch, and the geological and structural maps of the area are also given in this latest work.

Graptolites are only found in formations MB4 and MB6 in the middle part of the column with an early to middle Wenlockian age (VERNIERS & RICKARDS, 1978). No other macrofossils except for one Conularia sp. in CD-22E/40 were found lower or higher in the column. Additional information provided by 23 new samples (N° 57-78) completes the Chitinozoa biozonation of the entire column, first presented in 1980 (VERNIERS, 1981).

B. LOCALIZATION AND TREATMENT OF SAMPLES.

B.1. Localization.

The locations of Chitinozoa bearing samples in the Mehaigne area are given in fig. 1. The position of this area is also shown within the general structural framework of Belgium. For the exact localization within the outcrops and sections, we refer to the detailed localization maps (1/1000) and sectionlogs in VERNIERS (1982a). The 102 samples weighing 200-300 g were taken from sections at 10-15 m intervals in the strata. The sampling was mostly done in the top part of the Te interval(using BOUMA (1962)'s terminology for turbidite sediments) or in the complete Te interval if it was thin. Only in a few cases were samples taken from the Tb, Tc or Td intervals. Of these 102 samples only 78 yielded Chitinozoa. These are numbered 1 to 78. In the following text and figures, another label is sometimes used : the number of the section, e.g.: CD-22E, followed by the number of the "sequence of intervals", e.g.: CD-22E/36. This longer label allows easier recognition on the detailed localization maps and section logs in VERNIERS (1982a).

B.2. Treatment of samples.

The technique for preparation of organic microfossils has already been extensively published by several authors (TAUGOURDEAU, 1965; CRAMER, 1964, 1967; RAUSCHER, 1973; LAUFELD, 1974; PARIS, 1981). Most samples are treated in the following way : the occasionally present $CaCO_3$ is dissolved with 10 % HCl and washed with water; the silicates are dissolved by a prolonged HF 40% treatment (250 cc - 400 cc) at 60° C; the newly formed fluosilicates (e.g. hieratite, K_2SiF_6) are dissolved by three washes with 10 % HCl at 60° C; followed by three washes with water; the residue is filtered on a 47 μm filter (a copper filter with a 10 cm diameter or with nylon filtergauze (Nytal P-47 μm 395 made by Schweiz Seidengaze fabrik AG Thal, St. Gallen - Switserland) used on a Millipore filter apparatus (model XX1104700 Sterifil Filtration System); the minerals are separated with a heavy liquid in a centrifuge ($ZnBr_2$ solution, sometimes bromoform and later $ZnCl_2$ solution, d = 2,0 at 500^2c/m during 5 min).

After a thorough washing, the nylon filter is removed and kept wet with a gelatine-glycerine mixture. Under stereoscope(50 x magnification) all Chitinozoa, scolecodonts and occasional acritarchs, Leiosphaeridia, Incertae sedis sp. A, melanosclerites and Scutiferidae are picked out with a fine brush. When a sample is rich (more than 300 Chitinozoa) only half or a third of the Chitinozoa are removed. All the microfossils from one sample, up to 500 specimens, are put on one microscope slide, each group or genus of Chitinozoa on a separate row to facilitate future microscope work. After drying at 60° C the preparates are covered with Canada balsem. The Chitinozoa were studied with a Leitz-Orthoplan microscope with incident and transmitted light, usually at 600 x magnification (objective Fl. oel 60/0.95 with immersion oil and Periplan GF 10 x occulars). Photographs were made with an automatic photocamera LEITZ ORTHOMAT mounted on the same microscope. Special preparations were made for the twenty richest samples to photograph the best specimens with a scanning electron microscope (Cambridge) at the Laboratorium voor Elektronenmicroscopie at the Rijksuniversiteit Gent. The preparations are deposited in the collection of the Laboratorium voor Paleontologie at the University of Ghent, Belgium.

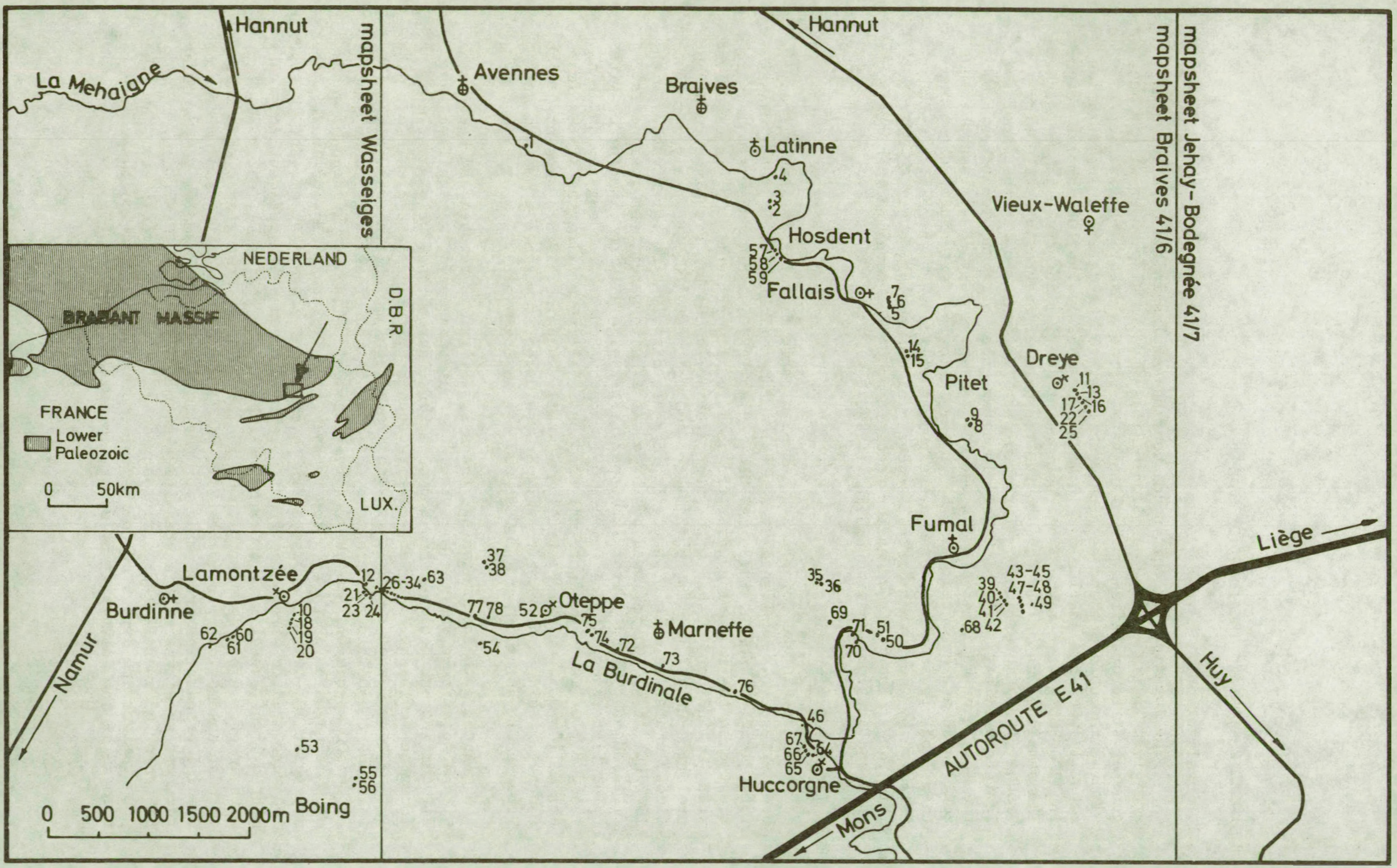


Fig. 1 : Localization of fertile Chitinozoa samples in the Mehaigne area. (scale : 1/50.000).

C. INVENTORY OF MICROPALAEONTOLOGICAL PREPARATIONS.

C.1. General inventory.

The detailed inventory of all samples is given in fig. 2. Of all Chitinozoa encountered approximately 86 % were determined to the generic and 71 % to the species level. This high result is biased and probably too high due to the fact that because of the high maturation level many Chitinozoa are not recognized as such, but merely as pieces of organic material. They belong to 10 genera and 38 species. The presence of other groups is marked: acritarchs, and one of their subgroups the Sphaeromorphs, with their thick or thinwalled laevigate Leiosphaeridia (presence or concentration), Incertae Sedis sp., Tasmanites? sp. A, (both last groups are described in the systematical description p. 49-50), scolecodonts, siculae and other fragments of graptolites, melanosclerites and Scutiferidae. Their presence, if observed, was marked but it was not systematically checked for in all samples (especially in the earlier prepared samples).

The stratigraphical ranges, the frequencies of all species and of the not specifically determined genera of Chitinozoa are given in fig. 8. The results of the biostratigraphical correlations (see VERNIERS, 1982a and p. 51-55) were used to construct this table. Only in 33 samples could more than 100 Chitinozoa be determined, and for these the frequency is given in four frequency classes. Statistically there is no difference between two neighbouring classes, but a difference does exist between non-neighbouring classes, e.g.: the D (dominant : more than 50 %) class is statistically different from the p (present : 5-30 %) class and the r (rare : less than 5 %) class, but it is not different from the f (frequent: 30-50 %) class. For samples with 35 to 99 specimens three frequency classes are used (see fig. 4). For samples with less than 35 specimens only the presence of the species is noted.

C.2. State of preservation of the Chitinozoa.

The Chitinozoa are moderately to poorly preserved. In most cases they are flattened which often seems to be the case in fine pelitic sediments (RAUSCHER, 1973, p. 17; LAUFELD, 1974). But there are two positive consequences to this flattening: they can now be easily observed with an incident light microscope, the flat specimen clearly reflecting all details on the opaque tegument, and during compaction, some internal structures withstood the pressure, and the impression or traces of the operculum or the prosome can be observed through the tegument.

The degree of conservation is between N3 and N5 according to the scale of CORREIA (1967). The Chitinozoa are opaque except for some rare cases where the collarette is slightly translucent and tinted dark grey to medium-brownish grey. The other microfossils show the degree of conservation more clearly. Acritarchs are grey turning light brown to opaque at the base of their appendices. Many of the small Leiosphaeridia are transparent (light to dark brown) while other small ones, and all the larger, thick-walled Leiosphaeridia are generally complete opaque. The reason for this difference in carbonization is not clear.

The state of preservation of the organic microfossils, from the base to the top of the stratigraphical column 2100 m thick, seems to be constant. To give us an idea of the degree of carbonization of the organic material,

Assemblagezones and subzones	Formations	N° of sample	Number of outcrop and sequence	Interval of BOUMA sequence	Weight of treated sample (in gram)	Concentration (Chitinozoa per gram)	Number of Chitinozoa observed	Number of Chitinozoa determined to the genus	Number of Chitinozoa determined to the species	Number of genera	Number of species	Acritarcha	Leiosphaeridia : presence or number per gram	Incertae Sedis sp. A	Tasmanites? sp.	Scolecodonts	Fragments of graptolites	Melanoslerites	Scutiferidae	Linotolypidae (artefact)
E	MB 9	56	CB-8/7	Te	96	1,5	141	138	124	4	3		17		33					
		55	CB-7/8	Te	100	0,2	18	10	7	3	2	X	0,5							
		53	CC-1/6	Te	87	0,1	9	9	4	4	1		13		X					
D3	MB 8	54	DD-13/2	Te	50	<0,1	2	1	1	1	1		0,4							
		-	DD-14/16	Te	100	0	0	0	0	0	0		1							
		-	ED-14/2	Te	100	0	0	0	0	0	0		2		X					
		52	ED-13/4	Te	100	0,2	23	12	9	1	2		X							
		78	ED-6/3	Te	82	4,8	390	390	383	3	6	X	42		X		X			
		-	ED-21	Te	100	0	0	0	0	0	0		2							
		-	DD-21/5	Te	85	0	0	0	0	0	0		0,6							
		77	DD-12/6	Te	95	11,4	1084	1082	1056	5	9	X	43		X	X	X	X		
		-	ED-16A	Te	91	0	0	0	0	0	0		0,1							
		-	DD-10/1	Te	100	0	0	0	0	0	0		0,5		X					
		-	ED-17/2	Te	90	0	0	0	0	0	0		0,2							
		-	ED-17/49	Te	90	0	0	0	0	0	0		0,2		X					
		76	GC-9/4	Te	100	<0,1	4	2	2	2	2		0,2		X					
	MB 7	75	FD-1/101	Te	80	11,4	915	906	893	4	8	X	140		X		X			
		74	FD-1/3	Te	70	1,0	72	66	51	5	6	X	39		X	X				
		73	FC-8/13	Te	89	0,3	29	27	19	2	5	X	29		X			X		
		72	FD-6/5	Te	75	1,8	137	133	130	4	6	X	19		X					
		71	HD-4/53	Te	87	3,0	265	265	244	4	8		12		X			X		
		70	HD-4/1	Te	86	2,0	175	167	155	4	4	X	10		X		X	X		
		69	HD-1/14 m	Te	85	6,1	515	509	425	4	7	X	X		X		X	X		
		51	ID-21/69	Te	100	2,7	272	192	159	6	7		X							
		50	ID-21/1 bis	Te	100	3,6	355	156	134	3	7		X					X		
		68	ID-9/11	Te	99	4,4	435	421	376	4	6		70		X	X	X	X		
D2		49	JD-3/29	Te	25	2,6	64	64	52	2	5		15							
		48	JD-2/1	Te	50	0,4	9	9	9	1	4		>1				X	X		
		47	JD-2/56	Te	50	4,1	204	181	158	4	7		>1					X		
		46	HC-1/36	Te	100	1,6	160	135	133	2	7		X							
		45	JD-2/177	Te	50	4,5	225	218	206	3	8		X							
		44	JD-2/124	Te	27	1,3	56	49	34	2	4		X					X		
		43	JD-2/152	Te	50	0,6	30	30	21	1	4		X							
		42	JD-1/165	Te	25	2,3	57	40	29	2	3		X							
		41	JD-1/96	Te	50	<0,1	3	3	1	2	1		X						X	
D1		40	JD-1/43	Te	90	3,3	293	244	211	3	7		X							
		39	JD-1/1	Te	25	0,9	23	16	5	3	4		20							
		67	HC-25/218	Te	80	1,4	108	104	73	4	7		12		X		X			X
		66	HC-25/75	Te	80	1,9	152	152	152	2	7		23							
		65	HC-25/1	Te	90	3,6	325	324	90	5	9		23		X	X		X		
		64	HC-10/18	Te	87	3,2	278	278	100	3	7		91							
		-	IE-1	Te	10	0	0	0	0	0	0	X	X							
	MB 7?	36	HD-3/03	Td	100	0,4	42	36	32	2	5		X		X					
		35	HD-3/02	Te	100	0,2	17	14	9	3	2		X		X					
	MB 6	38	ED-2/110	Te	100	0,4	40	34	23	3	4		X					X		
		37	ED-2/106	Td	100	0,3	34	14	8	3	4		X		X		X			

Fig. 2 : Micropaleontological inventory of all samples treated. Samples containing only determinable Chitinozoa are labeled with the outcrop and sequence number. All other samples recieved a sample number (1 to 78).

Assemblagezones and subzones	Formations and members	N° of sample	Number of outcrop and sequence	Interval of BOUMA sequence	Weight of treated sample (in gram)	Concentration (Chitinozoa per gram)	Number of Chitinozoa observed	Number of Chitinozoa determined to the genus	Number of Chitinozoa determined to the species	Number of the genera	Number of species	Acritarcha	Leiosphaeridia : presence or number per gram	Incertae Sedis sp. A	Tasmanites? sp.	Scolecodonts	Fragments of graptolites	Melanosclerites	Scutiferidae	Linotolypidae (artefact)
C4	MB 5	63	DD-9A	Te	82	<0,1	5	5	2	3	2		0,1			X				
		34	CD-22G/115	Te	100	0,4	38	32	14	4	5									
	MB 4B	33	CD-22G/78	Te	60	0,2	10	10	6	3	4									
		32	CD-22G/1	Te	100	1,5	151	119	91	5	5						X	X		
		31	CD-22F/17	Te	100	0,2	15	10	9	4	6		X							
C3		30	CD-22E/36	Tb	100	1,0	97	60	55	6	3		X					XX		
		29	CD-22E/35	Te	100	2,6	263	263	204	9	16	X								
	MB 4A	28	CD-22D/1	Te	100	4,0	397	332	257	8	15					X				
		27	CD-22B/1	Te	100	<0,1	1	1	1	1	1									
		-	KF-2F/44	Te	100	<0,1	1	0	0	0	0									
		-	KF-2F/2	Te	100	0	0	0	0	0	0									
		26	CD-22A/2	Te	100	1,1	114	98	69	7	9									
		25	KF-2E/2	Te	100	0,3	27	21	13	4	3					X	X			
		24	CD-20/224	Te	100	0,8	75	59	35	4	5									
		23	CD-20/144	Te	100	<0,1	2	1	0	1	0									
		22	KF-2D/4	Te	100	<0,1	1	1	1	1	1		X					X		
		21	CD-20/33	Te	33	6,5	214	208	146	5	6					X		X		
		20	CD-1F/198	Te	100	0,8	83	79	57	7	10									
		19	CD-1A/33	Te	100	5,8	578	499	380	8	16					X	X			
		18	CD-1A/6	Te	100	12,5	375	283	218	8	13	X	X							
?	MB 3E	-	HF-1A	Te	10	<0,1	1	0	0	0	0	X								
C2		17	KF-2C/91	Te	100	0,8	80	59	55	6	10									
		16	KF-2C/0	Te	130	0,3	41	29	24	7	10		X				X	X		
		15	IG-1/91	Te	72	<0,1	2	2	2	2	2									
		14	IG-1/8	Te	25	0,4	11	7	5	3	3	X	100							
		13	KF-2B/4	Te	100	3,2	321	300	226	7	13									
		12	CD-19/10	Te	100	1,5	146	134	124	5	8		X					X		
		11	KF-2A/2	Te	100	2,1	206	191	139	7	6		X							
		-	BD-25A	Te	87	0	0	0	0	0	0		0,6							
		62	BD-1A	Te	100	1,0	102	75	62	2	6	X	7,5							
?		-	IF-11/C3	Te	90	0	0	0	0	0	0	X	X					X		
		-	IF-11/C1	Te	100	0	0	0	0	0	0	X	X							
C1	MB 3D	-	CD-2/1	Te	55	<0,1	2	0	0	0	0		0,1							
		10	CD-2/5	Te	70	1,6	113	98	65	5	10									
		9	IF-9/+11,5m	Te	90	4,2	375	366	292	7	15									
		8	IF-9/-2,5m	Te	100	2,8	279	240	209	8	13									
	MB 3C	61	BD-7/46	Te	90	2,3	204	141	72	6	11	X	26	1		X		X		
		60	BD-7/2	Te	93	5,1	477	413	362	6	12	X	120		X	X				
B2	MB 3B	-	KG-4B	Te	100	0	0	0	0	0	0		0	29						
		-	CD-15A	Te	95	<0,1	4	0	0	0	0		0,02	14						
		-	CD-10	Te	50	<0,1	1	0	0	0	0		0	>2						
	MB 3A	7	IG-19/+24,8m	Te	70	6,2	434	404	354	5	7		29	1						
		6	IG-19/101	Te	100	0,2	23	13	11	1	1		0,08	9						
		5	IG-19/-5m	Te	70	<0,1	1	1	1	1	1		0,01	79						
		-	IG-19/175	Te	100	0	0	0	0	0	0		0	45						
		-	JG-1/35	Te	100	<0,1	5	0	0	0	0		0,02	16						
		-	IH-1/2	Te	60	<0,1	1	0	0	0	0		0,02	42						
		-	FH-9	Te	100	<0,1	1	0	0	0	0		0,01	>13						
		-	GH-2	Te	25	<0,1	2	0	0	0	0		0	0						
	MB 2B	59	HH-6E/51	Te	87	0,4	36	32	20	3	2	X	12							
		58	HH-6D/226	Te	87	0,6	54	42	36	4	3	X		X	X					
		57	HH-6A/5	Te	96	<0,1	1	1	1	1	1		0,2	1						
B1	MB 2A	4	GH-14	Te	100	0,4	35	19	3	3	2									
		3	GH-9/144	Te	100	0,3	25	13	1	3	1									
		2	GH-9/1	Te	100	0,4	37	25	20	2	4									
A	MB 1	1	EI-12A	Te?	100	<0,1	5	5	0	4	1									

Dr. Y. SOMERS from the I.N.I.E.X. at Liège (Belgium) (SOMERS, 1982 pers. comm.) analysed two samples from the lower and higher part of the column (sample N° 7(IG-19/+ 24,8 m)and sample N° 56 (CB-8/7) respectively) for their reflectance on vitrinite (i.e.: amorph organic material). This is a standard analysis for oil and coal research. The measurements gave values with a mean around 4 % R. med. (medium reflectance) ranging from 2,5 % to 5 % and more. These high values clearly show the rank of antracites or meta-antracites; in petrographical classification this corresponds to the deeper part of the zeolite facies (anchi-zone) and possibly, even a very low grade metamorphism. The petrographical observation in the field of an oblique slaty cleavage in the sediments, and the abundance of chlorite and sericite confirm these measurements.

Little cracks or fragmentation of the organic walled microfossils was hardly ever observed. Normally this only occurs in areas of major tectonic events (e.g. the Silurian from the Condroz-ridge, Belgium).

RAUSSCHER (1973) rarely or never obtained organic microfossils in samples from the anchizone or the very low grade metamorphism zone and his conclusion was that these microfossils are completely carbonized together with all the other organic material as soon as the the anchizone (at about 200° C) is reached, and no satisfactory palynology can be done. However, this study shows that at higher carbonization stadia a consistent biozonation with Chitinozoa is possible. Nevertheless we have to keep in mind that an important amount of the original organic microfossils and material was probably destroyed by this high diagenesis (or very low grade metamorphism) leaving only a small percentage of identifiable Chitinozoa.

In the genera Ancyrochitina EISENACK, 1955, Gotlandochitina LAUFELD, 1974 and Angochitina EISENACK, 1931 emend. 1968 (Pl. 8, fig. 191-199; Pl. 9, fig. 220-224; 230-240) nearly all appendices or large spines have been broken off at their base. This could be due to the high diagenesis or to the preparation technique, but more probably it is caused by rough transport in the turbidity currents.

Very few perforations or other holes caused by microorganisms were observed in the tegument as described by EISENACK (1931), JENKINS (1967) and LAUFELD (1967, 1974). Only by observation with a scanning electron microscope were some of these phenomena seen (Pl. 4, fig. 86). Particle impressions (size 10-15 μm) can be seen in the tegument, probably caused by mineral grains during compaction.

Framboïdal structures on the tegument were also often observed and described by many authors as a growth of pyrite from within the Chitinozoa (MARTIN, 1971; CARTER & LAUFELD, 1974; CHAIFFETZ, 1978). This pyrite occasionaly grew through the tegument, destroying it and leaving rare, round, internal casts of the Chitinozoa interior. These casts can still be vaguely assigned to one or several genera, though they cannot be included in the assemblage count.

In our study area the pyrite grew principally in Chitinozoa as in the larger Leiosphaeridia and Scolecodonts, but more rarely in acritarchs and smaller Leiosphaeridia. The pyrite, often desseminated in the sediments of the Mehaigne area, indicates a highly reducing environment during early diagenesis and even during deposition (KRUMBEIN & GARRELS, 1952).

It probably began growing from nuclei, which were partly organic microfossils such as Chitinozoa and Leiosphaeridia. In several specific horizons of the column (e.g. CD-22F, CD-22G, ED-1 and HD-3) nearly all Chitinozoa show an irregular corrosion of the tegument.

C.3. Abundance of Chitinozoa.

The concentration averages 1,5 Chitinozoa per gram of rock. Fifteen samples are completely barren, 55 samples have a concentration of less than 0.1 up to 1.5 Chitinozoa per gram of rock, 9 of these samples containing only undeterminable Chitinozoa; 32 samples have a concentration of more than 1.50, eight of these samples having more than 5, and 3 samples, more than 10, with a maximum of 12.5. This is still very low. In some places with very good living conditions and preservation, e.g. Gotland (Sweden) the concentration can attain 100 and even 1000 Chitinozoa per gram of rock (LAUFELD, 1974) which is indeed considerably more. But even when compared with rocks from the same region and with the same high diagenesis this specific concentration is low. MARTIN (1974) found an average concentration of 6 Chitinozoa per gram of rock with a maximum of 28 in borings from the late Ordovician to early Llandoverian strata in the Brabant Massif near Kortrijk (Belgium), some 140 km more to the east of the Mehaigne area. Most probably surface weathering from outcrops and higher diagenesis are the causes for a lower concentration in the Mehaigne area.

The concentration of Chitinozoa throughout the stratigraphical column (fig. 3) is generally higher and quite constant in formation MB7 (middle and/or late Wenlockian), medium or low with some higher levels of concentration in formation MB3, MB4 (middle Llandoverian to middle Wenlockian) and MB8 (late Wenlockian), and low in formations MB2 (middle or late Llandoverian) and MB6 (middle Wenlockian). In formations MB1, MB5 and MB9 there are too few samples to draw any conclusions. When we look at the mineralogical composition of the samples, we see that those with a chlorite matrix generally have a low concentration of Chitinozoa with some rich levels. In the quartzic matrix the concentration is quite constantly high, but with a calcareous cement the concentration is generally low. Observing the megacyclic variation of the turbidites we see a marked decrease in abundance of Chitinozoa at the transition from formations MB4 to MB5 (early in the middle Wenlockian) and MB7 to MB8 (late Wenlockian) which correspond to the diminished energy of the turbidity currents and an increase in the amount of transported material. We also remark an increase in the concentration with a concurring increase in the energy of the turbidity currents at the transition from MB3 to MB4 (late Llandoverian or early Wenlockian). However, looking at the smaller megacyclic changes there is no clear relation. Although there is a tendency to think that an increase in energy is linked to an increase in concentration: e.g. at the top of member MB3C to member MB3D and in formation MB7 in samples 43 to 45. Hence, the concentration of Chitinozoa in the sediments of the Mehaigne area is at least partially linked to the same factors that influenced the regime of turbidity currents.

C.4. Diversity of Chitinozoa.

In contrast to the low concentration of Chitinozoa in the samples, the diversity (number of species and genera per sample) is remarkably high in the comparison with other Silurian areas. In a given sample, 1 to

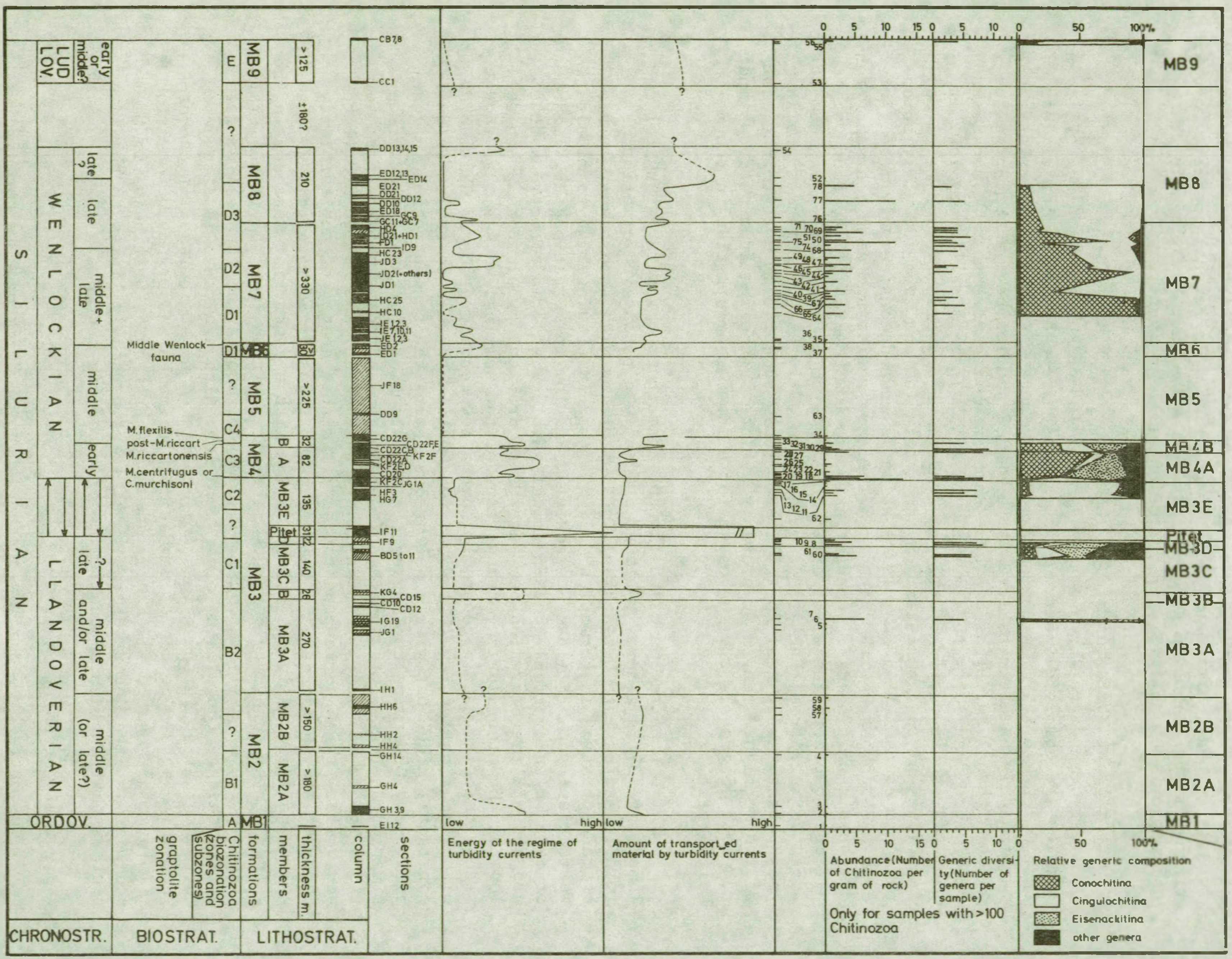


Fig. 3: Abundance, generic diversity and generic composition of the Chitinozoa and the relation to the litho-and biostratigraphy and the sedimentological evolution of the turbidites. (for explanation see text p. 11, 13, 56, 57)

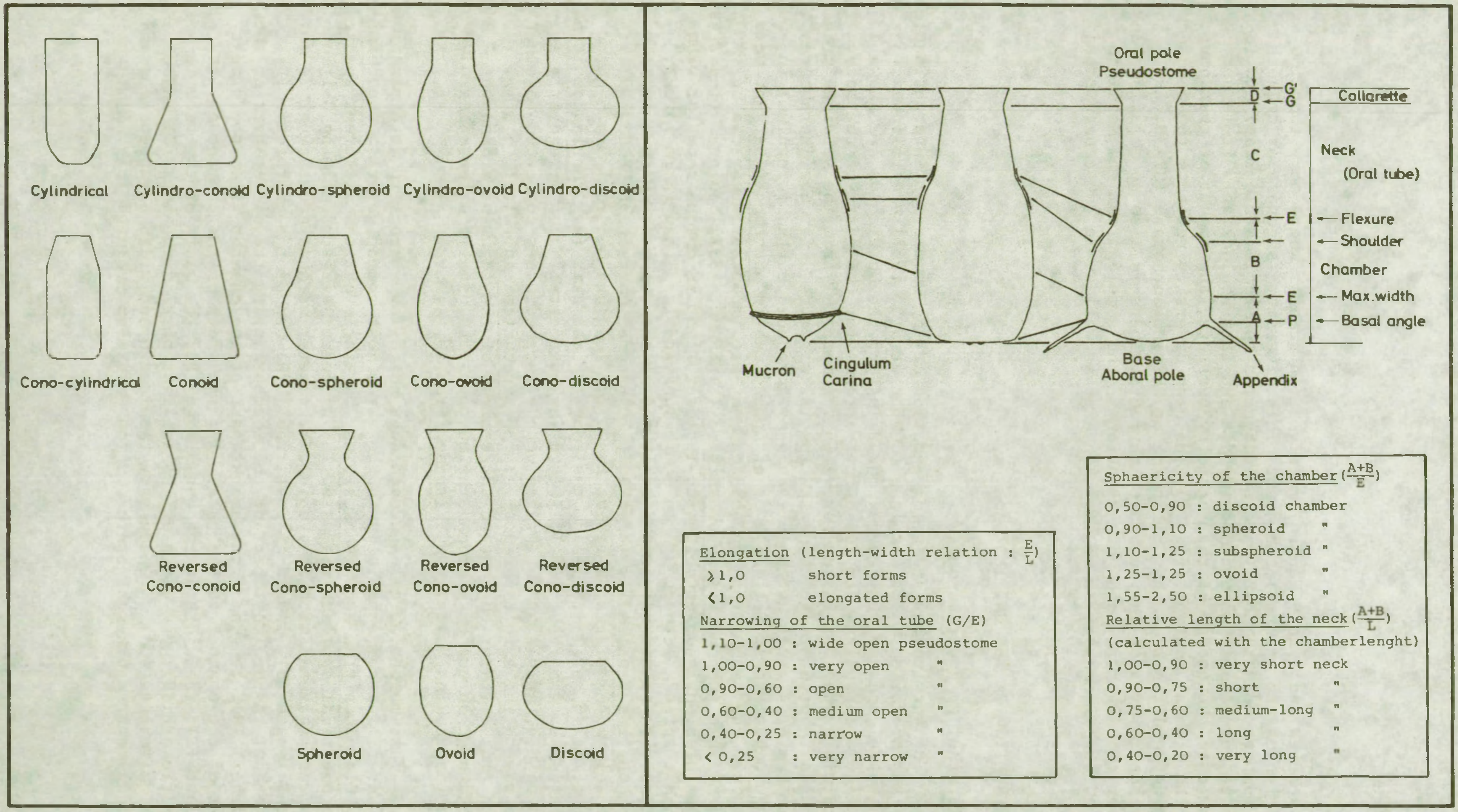
16 species and 1 to 9 genera, mainly 5 (in samples where more than 100 Chitinozoa are counted) can occur. This diversity is generally higher in members MB3D to MB4B (late Llandoverian to middle Wenlockian) and lower in formations MB7 and MB8 (middle and late Wenlockian). It is not linked to the energy of the turbidity currents, the amount of transport or the mineral content (fig. 3). The high diversity reflects the good living conditions of the Chitinozoa or Chitinozoophorans (GRAHN, 1981) in the source area of the turbidity currents. There is also no relation between the diversity and concentration in the samples from the Mehaigne area. The diversity can be large in high as well as in low concentrated samples.

D. DESCRIPTION OF THE CHITINOZOA.

D.1. Terminology and taxonomy.

The terminology and recommendations of the Commission internationale des microfossiles du Paléozoique (COMBAZ et al., 1967) are followed. The terms used for the general morphology of the Chitinozoa are shown in fig. 4 as well as some descriptive terms for the parts of the body. Determining the Chitinozoa genera in the material from the Mehaigne area was easy, but distinguishing the species was more difficult. Morphographic features, such as the presence of a reduced carina (cingulum) in Cingulochitina PARIS (1981), or of appendices in Ancyrochitina spp. were helpful. The decorations on the tegument are important: they can be : smooth (e.g. Conochitina proboscifera (EISENACK, 1937), pointed (less than 1 μm high, only observable with incident light in opaque forms or with S.E.M.; spined (between 0.5 to 5 μm long and less than 1 μm thick), either with spines uniformy distributed or set out more or less in rows (Angochitina longicollis (EISENACK, 1959 nomen correct. LAUFELD, 1974); with elongated ridges, a few up to 20 μm long and 0.5 to 1 μm high, sometimes in rows parallel to the longitudinal axis (e.g. Gotlandochitina corniculata (LAUFELD, 1974); felted (an ornamentation of irregularly spaced points, spines and/or ridges with elongated bases connected together and resembling a felt surface (e.g. Eisenachitina sp. C: pl. 5, fig. 105); with rings (faint,concentric thickenings of the tegument around the flexure or on the base around the mucron, both usually orientated normal to the longitudinal axis: e.g. Eisenackitina sp. A).

This morphological approach does not allow a specific determination in several cases, especially in the three most common genera : Conochitina, Cingulochitina and Eisenackitina. To single out the different species a biometrical approach was used. The different sizes of all the Chitinozoa were measured with an eyepiece micrometer with an accuracy of 2 μm: total length (L), length of oral tube (C+D) and of the collarette (D), length of the oralmost part of the chamber (up to the widest part of the chamber) (B), length of the aboral part of the chamber (from the widest part of the chamber to the base) (A); the width of the chamber at its widest (E); the width at the basal edge (P); the width of the neck at the flexure (F); the width of the smallest part of the neck (G) and of the collarette (G'). If necessary the length and width of appendices and the diameter and height of the mucron were also measured (fig. 4).



<u>Elongation</u> (length-width relation : $\frac{E}{L}$)

≥1,0 short forms

<1,0 elongated forms

<u>Narrowing of the oral tube</u> (G/E)

1,10-1,00 : wide open pseudostome

1,00-0,90 : very open "

0,90-0,60 : open "

0,60-0,40 : medium open "

0,40-0,25 : narrow "

< 0,25 : very narrow "

<u>Sphaericity of the chamber</u> ($\frac{A+B}{E}$)

0,50-0,90 : discoid chamber

0,90-1,10 : spheroid "

1,10-1,25 : subspheroid "

1,25-1,25 : ovoid "

1,55-2,50 : ellipsoid "

<u>Relative length of the neck</u> ($\frac{A+B}{L}$)

(calculated with the chamberlenght)

1,00-0,90 : very short neck

0,90-0,75 : short "

0,75-0,60 : medium-long "

0,60-0,40 : long "

0,40-0,20 : very long "

Fig.4: Descriptive terms for the overall morphology of the Chitinozoa, for the different parts of the Chitinozoa in an example of Cingulochitina, Conochitina and Ancyrochitina and for the parameter classes.

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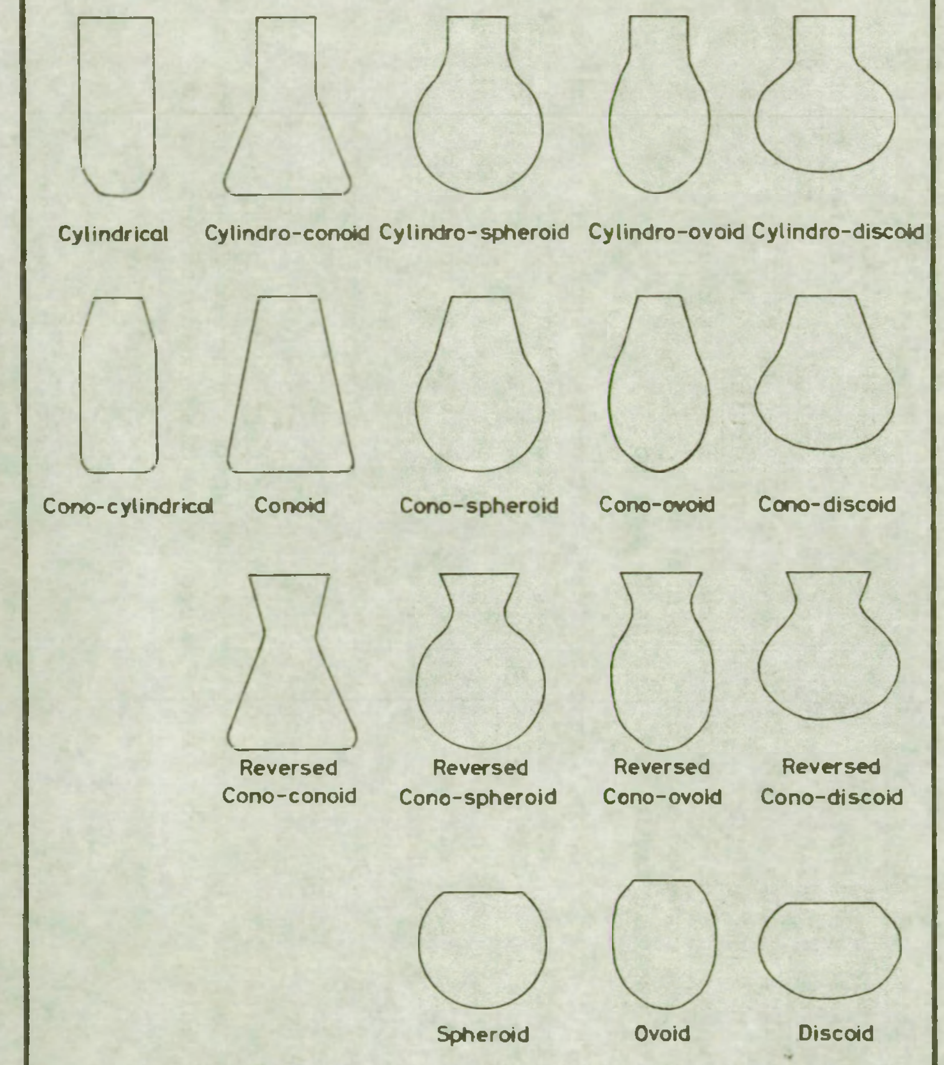

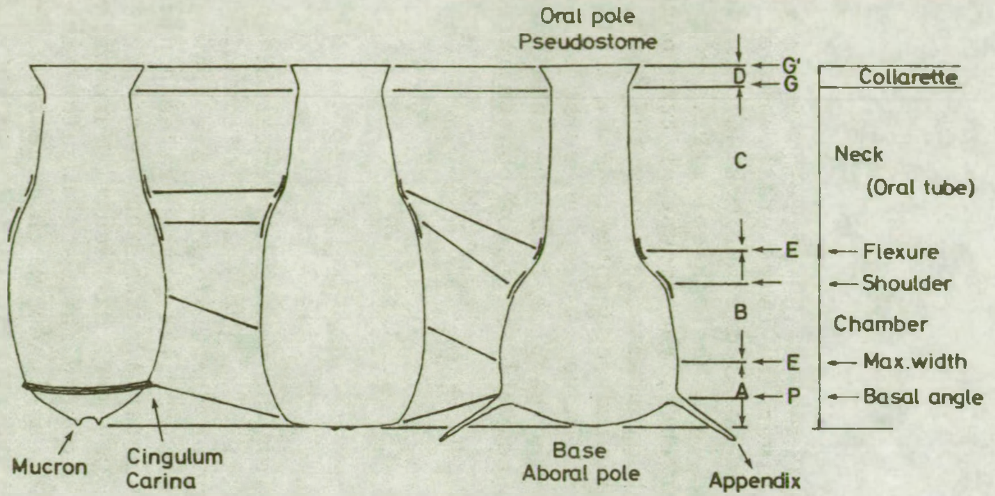

Elongation (length-width relation : $\frac{E}{L}$)
>1,0 short forms
<1,0 elongated forms

Narrowing of the oral tube (G/E)
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1,55-2,50 : ellipsoid "

Relative length of the neck ($\frac{A+B}{L}$)
(calculated with the chamberlenght)
1,00-0,90 : very short neck
0,90-0,75 : short "
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Fig. 4: Descriptive terms for the overall morphology of the Chitinozoa, for the different parts of the Chitinozoa in an example of Cingulochitina, Conochitina and Ancyrochitina and for the parameter classes.

Different parameters were calculated for the numerical description of the populations. The elongation of the Chitinozoa is given by E/L (width of the Chitinozoa divided by its length). When E/L is more than 1 they are called short forms; with E/L less than 1 they are elongated forms (fig. 4). The narrowing of the oral tube is calculated by G/E (the width of the collar at its narrowest, divided by the width of the chamber). It varies from very open to very narrow (fig. 4). For Lagenochitinidae (PARIS, 1981) the sphericity of the chamber was calculated with (A+B)/E (length of the chamber divided by its maximum width). It varies from spherical through subspherical and ovoid to ellipsoid (fig. 4). The relative importance of the chamber of this same Lagenochitinidae is also calculated as is the relation between the oral tube length to the total length of the Chitinozoa (A+B/L). This parameter varies from a very short to a very long neck (fig. 4).

For the genera Cingulochitina and Conochitina (EISENACK, 1931 emend. JANSONIUS, 1964)L, E, G, G', m, n and eventually i and j, the elongation E/L and the oral tube opening G/E are measured. For the genera Eisenackitina JANSONIUS, 1964 and Desmochitina EISENACK, 1931, restr. 1968, L, E, G and eventually the diameter of the operculum, the elongation, and the oral tube opening are measured (because of the frequent absence of a neck, this is calculated by the relation between the width at the flexure F and the widest width E). For Margachitina EISENACK, 1968, L, E and the length of the stolon (S) are measured. For Ancyrochitina, Angochitina, Gotlandochitina and Sphaerochitina EISENACK, 1955, L, E, G, G', F, A+B, C, D, I and J are measured and the relative part of the neck (A+B/L) and the sphericity of the chamber (A+B/E) are calculated.

These two or three parameters were put on a graph (e.g.: E versus L) and the concentration of points in one or several clusters was checked and controlled in nearby samples. This allowed us to delimitate the different species of a genus.

It is important to mention here that all measurements put in our graphs were made on flattened and carbonized Chitinozoa (opaque tegument). The effect of carbonization is not precisely known, but possibly results in a slight decrease of the dimensions (CORREIA, 1967, 1969). The flattening only slightly increases the total length of the Chitinozoa, but surely increases their width. PARIS (1981) is the first to fully acknowledge this frequent problem in the study of Chitinozoa. He therefore illustrates some of the species encountered in both their flattened state, and in full relief. He also uses a correction factor of 0.7 or 0.8 to calculate the original width of the flattened specimens. Although about 5 % of the Chitinozoa from the Mehaigne area are not flattened, all measurements of Chitinozoa are done on flattened specimens, and to compare our data on dimensions with the published data the same correction of 0.7 or 0.8 should be used for all width dimensions. We are aware that for the material encountered in the Mehaigne area, this biometrical approach is clearly biased, but it is biased in a similar way for all species of the same genus. Although LAUFELD (1976 pers. comm.) doubted the validity of this method, the biometric approach proved to be a helpful tool in singling out the different species within a genus. However, because of the deteriorated state of preservation of the Chitinozoa, no other goals can be archieved with this method.

Most of these populations, delimitated partly by the biometrical approach and partly by general morphological features, can be referred to species already described in other areas. Eighteen species cannot be assigned to any of the species described in other areas, and are classified under open nomenclature. They probably belong to still undescribed new species but the state of preservation is not good enough to propose the establishment of new specimens (cf. LAUFELD, 1976, pers. comm.).

In the systematical description of the Chitinozoa, the dimensions of the different parameters and the relation between the parameters are given. The meaning is explained above. Five numbers were used if enough specimens were measured (more than 6 specimens): i.e. the minimum value, the mathematical mean value minus the standard deviation, the mathematical mean of values, the mathematical mean plus the standard deviation and the maximal value. With asymmetrical distributions the mean value minus or plus the standard deviation may be smaller or larger than the minimum or the maximum value respectively. It is then put between brackets. In some cases where less than 6 specimens were counted only the minimum or maximum values encountered are given with the mean. In cases with only a few measurements, only the maximum and minimum are given.

When the range and apogee of one species coincides with the presence of another less frequent species, and a certain similarity exists between them, there is some doubt about their classification as either two distinct species or variants of the same species. Four examples: *Conochitina flamma* LAUFELD, 1974 occuring at the apogee of *Conochitina acuminata* EISENACK, 1959 emend. LAUFELD, 1974; the large variety of *Eisenackitina* sp. C occuring at the apogee of the typical *E*. sp. C; *Cingulochitina* sp. D coinciding with the apogee of *C*. sp. C, and *C*. sp. A coinciding with the apogee of *C*. sp. E. It is our opinion, however, that except for the second example, these groups are distinct enough to separate them as proper species.

In some other cases, where the ranges of two similar species occur separated by a section where none have been found, some evolutionary tendencies may be present; two examples : *C*. sp. E and *C*. *cingulata* or *Eisenackitina* sp. A and *Conochitina brevis brevis*? (in which case the generic determination of one of the two may prove to be wrong). In two other examples the ranges of two species coincide over a short interval, with one species ranging principally lower in the section, and the other, higher up: *Eisenackitina* sp. A and the dwarf species *E*. sp. B, and *Gotlandochitina corniculata* LAUFELD, 1974 and the species with a shorter neck *G*. aff. *G*. *corniculata*. More research is needed to control these possible tendencies.

D.2. Systematic description of the Chitinozoa.

Genus Ancyrochitina EISENACK, 1955

type species : Conochitina ancyrea EISENACK, 1931

Ancyrochitina spp.

Pl. 8, fig. 191A to 199.

Remarks : Specimens of this genus are found, but no specific determination is possible because nearly all appendices have been broken off. Nevertheless according to their general shape and other features they can be divided into three groups.

Group 1 : cylindro-spherical forms, a medium-long cylindrical or conical neck with or without an evaded collarette, with a sharp flexure and a nearly spherical chamber; the tegument is thin and smooth and bears appendices on the lower half of the chamber; the base of the appendices are approximately 5 μm thick . (Pl. 8, fig. 191A, B, 193-195).

Group 2 : cylindro-conical or cylindro-ovoid forms with a short cylindrical or conical neck, flexure and light shoulders, conical chamber, a quite sharp basal edge and a convexe base; the tegument is thin, finely spined or smooth and bears (broken) appendices at the basal edge; at their base, the appendices are 10 to 13 μm thick. (Pl. 8, fig. 196-197).

Group 3 : cylindro-conical forms with a cylindrical neck, a little widening to the pseudostome, a slight flexure and shoulders, a slighty inflated conical chamber, a sharp basal edge and a convexe base; the tegument is smooth and quite thick: there are spines around the flexure and at the basal edge. (Pl. 8, fig. 192A, B, 198, 199).

Occurrence : In the Mehaigne area : middle Llandoverian to early Ludlovian throughout formations MB3 to MB9 in low frequencies (less than 15 %).

Genus Angochitina EISENACK, 1931, emend. 1968

type species : Angochitina echinata EISENACK, 1931

Angochitina longicollis EISENACK, 1959 nom. correct. LAUFELD, 1974.

Pl. 9, fig. 230-237.

Synonymy : Angochitina longicolla n. sp.in EISENACK, 1959, p. 13, pl. 2: 8-9.

Angochitina longicollis EISENACK, 1959 nom. correct. in LAUFELD, 1974, p. 56-57, fig. 19, q.v. complete synonymy.

Gotlandochitina? sp. B in VERNIERS & RICKARDS, 1978, p. 156, pl. 1, fig. 5, 6, 7.

Angochitina longicollis EISENACK, 1959 in VERNIERS, 1981, p. 171-172, pl. 1, fig. 13.

Remarks : As described in VERNIERS & RICKARDS, 1978 included in this species are specimens with a cylindro-ovoid form, a variable long neck, a short and very fine collarette, an ovoid chamber, distinct shoulders, a broad basal edge, and a convexe base; the ornamentation of the tegument is made of spines, granules or longitudinally orientated ridges which sometimes seem to occur in rows (30 to 40) parallel to the longitudinal axis. This observation previously let us to classify this species under the genus *Gotlandochitina*. After comparison with material from Gotland we now consider them as *A. longicollis*. Some specimens tend to show ridges in parallel lines instead of spines and are considered here as variants of the species. These ridges are 3 to 8 μm long, 1 μm wide and about 1 μm high, sometimes more. Beginning at the shoulders and towards the neck, the ornamentation and the number of "lines" decreases.

Dimensions :

			min	Md-σ	Md	Md+σ	max §
L	:	n = 50	98	114	140	166	205
E	:	n = 49	65	73	83	93	101
G	:	n = 41	26	33	41	50	57
E/L	:	n = 18	0.40	0.47	0.58	0.69	0.75
(A+B)/E	:	n = 36	0.63	(0.51)	0.76	1.02	1.48
(A+B)/L	:	n = 35	0.46	0.57	0.77	(0.95)	0.90

§ for explanation of the symbols see p. 16 .

Occurrence : In Gotland (Sweden) the species occurs in the submarine strata of the Visby Formation (sensu LAUFELD, 1974) under the Lower Visby Beds. It starts just above the Red *Arachnophyllum* Marl (late Llandoverian) and occurs throughout the Lower Visby Beds, into the Upper Visby Beds (base of the early Wenlockian) where it disappears before the top of this unit (EISENACK, 1964, 1968, TAUGOURDEAU & DE JEKHOWSKY, 1964, LAUFELD, 1971, 1974). In Dalarna (Sweden) its earliest occurrence is in the post-*M. turriculatus* Zones (base of late Llandoverian) and in Scania (Sweden) it has not been encountered in rocks younger than the *S. spiralis* Zone (corresponding to the *M. crenulata* Zone and probably the *M. griestoniensis* Zone, both from the upper part of the late Llandoverian (LAUFELD, 1971, 1974). In Estonia (USSR) KALJO (1970) reported the species without giving illustrations in the Adavaran (late Llandoverian) and the basal Jaanian (early Wenlockian), which is consistent with the ranges in Gotland and mainland Sweden.

In Podolia (USSR), it is also mentioned in the basal conglomerate of the Restovo Beds which was dated by comparison with the Chitinozoa in Sweden as middle Llandoverian (LAUFELD, 1971). LAUFELD (1974) reviewed the occurrence of *A. longicollis* and concluded it was most useful for correlations. In Gotland (Sweden) it occurs in middle and late Llandoverian beds and disappears in the lower part of the early Wenlockian beds. LAUFELD (1977) mentioned that this species is indicative of the deepest part of the shelf : Benthic Assemblage Zone 5 BOUCOT (1975).

In the Mehaigne area: it occurs from late Llandoverian to early Wenlockian, in members MB3C, MB3D and MB3E and formation MB4 up till the upper part of the early Wenlockian, which is higher in the stratigraphical column the observed elsewhere (from less than 1 % up to 15 % of the assemblages).

Angochitina sp. A

Pl. 9, fig. 243-245.

Synonymy : Angochitina sp. A in VERNIERS & RICKARDS, 1978, p. 156, pl. 1, fig. 1.

Angochitina sp. A in VERNIERS, 1981, Fig. 1, p. 166.

Description : As described in VERNIERS & RICKARDS, 1978 included here are cono-ovoid forms with a short to medium-long neck widening towards the pseudostome, no collarette is observed; just aborally of the flexure the body chamber widens via straight shoulders to the ovoid chamber; its greatest width is at one third of the base; the basal edge is weak or absent, the base is convexe; the tegument is thin and bears a fine decoration of points, sometimes spines mostly broken off on the chamber and around the flexure. Too few specimens are found to be able to designate this species under open nomenclature to tone of the already described species of Angochitina.

Dimensions :

		min	Md-σ	Md	Md+σ	max
L	: n = 16	80	81	110	140	197
E	: n = 17	65	68	77	87	91
G	: n = 16	15	22	30	38	45
(A+B)/E	: n = 11	0.87	(0.82)	1.11	1.41	1.89
(A+B)/L	: n = 12	0.34	(0.16)	0.58	0.73	0.68

Occurrence : In the Mehaigne area : late Llandoverian to early Wenlockian ; less than 1 % up to 15 % in member MB3D, MB3E and formation MB4; zone C1 to C3.

Angochitina sp. B

Pl. 9, fig. 238-240.

Synonymy : Angochitina sp. B in VERNIERS & RICKARDS, 1978, p. 156, pl. 1, fig. 2.

Angochitina sp. B in VERNIERS, 1981, fig. 1, p. 166.

Description : As described in VERNIERS & RICKARDS (1978) included here are forms with a short to medium-long cylindrical neck, widening or narrowing towards the pseudostome; a sharp flexure, slight shoulders and an ovoid chamber; nearly no basal edge and a round base; no collarette, operculum or mucron is observed; the tegument is thin and covered with thick spines up to 10 μm long, mostly broken off.

Dimensions : length : 100-146-172 μm, width : 75-86-95 μm; pseudostome 34-40-45 μm; sphericity of the chamber (A+B)/E : 1.12-1.21-1.49.

relative length of the chamber (A+B:/L) : 0.69-0.75-0.90.

Occurrence : In the Mehaigne area : late Llandoverian to early Wenlockian; rare (less than 5 %) in member MB3D and in formation MB4.

Genus *Cingulochitina* PARIS, 1981

type species : *Cingulochitina cingulata* EISENACK, 1931

Cingulochitina cingulata (EISENACK, 1937)

Pl. 6, fig. 122, Pl. 7, fig. 148, 157-169.

Synonymy : *Desmochitina cingulata* n. sp. in EISENACK, 1937 , p. 220, pl. 15, fig. 6-7.

Linochitina cingulata (EISENACK, 1937) in LAUFELD, 1974, p. 97, fig. 57, *q.v.* complete synonymy.

Linochitina cingulata (EISENACK, 1937) in VERNIERS & RICKARDS, 1978, pl. 2, fig. 14.

Linochitina cingulata (EISENACK, 1937) in VERNIERS, 1981, pl. 2, fig. 26.

Remarks : The accurate description given by LAUFELD, 1974 is followed here. In samples 37 and 38 typical forms occur with an orally widening pseudostome, a fine, wide cingulum (carina) and a constriction of the chamber orally of the cingulum, which are characteristic of the species. Higher up in the stratigraphical column of the Mehaigne area, the species becomes less elongated. Fig. 5 shows the length-width diagram for different samples from formations MB6 and MB7. According to the measurements of a typical population given by EISENACK (1937)the E/L relation has to be 1/1.4 to 1/1.7 (0.71 to 0.59). Measuring his illustrations, we found 0.71 to 0.44. The E/L relation in the populations of the Mehaigne area falls between 1.02 and 0.52 (except for some extreme values). This shows that they are not as elongated as in the type material, but still, about half to one third of the specimens fall within the limits.

Dimensions : (see fig. 5) length : 59-115 μm; width : 48-77 μm; pseudostome-width relation : 0.36-0.80; width-length relation : 0.52-1.02.

Occurrence : *C. cingulata* is a good marker when the more restricting and more accurate definition by LAUFELD, 1974 is followed. He critically comments the litterature referring to the species and concludes that *C. cingulata* is a good index fossil for the Slite Beds (from the *Conchidium tenuistriatum* Beds upwards) through the Halla Beds to the top of the Mulde Beds in Gotland (Sweden). According to LAUFELD & JEPPSON (1976) this is from the top of the *C. linnarsoni*-Zone through the *C. ellesae* and *C. lundgreni*-Zone to the top of the *G. nassa*-Zone (from the middle of the middle Wenlockian to the middle of the late Wenlockian). In Scania (Sweden) it occurs to the top of the *Cyrtograptus* shale (top of the *G. nassa*-Zone) but does not pass into the *Colonus*-shale (*P. ludensis*-Zone).

In other parts of the world it has been mentioned from the Caradocian to Devonian but this wide range is doubted by LAUFELD (1974, p. 97). In the Mehaigne area it occurs in the middle and late Wenlockian; it

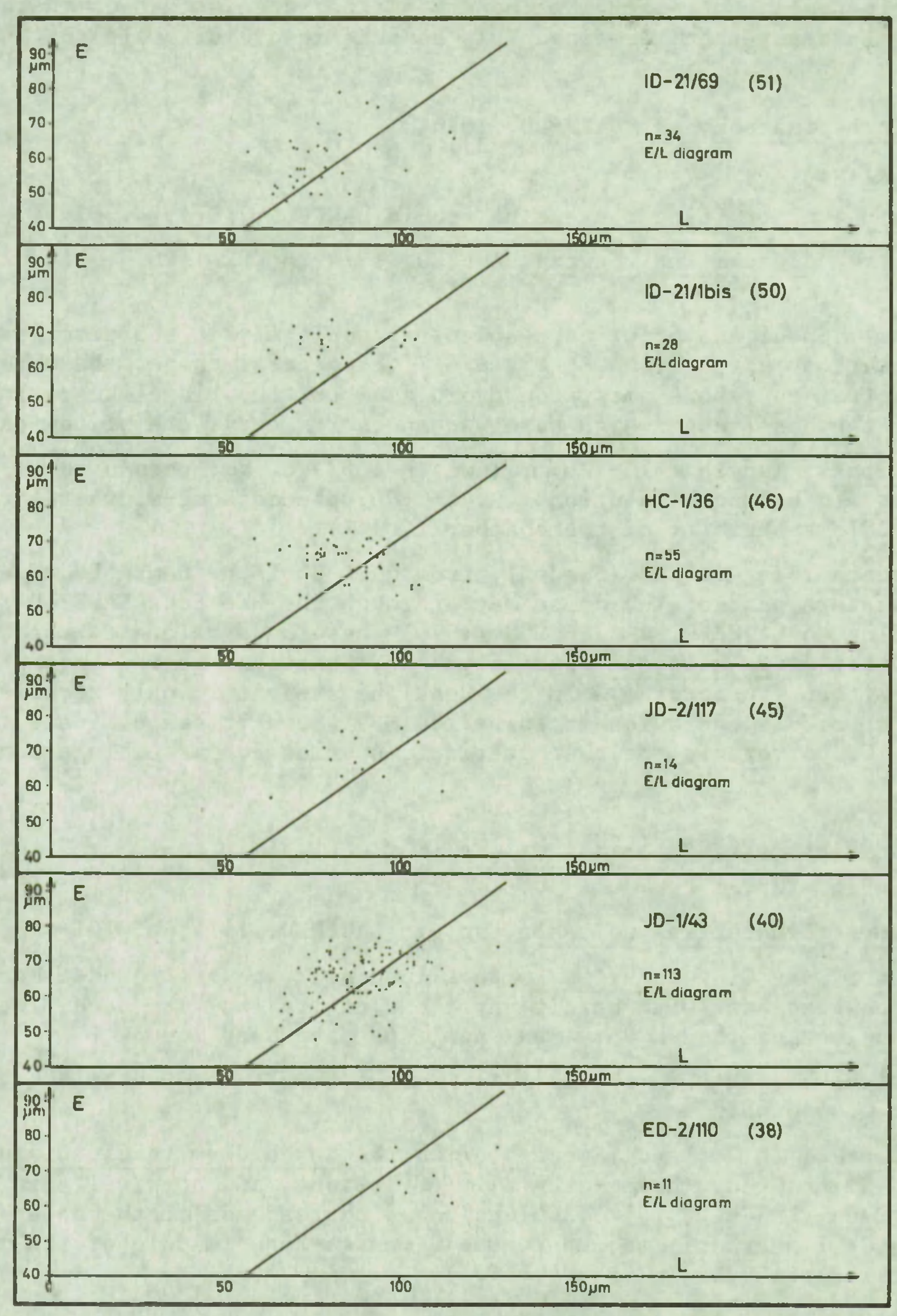

Fig. 5 : Width-Length diagram for flattened *Cingulochitina cingulata* (EISENACK, 1931) in six samples showing a gradual "shortening" of the populations (decreasing E/L) going upward in the stratigraphical column in formations MB6 and MB7 (middle and late Wenlockian). The line gives an E/L relation of 0,71 (see text).

occurs in the formation MB6, and is rare to dominant (up to 91 %) in formations MB7 and MB8. Together with Conochitina sp. D it forms the characteristic species of assemblage zone D. Either species can dominate up to 90 %, the other then receding. This happens in a cyclic alternating pattern.

Cingulochitina convexa (LAUFELD, 1974)

Pl. 6, fig. 126, 127A, B.

Synonymy : Linochitina convexa n. sp. in LAUFELD, 1974, p. 97-98, fig. 58.

Linochitina convexa LAUFELD, 1974 in VERNIERS, 1981, pl. 2, fig. 27.

Remarks : Specimens occur corresponding completely to the description and illustrations given by LAUFELD (1974): the general shape, the widening collarette, the short neck, the ovoid chamber, the ridgelike carina on top of the basal edge which hardly changes its curvature at the carina.

Dimensions : length : 70-126 μm; width : 57-76 μm; pseudostome : 36-54 μm; width-length relation : 0.45-0.96; pseudostome-width relation : 0.61-0.81; sphericity of the chamber (A+B/E) : 0.73-1.56.

Occurrence : In Gotland (Sweden), from unit C of the Hemse Beds and the northwestern part of the Hemse Marl through the Eke Beds(LAUFELD ,1974). According to LAUFELD & JEPPSON (1976) these beds belong to the Ludlovian: upper part of P. nilssoni-zone (Eltonian, Gorstian) to the base of the Whitcliffian (Ludfordian). In the Mehaigne area it is only recorded in the early or middle Ludlovian in formation MB9 where it can dominate (up to 73 %). C. convexa is the characteristic species for assemblage zone E.

Cingulochitina odiosa (LAUFELD, 1974)

Pl. 6, fig. 128.

Synonymy : Linochitina odiosa n. sp. in LAUFELD, 1974, p. 101-103, fig. 61.

Remarks : Long Cingulochitina with a long neck, a very rounded basad edge and a convexe base with hardly any cingulum (carina) are determined here as C. odiosa, although very few specimens have been found.

Dimensions : length : 110-123 μm; width : 50-57 μm; width-length relation : 0.45-0.49.

Occurrence : In Gotland (Sweden), from the Conchidium tenuistriatum Beds of the Slite Group through the Slite Siltstone, and atypically in the Mulde Beds (LAUFELD, 1974), which in age corresponds to the upper part of the C. linnarsoni-Zone up to the G. nassa-Zone (middle of the middle Wenlockian)(LAUFELD & JEPPSON, 1976).

In the Mehaigne area : very rare, only found in the middle or late Wenlockian in three samples from formation MB7.

Cingulochitina sp. A

Pl. 7, fig. 138-142.

Description : A cylindrical,slightly ovoid general shape; indistinct shoulders and flexure, a fine and small collarette, the neck passes very gradually into the slightly ellipsoid chamber; the basal edge is very rounded and the base, very convexe; a mucron or the impression from one is present, in the middle of the large basal edge a ridge-like low carina is visible and the basal edge does not change its curve under this carina; the tegument is smooth and very thin (about 1 μm). The elongation (E/L) between 0.32 and 0.37 , the very convexe base and the low carina in the middle of the basal edge is characteristic. It differs clearly from the other Cingulochitina species in the Mehaigne area.

Dimensions :

		min	Md-σ	Md	Md+σ	max
L	: n = 11	141	146	153	159	163
E	: n = 11	43	49	53	57	57
G	: n = 11	32	32	38	46	55
E/L	: n = 11	0.32	0.32	0.34	0.36	0.37
G/E	: n = 11	0.59	0.60	0.71	0.82	0.92
(A+B)/E	: n = 9	1.41		2.04		2.38

Occurrence : In the Mehaigne area : rare in the late Llandoverian and early Wenlockian in certain samples from members MB3D and the base of MB4A.

Cingulochitina sp. B

Pl. 7, fig. 143-147, 150-156.

Synonymy : Linochitina sp. B in VERNIERS & RICKARDS, 1978 , p. 157, pl. 1, fig. 9-10.

Linochitina sp. B in VERNIERS, 1981 , pl. 2, fig. 24.

Description : A slightly cono-ovoid general shape, with a short or no neck no shoulders and an indistinct flexure; an ovoid chamber, a very rounded basal edge and a round convexe base where a low mucron is present; it frequently occurs in chains (20 % in sample 30). In solitary specimens a ridge-like carina is present under the basal edge. The tegument is thin and seems to fold, in most cases, parallel to the longitudinal axis, which could be an original characteristic ; typical and frequent in sample 29, MB4B, Bounia, Lamontzée.

Dimensions :

			min	Md-σ	Md	Md+σ	max
L	:	n = 91	84	85	98	111	117
E	:	n = 90	48	58	62	67	70
G	:	n = 88	30	40	47	53	57
E/L	:	n = 61	0.38	0.47	0.63	0.78	1.05
G/E	:	n = 72	0.56	(0.55)	0.71	0.87	0.91

Occurrence : In the Mehaigne area, atypical in the late Llandoverian member MB3D, rare to dominant in the early Wenlockian formation MB4, especially around samples 29 and 30.

Cingulochitina sp. C

Pl. 6, fig. 125; Pl. 7, fig. 170-182.

Synonymy : Linochitina sp. C in VERNIERS & RICKARDS, 1978, p. 157, pl. 1, fig. 11, 12.

Linochitina sp. C in VERNIERS, 1981, pl. 2, fig. 20.

Description : Short, ovoid, slightly conical forms with a short to very short neck and a short, simple, thin collarette : often the neck narrows quite abruptly when it passes into the collarette; in which case the specimen usually has an operculum on top of the pseudostome; in several cases, the impression of a thin prosome can be seen in flattened specimens about ten μm aboral of the pseudostome; the prosome can sometimes stick out of the neck (Pl. 7, fig. 170). In other cases no operculum or prosomes have been observed; in this last case the neck together with the collarette is cylindrical and subconical (Pl. 7, fig. 172); the chamber is generally ovoid and slightly conical; the basal edge, usually rounded, and the base convexe or rarely, flat; in the middle of the basal edge a ridge-like low carina occurs and the basal edge does not change its curvature under the carina; a low mucron sometimes occurs but mostly only an opening is seen; the tegument is thin and usually smooth, or sometimes covered with points or very vague concentrical rings oblique to the longitudinal axis; no chains were observed; typical populations occur in sample 13 of member MB3E in locality KF-2B, Dreye.

Remarks : Other forms occur with a similar shape to C. sp. C, but with a long neck. These forms are classified as C. sp. D. Both species probably have an affinity with each other. Some other forms (up to 10 %) have a flat, broad base.

Dimensions :

			min	Md-σ	Md	Md+σ	max
L	:	n = 60	79	90	101	113	117
E	:	n = 60	54	61	65	69	72
G	:	n = 60	26	37	42	46	49
E/L	:	n = 60	0.50	0.55	0.64	0.73	0.92
G/E	:	n = 60	0.46	0.54	0.61	0.68	0.69

Occurrence : In the Mehaigne area: rare in late Llandoverian members MB3C and MB3D; very frequent to dominant in late Llandoverian or early Wenlockian member MB3E and the base of member MB4A, and rare to present in the rest of the early Wenlockian formation MB4; the high frequency of C. sp. C together with C. sp. D is typical of assemblage subzone C2.

Cingulochitina sp. D

Pl. 6, fig. 123; Pl. 6, fig. 183-190.

Synonymy : Linochitina sp. D in VERNIERS & RICKARDS, 1978, p. 157, pl. 1, fig. 13-14.

Linochitina sp. D in VERNIERS, 1981, pl. 2, fig. 25.

Description : Cono-ovoid to cylindro-ovoid forms, with a medium-long to long neck and a thin collarette in the prolongation of the neck; in some cases the neck narrows just below the collarette; the flexure and shoulders are indistinct; the chamber is slightly cono-ovoid or ovoid, the basal edge, sharp or very sharp, with a low, ridge-like carina occuring on it; a slight constriction of the chamber can occur orally of the carina; the base is slightly convexe or flat with an opening in the middle; only seldom is a low mucron observed; the tegument is thin, covered with points, or sometimes smooth.

Remarks : C. sp. D differs from C. sp. C by its longer size and the presence of a long neck; some C. sp. D specimens have a point ornamentation, and the basal edge is sharper. C. sp. D differs from C. cingulata by its more elongated ovoid chamber, indistinct shoulders and flexure and by the low ridge-like carina and the point ornamentation;but because of the small constriction of the chamber just orally of the carina it slightly resembles C. cingulata. C. sp. D can be differentiated from C. sp. E on a width-length diagram. This last species is slightly more slender and longer (E/L relation of C. sp. E: 0.36 to 0.59 and of C. sp. D: 0.48-0.65). A typical population occurs in sample 18 at the base of formation MB4 in locality CD-1A, Lamontzée.

Dimensions in sample 18 :

			min	Md-σ	Md	Md+σ	max
L	:	n = 65	89	98	118	137	143
E	:	n = 65	55	60	64	69	72
G	:	n = 65	27	39	47	54	64
E/L	:	n = 65	0.48	(0.47)	0.54	0.61	0.65
G/E	:	n = 65	0.43	0.60	0.68	0.76	0.81

Occurrence : In the Mehaigne area in late Llandoverian to early Wenlockian rare to present in members MB3C and MB3D, rare to very frequent in members MB3E and the base of member MB4A; rare in some levels of the remainder of formation MB4.

Cingulochitina sp. E

Pl. 6, fig. 133-137.

Synonymy : Linochitina sp. E in VERNIERS, 1981, pl. 2, fig. 28.

Description : A cylindro-ovoid general shape, with a medium-long neck, ending in a sample or widening collarette; a slight flexure and indistinct shoulders, an elongated ovoid chamber, a very sharp basal edge on which a ridge-like carina occurs; the base is flat or slightly convexe with a small protruding mucron; in several specimens the collarette of the underlying individual still hangs on to the basal edge and hides the base; the tegument is thin and smooth; quite often observed in chains of two specimens; a typical population occurs in sample 9 of member MB3D at locality IF-9, Les Falihottes, Pitet, Fallais.

Remarks : C. sp. E differs from C. cingulata by its much shorter carina, by its more slender and more elongated, ovoid chamber, by its vague flexure and indistinct shoulders, its small protruding mucron and the lack of constriction orally of the cingulum. C. sp. E differs from C. sp. D by its more slender form, the small protruding mucron and the always smooth tegument. Both last species can be differentiated on a width-length diagram (see p. 25).

Dimensions : sample 9

			min	Md-σ	Md	Md+σ	max
L	:	n = 37	94	(93)	118	142	156
E	:	n = 37	50	52	56	59	60
G	:	n = 37	32	36	41	47	50
E/L	:	n = 34	0.59	0.52	0.45	0.38	0.36
E/A+B	:	n = 37	0.49	0.53	0.69	0.84	1.07
G/E	:	n = 37	0.55	0.64	0.72	0.81	0.92

Occurrence : In the Mehaigne area: rare to present in the late Llandoverian and early Wenlockian, in members MB3C, MB3D and MB3E and the base of MB4A but does not continue higher up. After a gap Cinulochitina cingulata, a species similar to C. sp. E, appears in formation MB6 and continues higher.

Cingulochitina sp. F

Pl. 6, fig. 129-132.

Synonymy : Linochitina sp. G in VERNIERS & RICKARDS, 1978, p. 157, pl. 1, fig. 3, 4.

Linochitina sp. F in VERNIERS, 1981, pl. 2, fig. 23.

Description : Large ovoid forms, no collarette, very short neck, no flexure, slight shoulders, the chamber is orally conical and ovoid in the middle; the basal edge is sharp with a carina (3-5 μm wide) on it; the base, concave with an impression of the mucron; an operculum is sometimes observed on top of the pseudostome; a typical population occurs in sample 32 at the top of formation MB4 in locality CD-22G, Bounia, Lamontzée.

Remarks : The larger variant slightly resembles Cyathochitina cf. dispar BENOIT & DE TAUGOURDEAU, 1961, in CRAMER, 1967, p. 85 and ?Cyathochitina dispar BENOIT & DE TAUGOURDEAU, 1961, in CRAMER, 1964, p. 344 and pl. XXIII, fig. 8, 13, 14, but differs from it by its smaller size, the lack of a long neck and the presence of an operculum.

Dimensions : Two size variants occur in the same samples.

Smaller variety :		min	Md-σ	Md	Md+σ	max
L :	n = 9	65	78	99	(120)	120
E :	n = 9	74	79	88	98	100
G :	n = 4	40		47		55
E/L :	n = 9	0.77	0.79	0.94	1.09	1.15
G/E :	n = 4	0.44		0.54		0.59

Larger variety :		min	Md-σ	Md	Md+σ	max
L :	n = 8	94	120	128	156	177
E :	n = 7	102	(120)	117	132	145
G :	n = 5	57		69		85
E/L :	n = 8	0.75	(0.74)	0.94	1.13	1.26
G/E :	n = 5	0.50		0.59		0.68

Occurrence : In the Mehaigne area: early Wenlockian (from the M. riccartonensis-Zone upwards) to middle Wenlockian; rare to frequent (up to 18 %) in member MB4B and the base of formation MB5, also rare but atypical in the middle or late Wenlockian at the base of formation MB7.

Genus *Conochitina* EISENACK, 1931 emend. JANSONIUS, 1964

type species : *Conochitina claviformis* EISENACK, 1931

Conochitina acuminata EISENACK, 1959 emend. LAUFELD, 1974

Pl. 4, fig. 74-82.

Synonymy : *Conochitina acuminata* n. sp. in EISENACK, 1959, p. 6, pl. 3, fig. 10-11.

Conochitina acuminata EISENACK, 1959 in LAUFELD, 1974,p. 58-59, fig. 21 *q.v.* complete synonymy .

Conochitina acuminata EISENACK, 1959 emend. LAUFELD, 1974, in VERNIERS & RICKARDS, 1978, pl. 2, fig. 1-2.

Conochitina acuminata EISENACK, 1959 emend. LAUFELD, 1974, in VERNIERS, 1981, p. 171-172; pl. 1, fig. 11.

Remarks : This species is characterized by its conical shape, large protuding mucron and a sharp basal edge on which a ridge-like incipient carina can often be observed. LAUFELD (1974, p. 59) restricted *C. acuminata* originally defined by EISENACK (1959) in Gotland, to the smaller forms occuring in the Lower Visby Beds. Longer forms (more than 215 μm long) in the Högklint Beds are distinguished as *C. flamma* LAUFELD, 1974. In the Upper Visby Beds intermediate forms occur. In the Mehaigne area the specimens usually smaller than 160 μm are determined as *C. acuminata*. They occur in members MB3D and MB3E and formation MB4 of a late Llandoverian to early Wenlockian age. Only in samples 28 and 29, dated by graptolites as *M. riccartonensis* Zone (top of early Wenlockian), do intermediate forms between *C. flamma* and *C. acuminata* occur. In these two levels where *C. acuminata* is the most represented,some individuals attain a length between 190 and 210 μm, and are determined as *C. flamma*.

Dimensions :

			min	Md-σ	Md	Md+σ	max
L	:	n = 122	80	107	127	147	152
E	:	n = 120	51	60	65	70	74
G	:	n = 74	35	42	49	56	64
E/L	:	n = 115	0.36	0.45	0.53	0.62	0.72
G/E	:	n = 70	0.60	0.67	0.76	0.86	0.97

Occurrence : In Gotland (Sweden) *C. acuminata* typically occurs in the Lower Visby Beds and below (late Llandoverian); it also occurs in the Upper Visby Beds (base of the early Wenlockian); longer specimens ocurring in the Högklint Beds (early Wenlockian) are distinguished as *C. flamma* (TAUGOURDEAU & DE JEKHOWSKY, 1964; LAUFELD, 1974). In the Mehaigne area: late Llandoverian to early Wenlockian; rare (less than 5 %) in member MB3D and MB3E, and rare to frequent (between 5 and 41 %) in formation MB4.

Conochitina armillata? TAUGOURDEAU & DE JEKHOWSKY, 1960

Pl. 2, fig. 20-27.

Synonymy : *Conochitina armillata* n. sp. in TAUGOURDEAU & DE JEKHOWSKY, 1960, p. 1222, pl. 3, fig. 44, 45, 46.

Conochitina armillata TAUGOURDEAU & DE JEKHOWSKY, 1960 in TAUGOURDEAU & DE JEKHOWSKY, 1964, pl. 3, fig. 30.

Conochitina armillata TAUGOURDEAU & DE JEKHOWSKY, 1960, *var. minor*, *var. nov.* in LISTER, 1968, m.s., p. 158, pl. 27, fig. 1-8.

Conochitina armillata TAUGOURDEAU & DE JEKHOWSKY, 1960,*var. nov*. in LISTER, 1970 tabel 4.

Conochitina armillata? TAUGOURDEAU & DE JEKHOWSKY, 1960 in VERNIERS, 1981, p. 172, pl. 1, fig. 8.

Remarks : In *C. armillata*? are grouped all specimens similar, but definitely smaller than *C. armillata*, as pictured in TAUGOURDEAU & DE JEKHOWSKY, 1960, pl. 3, fig. 44-46. The type material has to be examined in more detail before it can be decided whether our species belongs to *C. armillata* or not. They are cylindro-conoid forms with a conical neck half the total length of the specimen and no collarette; the chamber has its maximum width at one third of the total length from the base; a rounded basal edge and a flat to slightly convexe or concave base; the tegument is not completely smooth but irregularly rugose, without felt or point decorations; the mucron points out from the base. *C. armillata*? has about the same shape as the more slender forms of *C.* sp. D but they are larger in size and more elongated. *C.* sp. C is smaller and much more slender than *C. armillata*?. *C. brevis brevis*? has a short or nearly no neck and is generally much broader.

C. armillata? forms together with *C.* sp. C, *C.* sp. D and *C. brevis brevis*? a closely related group of *Conochitina* species occuring in formations MB6, MB7 and MB8 (middle and late Wenlockian). When typical populations occur they are easely differentiated, but transitional forms may occur. These four species differ from *C. tuba*, a similar species with a large variability (EISENACK, 1932; 1962a: p. 294-295; 1964: p. 316; LAUFELD, 1974: p. 73) by the lack of straight flancs, typical of *C. tuba*. There is also a possible affiliation of this species with *C. elenitae*, as described in CRAMER & DIEZ (1978, p. 166).

Dimensions : see E/L diagram (fig. 6); measurements on samples 46, 47, 50, 51.

			min	Md-σ	Md	Md+σ	max
L	:	n = 46	176	177	195	214	230
E	:	n = 45	77	86	97	108	113
G	:	n = 38	56	57	64	71	75
E/L	:	n = 46	0.42	0.46	0.57	0.67	0.69
G/E	:	n = 41	0.34	0.52	0.61	(0.71)	0.71

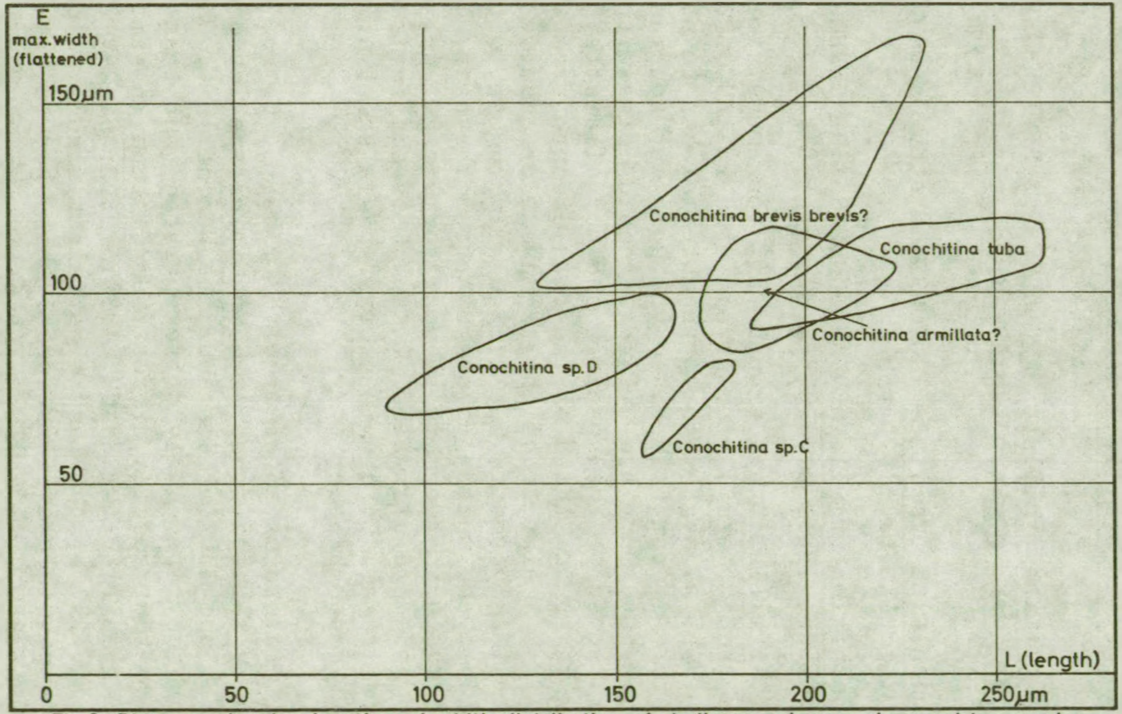

Fig.6: Diagram showing length and width distribution of similar species as observed in samples of the Mehaigne area (formations MB6, MB7 and MB8; middle and late Wenlockian).

Occurrence : The type species *C. armillata*, which is bigger than *C. armillata?* is found in zone 5 (Silurian) of the Algerian Sahara (TAUGOURDEAU & DE JEKHOWSKY, 1960, fig. 2). *C. armillata var. nov.* LISTER, 1970 and *C. armillata var. minor* LISTER, 1968 which greatly resemble our specimens were found in the Welsh Borderland (U.K.) in the top of the Wenlock Limestone (uppermost Wenlockian) up into the Lower Bringewood Beds (Gorstian, early Ludlovian). But its occurrence in older strata has never been verified in Wales. In the Mehaigne area *C. armillata?* occurs in formations MB7 and MB8 (middle and late Wenlockian).

Conochitina brevis brevis? TAUGOURDEAU & DE JEKHOWSKY, 1964

Pl. 3, fig. 46-50.

Synonymy : *Conochitina brevis* n. sp. in TAUGOURDEAU & DE JEKHOWSKY, 1960, p. 1222, pl. 3, fig. 47-49.

Conochitina brevis brevis n. var. TAUGOURDEAU & DE JEKHOWSKY, 1964, p. 858.

Conochitina brevis brevis TAUGOURDEAU & DE JEKHOWSKY, 1964 in VERNIERS, 1981, pl. 1, fig. 10.

Remarks : Classified as *Conochitina brevis brevis?* are forms which most resemble the illustrations of this species by TAUGOURDEAU & DE JEKHOWSKY, 1960, pl. 3, fig. 47-49 also described by TAUGOURDEAU & DE JEKHOWSKY (1964, p. 858). Because of the lack of good illustrations by these authors and until the type material is better described, this determination will remains doubtful. They are broad *Conochitina* forms with a short or absent neck, a cono-ovoid general shape, a spherical to ovoid chamber with a quite sharp basal edge and a flat base where a large impression of a mucron can occur; the tegument is rugose but without spines or points. They differ from *C. armillata?* by the absence of a neck, or the presence of only a short neck, and from *C.* sp. D by their wider chamber. This species falls within the dimensions and corresponds to the description of the larger forms of *C. gordonensis* CRAMER, 1964. However, this species was declared *nomen nudum* by the author himself (CRAMER, 1967; CRAMER & DIEZ, 1978); what the new diagnosis should be was never stated. Nevertheless we must mention that *C. brevis brevis?* from the Mehaigne area are also smaller in size than the large *C. gordonensis* and range into the size of *C. oelandica silurica* TAUGOURDEAU, 1963. However, they differ from this last one by their general shape, their short or non-existant neck and by the lack of a collarette. The species could be identical to *Belonechitina?* sp. A PARIS (1981) whose dimensions and observed decorations are similar and which occur in the base of the Sazes Formation (Contenças, Portugal) dated by graptolites as late Wenlockian (equivalents of *G. nassa* and *M. ludensis* Zone (see also p. 63).

Dimensions : length : 125-230 µm; width : 105-167 µm; pseudostome : 41-84 µm; width-length relation : 0.55-0.80; (E/L diagram: fig. 6).

Occurrence : *C. brevis brevis* in its typical form is widely reported from Ordovician to Llandoverian (zone 2 and 3) in the Algerian Sahara (TAUGOURDEAU & DE JEKHOWSKY, 1960), and in Aquitaine, France, at the Ordovician-Silurian transition according to (TAUGOURDEAU, 1966), in the middle Ordovician according to RAUSCHER (1973), and in middle and late Llandoverian in the Sahara (TAUGOURDEAU, 1962). It was recognized by TAUGOURDEAU & DE JEKHOWSKY (1964) in Gotland (Sweden), but not confirmed in the more elaborate study of the same island by LAUFELD (1974). In the Cantabrian Mountains (NW Spain), CRAMER (1967) described it in the middle and upper part of the Formigoso Formation and in the lower part of the San Pedro Formation (Wenlockian-Ludlovian). In the Mehaigne area: middle and late Wenlockian; less than 1 % up to 25 % in formations MB7 and MB8.

Conochitina cf. C. iklaensis NESTOR, 1980

Pl. 3, fig. 58-60.

Synonymy : Conochitina iklaensis n. sp. in NESTOR, 1980b, p. 139-140, tab. III, fig. 3-5.

Conochitina edjelensis elongata? TAUGOURDEAU, 1963 in VERNIERS, 1981, fig. 1.

Remarks : Grouped here are all the forms with a conical to subcylindrical shape, with a small collarette, a long to medium-long neck, very indistinct shoulders and a slightly ovoid chamber; the basal edge is sharp; the bottom is flat; the tegument is thin and smooth, or sparsely pointed; in flattened specimens the place of the prosome in the top part of the neck is shown by a protrusion (pl. 3, fig. 58). These specimens are easily differentiated from C. proboscifera by their thin tegument and from C. sp. E with the same dimensions, by a more clearly differentiated and more narrowing neck, and a thinner tegument. In earlier work I attributed this species to a possible variant of C. edjelensis elongata, but the encountered forms were more slender than the diagnosis of TAUGOURDEAU, 1963, especially when considering the specimens'flattened state of preservation. In their general shape they resemble the newly described C. iklaensis found in boreholes in south western Estonia, but they are not the same because their size, 110-250 μm, is smaller than C. iklaensis (220-580 μm).

Dimensions :

			min	Md-σ	Md	Md+σ	max
L	:	n = 8	111	133	185	236	250
E	:	n = 8	63	65	73	82	87
G	:	n = 5	38		55		68
E/L	:	n = 8	0.30	(0.30)	0.43	0.55	0.60
G/E	:	n = 5	0.60		0.72		0.80

Occurrence : The type material occurs in Estonia (USSR) in boreholes from the top of the Juuru stage through the Raikküla stage into the base of the Adavere stage; in age, from the pre-P. cyphus Zone (Rhuddanian) to the post-M. convulutus Zone (beginning of the late Llandoverian). In the Mehaigne area: rare in late Llandoverian to early Wenlockian, in members MB3C, MB3D, MB3E and MB4A.

Conochitina cf. *C. edjelensis elongata* TAUGOURDEAU, 1963 in NESTOR, 1980

Pl. 3, fig. 64.

Synonymy : *Conochitina edjelensis* n. sp. subsp. *elongata* n. subsp. in TAUGOURDEAU, 1963, p. 138, pl. 3, fig. 59-66.

Conochitina edjelensis elongata TAUGOURDEAU in NESTOR, 1980b, p. 140, tab. IV, fig. 3.

Conochitina aff. *pachycephala* in MÄNNIL, 1970.

Conochitina cf. *edjelensis* in NESTOR, 1976, p. 322.

Remarks : Medium size *Conochitina*, with a conical shape, a rounded basal edge, a slightly convexe base, and a thin smooth tegument. This species, although smaller in size, is quite similar to the species described and illustrated by NESTOR (1980b); but more samples have to be studied before our specimens can be attributed to the species described by NESTOR (1980b) with certainty. It is our opinion that *C. edjelensis elongata*, as defined by TAUGOURDEAU (1963), is not completely identical to the specimens described by NESTOR (1980b).

Dimensions : length : 115-250 μm; width : 57-110 μm; pseudostome : 40-75 μm.

Occurrence : In south-western Estonia (USSR) in boreholes : in the *P. gregarius* and *M. convolutus* zones of the Raikkula stage (middle Llandoverian). In the Mehaigne area : only in middle or late? Llandoverian; in member MB2B where it is frequent (up to 47 %).

Conochitina flamma LAUFELD, 1974

Pl. 4, fig. 71-73.

Synonymy : *Conochitina flamma* n. sp. in LAUFELD, 1974, p. 60-61, fig. 23.

Conochitina flamma LAUFELD, 1974 in VERNIERS & RICKARDS, 1978, pl. 2, fig. 3.

Conochitina flamma LAUFELD, 1974 in VERNIERS, 1981, pl. 1, fig. 12.

Remarks : As mentioned in the remarks about *C. acuminata* (p. 28) transitional forms with lengths from 160 to 190 μm occur between *C. acuminata* and *C. flamma*. Only specimens between 190 and 210 μm are determined as *C. flamma*. In comparison with the diagnosis of LAUFELD (1974) they are rather small. An incipient ridge-like carina on the basal edge is observed in *C. flamma* (as well as in *C. acuminata*), which is an uncommon characteristic in *Conochitina* spp. It is also visible on fig. 23 of LAUFELD (1974).

Dimensions :

	min	Md	max
L	161	179	207
E	52	66	71
G	48	53	61
E/L	0.34	0.38	0.40
G/E	0.72	0.79	0.85

Occurrence : In the Högklint Beds (early Wenlockian) in Gotland, Sweden (LAUFELD, 1974). In the Mehaigne area : rare in the top of the early Wenlockian in formation MB4; it occurs in the levels where *C. acuminata* is the most represented.

Conochitina gutta LAUFELD, 1974

Pl. 3, fig. 55-57.

Synonymy : *Conochitina gutta* n. sp. in LAUFELD, 1974, p. 62-63, fig. 25.
Conochitina gutta LAUFELD, 1974 in VERNIERS, 1981, pl. 1, fig. 4.

Remarks : The general shape, the inflated ovoid chamber, the form of the mucron and of the base and the dimensions concord with those observed in this species in Gotland. Only the polygonal rugose decoration of the tegument is not observed, perhaps due to the bad state of preservation of our specimens.

Dimensions :

	min	Md	max
L	110	141	195
E	93	115	145
G	61	62	65
E/L	0.63	0.85	1.35
G/E	0.66	0.54	0.45

Occurrence : In Gotland, Sweden: only in the middle Wenlockian Slite Beds between the *Conchidium tenuistriatum* Beds and the *Pentamerus gotlandicus* Beds (LAUFELD, 1974). In the Mehaigne area: rare in middle and late Wenlockian formations MB7 and MB8.

Conochitina proboscifera EISENACK, 1937.

Pl. 1, fig. 1-17.

Synonymy : Conochitina proboscifera n. sp. in EISENACK, 1937, p. 225, pl. 15, fig. 4-5.

Conochitina proboscifera EISENACK, 1937 in LAUFELD, 1974, p. 70, fig. 32, 33, 34; q.v. complete synonymy.

Conochitina proboscifera EISENACK, 1937 forma truncata LAUFELD, 1974 in VERNIERS & RICKARDS, 1978, pl. 2, fig. 4,5.

Conochitina proboscifera EISENACK, 1937 emend. LAUFELD, 1974 in VERNIERS & RICKARDS, 1978, pl. 2, fig. 6.

Conochitina proboscifera EISENACK, 1937 in VERNIERS, 1981, pl. 1, fig. 1-2.

Remarks : Specimens of C. proboscifera are characterised by their smooth and thick tegument (5 to 8 μm thickness), their large size (280-455 μm), their protruding mucron and their conical to subcylindrical general shape. LAUFELD (1974) made a formal division into 3 sizegroups: a typical form (E/L: 0.17-0.12); a forma gracilis (E/L: 0.11-0.10) and a forma truncata (E/L: 0.33-0.20). The presence of these three sizegroups was already mentioned before by TAUGOURDEAU & DE JEKHOWSKY (1964, p. 853). In formation MB4 between samples 21 and 29, where the typical populations occur (long, slender with a thick tegument and protruding mucron), in most cases forma truncata is found, and rarely the typical form. Forms longer than 455 μm were not encountered, so we assume that forma gracilis is not present. But lower down in the stratigraphical column in members MB3C, MB3D and MB3E, aside from the forma truncata, forms occur that resemble C. proboscifera by their general subcylindrical to conical shape, protruding mucron, and thick, smooth tegument (2-5 μm thickness), but they are considerably smaller (126-252 μm). These forms are also included in C. proboscifera as smaller forms from an earlier period.E.g. in sample 7 a few short but already typical forms occur (with a thick tegument and protruding mucron), in sample 9 short, conical forms occur with a small mucron, or callus and a thin or thick tegument. Only when the protruding mucron disappears and the tegument becomes thinner are these specimens classified as cf. in members MB2A and MB3A.

Dimensions : typical form : length: 350-410 μm; width : 113-130 μm; pseudostome : 76-85 μm.

forma truncata : length : 295-460 μm.

small forms : in samples 9 and 10.

			min	Md-σ	Md	Md+σ	max
L	:	n = 27	126	163	196	228	252
E	:	n = 27	70	79	89	100	112
G	:	n = 23	54	56	66	76	85
E/L	:	n = 15	0.65	0.55	0.47	0.39	0.38
G/E	:	n = 25	0.59	0.66	0.74	0.83	0.95

Occurrence : In Gotland (Sweden) in the Visby Formation from 50 m beneath the top of the Lower Visby Beds to the top of the Högklint Beds,as scattered specimens in unit b of the Slite Beds and in the northwesternmost part of the Slite Marl (LAUFELD, 1971, 1974). The typical form and forma gracilis are recorded from the top of the Lower Visby Beds and upwards into the Högklint Beds (LAUFELD, 1979b). In Estonia it occurs in the Adavere and Jaani stages (late Llandoverian - early Wenlockian) (EISENACK, 1968). In Podolia (USSR) it occurs in the basal conglomerate of the Restevo Beds (LAUFELD, 1971). In the armorican massif (France) it is found in the upper part of the M. turriculatus-Zone (late Llandoverian) (PARIS et al., 1980; PARIS, 1981).

In the Mehaigne area : atypical forms occur in members MB2A and MB3A (middle and late Llandoverian); a small variety is rare to present (up to 27 %) in late Llandoverian and early Wenlockian? in members MB3C, MB3D and MB3E; typical forms and forma truncata occur at the top of member MB3E (sample 17) and in formation MB4 (late Llandoverian? and/or early Wenlockian); atypical forms occur in the base of formation MB5 (middle Wenlockian).

Conochitina aff. proboscifera EISENACK, 1937

Pl. 1, fig. 18-19.

Synonymy : Conochitina proboscifera n. sp. in EISENACK, 1937, p. 225, pl. 15, fig. 4-5.

Conochitina aff. proboscifera in LAUFELD, 1974, p. 72, fig. 35.

Conochitina aff. C. proboscifera EISENACK, 1937 in VERNIERS & RICKARDS, 1978, fig. 5.

Conochitina aff. proboscifera in VERNIERS, 1981, Pl. 1, fig. 1.

Remarks : In formation MB5, MB6 and the lower part of MB7 occur forms with a general shape similar to C. proboscifera, a species having its most typical form in the underlaying formation MB4. A characteristical feature of C. aff. proboscifera is the long silhouette and the protruding large mucron, but the tegument, although still thick, is nevertheless thinner than in C. proboscifera.

Dimensions : length : 116-370 μm; width : 83-124 μm; pseudostome : 56-57 μm.

Occurrence : In Gotland (Sweden) from middle Wenlockian in the upper parts of the Slite Beds (unit d, f, g and Pentamerus gotlandicus Beds) and the Mulde Beds; it disappear just before the M. ludensis Zone (late Wenlockian) (LAUFELD, 1974); in Wales and Shropshire it is mentioned in the Upper and Lower Elton Beds (Eltonian, early Ludlovian) (LISTER, 1968).

In the Mehaigne area: possible in formation MB5, rare to present (up to 30 %) in formation MB6 and the lower part of MB7 (middle and late Wenlockian).

Conochitina tuba EISENACK, 1932

Pl. 3, fig. 51-54.

Synonymy : Conochitina tuba n. sp. in EISENACK, 1932, p. 271, pl. 12, fig. 8-10.

Conochitina tuba EISENACK, 1932 in LAUFELD, 1974, p. 72-73, q.v. complete synonymy.

Conochitina tuba EISENACK, 1932 in VERNIERS & RICKARDS, 1978, pl. 2, fig. 7.

Conochitina tuba EISENACK, 1932 in VERNIERS, 1981, pl. 1, fig. 5.

Remarks : Classified within this species are cono-ellipsoid forms with a short to medium-long neck, an ovoid chamber, and a convexe base with or without a protruding mucron. The tegument is thin and decorated with felt. They greatly resemble the shorter specimen in Gotland, as illustrated by LAUFELD, 1974, fig. 36E. The specimens have nearly straight flanks, but still retain a slight flexure; indistinct shoulders and an inflated chamber are still seen. They differ from C. armillata? by their straight flanks. They have almost the same size, but can be longer and generally a bit more slender.

Dimensions : see fig. 6 : length : 185-262 μm; width : 93-117 μm; elongatior (width/length): 0.42-0.55.

Occurrence : In Gotland (Sweden), in the middle Wenlockian until early Ludlovian : in the Slite group from the Katrinelund Limestone and the northwestern part of the Slite Marl to unit a of the Klinteberg Beds in which they occur atypically and also in the northwesternmost part of the Hemse Marl (for almost the entire middle Wenlockian up to the base of the P. ludensis Zone of the late Wenlockian, and in the base of the early Ludlovian (EISENACK, 1962b, 1964, TAUGOURDEAU & DE JEKHOWSKY, 1964, LAUFELD, 1974). In Estonia they occur in the upper half of the Jaagarahu Beds (middle to late Wenlockian) (KALJO, 1970, p. 179). In Wales and Shropshire they are mentioned in the top of the Wenlock Limestone, the Elton Beds and the Lower Bringewood Beds (LISTER, 1968).

In the Mehaigne area their occurrence is doubtful in formation MB5, and rare to frequent in formation MB6, MB7 and MB8 (middle and late Wenlockian).

Conochitina sp. A

Pl. 4, fig. 67-70.

Synonymy : Conochitina sp. A in VERNIERS, 1981, pl. 1, fig. 3.

Description : A cono-ovoid general shape, a straight, short to medium-long, conical neck, no collarette is observed, just a thinning of the tegument towards the pseudostome; the flexure is weak with distinct shoulders; an ovoid chamber, and a gentle to sharp basal edge with a convexe, flat or concave base; no mucron is observed; the tegument is smooth and very thin (less than 1 μm); in flattened specimens the impression of an operculum is visible just aborally of the pseudostome. The most characteristic features are : the very thin tegument, the general form, and the shape of the distinct shoulders and the flexure. Due to their bad state of preservation and the thin tegument, most of the specimens in our study material are incomplete. C. sp. A are very frequent in sample 7 of outcrop IG-19 at Fallais.

Dimensions :

		min	Md-σ	Md	Md+σ	max
L :	n = 86	85	106	135	164	235
E :	n = 86	51	71	85	99	123
G :	n = 85	32	43	55	67	106
E/L :	n = 84	0.33	0.52	0.65	0.78	1.01
G/E :	n = 84	0.36	0.53	0.63	0.72	0.85

Occurrence : In the Mehaigne area : rare in members MB2A, MB3C, MB3D and MB3E, frequent up to 50 % in members MB2B and MB3A (middle and late Llandoverian, possibly early Wenlockian).

Conochitina sp. B

Pl. 3, fig. 61-62

Synonymy : Conochitina sp. B in VERNIERS, 1981, fig. 1.
Linochitina aff. L. erratica (EISENACK, 1931) in LAUFELD et al.,1975 in VERNIERS, 1981, pl. 2, fig. 29.

Description : Included in Conochitina sp. B are short, slender, subcylindrical forms with a neck passing gently into the cylindrical chamber; no collarette or operculum is observed. There is almost no flexure or shoulders, they have a quite sharp basal edge, and in most cases a convexe base; the tegument is very thin, smooth or slightly rugose; a typical population is found in sample 51, (Fumal).

Remarks : In VERNIERS (1981), the specimens of C. sp. B in sample 51 were considered to be Linochitina aff. L. erratica. After more samples from this part of formation MB7 were treated, no evidence came out in favor of this determination. Only the general shape and the convexe base resemble L. aff. L. erratica, as figured by LAUFELD et al. (1975), but no ridge-like carina was observed. We prefer to keep similar forms under open nomenclature until more material will definitely prove affiliation with or its difference to L. aff. L. erratica.

Dimensions : length : 104-156 μm; width : 45-68 μm; pseudostome : 25-50 μm; width-length relation : 0.50-0.32 (fig. 7).

Occurrence : In the Mehaigne area: middle Wenlockian to early Ludlovian; in the upper part of formation MB7 (above section JD3) up to 14 %; rare in formations MB8 and MB9. There may also possible be an affiliation with the Conochitina edjelensis group, as described by CRAMER & DIEZ(1978,p.116) from the Wenlockian-Ludlovian in the Iberian peninsula.

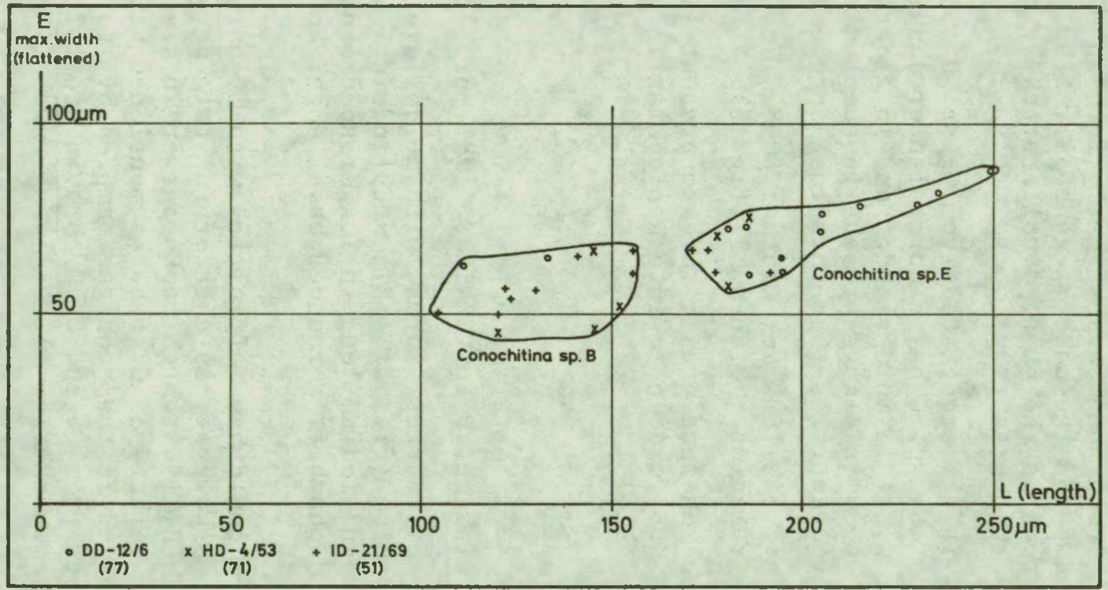

Fig. 7: Diagram showing length and width distribution of Conochitina sp.B and Conochitina sp.E in 3 samples of formation MB7 and MB8 (middle and late Wenlockian).

Conochitina sp. C

Pl. 2, fig. 28-29, 32-33.

Synonymy : *Conochitina* sp. C in VERNIERS, 1981, pl. 1, fig. 7.

Description : Cylindro-conical body with a long cylindrical neck half the total length of the body that passes gently into an ovoid chamber; the basal edge is rounded and the base is generally flat, the maximum width of the chamber is towards the base; a collarette may be present; the tegument is thin and smooth.

Remarks : *C.* sp. C is differentiated from *C.* sp. D and *C. armillata*? by biometrical methods. *C.* sp. C has a more slender shape and is generally larger than *C.* sp. C. It is more slender and in general, smaller than *C. armillata*?. *C.* sp. C is always present in samples where *C.* sp. D occurs, but in much smaller quantities than this last species.

Dimensions : length : 160-180 µm; width : 60-82 µm; pseudostome : 41-60 µm; width-length relation : 0.46-0.37 (fig. 6).

Occurrence : In the Mehaigne area : rare to present (less than 9 %) in formations MB7 and MB8 (middle to late Wenlockian).

Conochitina sp. D

Pl. 2, fig. 30-31, 34-35.

Synonymy : *Conochitina* sp. D in VERNIERS, 1981, pl. 1, fig. 6 and 9.

Description : Cono-cylindrical forms, with no collarette observed, a sometimes present operculum (fig. 31 A+B); a cylindrical neck hardly present in short specimens and medium-long in longer specimens, with a flexure and shoulders, an ovoid chamber, a rounded basal edge, and a flat to slightly concave base.

Remarks : This form could have affinities with *C. oelandica silurica* TAUGOURDEAU, 1963 which however, is shorter in its general shape, and with *C. gordonensis* CRAMER, 1964 which looks larger in size; *C.* sp. D could also be a very short variety of C. tuba as mentioned before (p. 29). *C.* sp. D is easily recognized in the Mehaigne samples by its general shape and can be distinguished from *C.* sp. C, *C. brevis brevis*? and *C. armillata*? by biometrical measurements (fig. 6).

Dimensions : length : 90-165 µm; width : 65-100 µm; pseudostome : 55-65 µm; width-length relation : 0.80-0.53 (fig. 6).Dimensions of sample 45.

			min	Md - σ	Md	Md + σ	max
L	:	n = 144	67	114	137	161	183
E	:	n = 141	65	70	93	(116)	104
G	:	n = 109	40	56	62	69	80
E/L	:	n = 141	0.51	0.54	0.65	0.76	1.18
G/E	:	n = 116	0.62	0.63	0.71	0.78	0.88

Occurrence : In the Mehaigne area : doubtful in formation MB5, present in formation MB6, rare to dominant (up to 82 %) in formation MB7, and rare in formation MB8 (middle and late Wenlockian). Together with Cingulochitina cingulata it is representative of assemblage zone D.

Conochitina sp. E

Pl. 3, fig. 63, 65, 66.

Synonymy : pro partim Conochitina edjelensis elongata? TAUGOURDEAU, 1963 in VERNIERS, 1981, fig. 1 (all specimens in formations MB5 to MB9).

Description : Included in Conochitina sp. B are long, slender, subcylindrical or slightly conical forms with a neck but no collarette, passing very gently into a cylindrical chamber; no flexure or shoulders; a quite sharp basal edge and a slightly convexe base where the impression of a mucron is visible, the tegument is thin and covered with a light felted ornamentation.

Remarks : These specimens resemble those in CRAMER (1967, fig.54) which were called a non-determinated variety of C. edjelensis. C. sp. E differ from C. edjelensis elongata?, which occur lower in the stratigraphy of the Mehaigne area (formation MB3 and MB4) by the absence of shoulders and flexure, and a thicker tegument. C. sp. E is much larger than C. sp. B but has the same or a slightly more slender general shape. This species under open nomenclature may be affiliated with C. latifrons, C. aff. elegans or the C. edjelensis elongata-group as e.g. described in CRAMER & DIEZ (1978) from the Iberian peninsula. More well preserved specimens have to be studied before the exact affiliation can be established.

Dimensions : length : 171-236 µm; width : 57-82 µm; pseudostome : 38-67 µm; width-length relation : 0.41-0.31 (fig. 7).

Occurrence : In the Mehaigne area : rare in formations MB7 (upper part), MB8 and MB9 (middle and late Wenlockian, early and middle? Ludlovian).

Genus Cyathochitina EISENACK, 1955.

type species: Cyathochitina campanulaeformis (EISENACK, 1931)

Cyathochitina spp.

Pl. 9, fig. 24.

Synonymy : Cyathochitina sp. in VERNIERS, 1981, fig. 1 and p. 168.

Remarks : Two specimens belonging to this genus are found in the poor assemblage of sample 1. It shows similarities with C. novempopulanica TAUGOURDEAU, 1961 and the Cyathochitina spp. found by F. MARTIN (1974) in Upper Ordovician to Lower Silurian strata of Deerlijk (Belgium). However, more material is necessary to determine which species is present here.

Genus *Desmochitina* EISENACK, 1931, restr. 1968

type species : *Desmochitina nodosa* EISENACK, 1931

Desmochitina minor EISENACK, 1931

Pl. 9, fig. 242.

Synonymy : *Desmochitina minor* n. sp. in EISENACK, 1931, p. 94, pl. 3, fig. 14-15.

Desmochitina minor EISENACK, 1931 in VERNIERS, 1981, fig. 1.

Remarks : Two specimens ressembling *D. minor* were found in the poor assemblage of sample 1. Lack of better preserved material does not allow the designation of the subspecies.

Dimensions : length : 66 μm; width : 65 μm; pseudostome : 36 μm.

Occurrence : *D. minor* has been found in Middle to Late Ordovician rocks and is only found in the Mehaigne area in locality EI-12 of formation MB1.

Desmochitina opaca LAUFELD, 1974

Pl. 9, fig. 225-226.

Synonymy : *Desmochitina opaca* n. sp. in LAUFELD, 1974, p. 79-80, fig. 42.

Desmochitina opaca LAUFELD, 1974 in VERNIERS & RICKARDS, 1978, pl. 2, fig. 8.

Desmochitina opaca LAUFELD, 1974 in VERNIERS, 1981, pl. 2, fig. 32.

Remarks : In 2 samples (28, 29) a few specimens occur in chains of 3 to 4 individuals. In VERNIERS & RICKARDS (1978, pl. 2, fig. 8) a chain is shown photographed with normal light, but by mistake was placed upside down. New preparation and scanning microphotos in VERNIERS, 1981 give more evidence of the presence of this species in the Mehaigne area.

Dimensions : length : 36-56 μm; width : 71-96 μm; pseudostome : 48-77 μm; width-length relation : 1.64 to 2.06.

Occurrence : In Gotland (Sweden) in the Upper Visby Beds and Högklint Beds early Wenlockian (LAUFELD, 1974).

In the Mehaigne area it occurs in member MB4B at levels dated by graptolites as *M. riccartonensis* Zone (top of the early Wenlockian).

Genus *Eisenackitina*, JANSONIUS, 1964

type species : *Eisenackitina castor* JANSONIUS, 1964

Eisenackitina sp. A

Pl. 5, fig. 89-98, 102.

Synonymy : *Eisenackitina concava* EISENACK, 1972 in VERNIERS & RICKARDS, 1978, pl. 2, fig. 11.

Eisenackitina sp. A in VERNIERS, 1981, pl. 2, fig. 18-19.

Description : A large Eisenackitina species with a cono-ovoid form, a short neck and no collarette, a distinct flexure and shoulders, a conical or ovoid chamber; the basal edge is round to sharp, and the base, usually flat, sometimes convexe, with a mucron or the impression from one on it; in some cases an operculum is observed on top of the pseudostome or in the neck. The tegument inside is smooth, and outside, slightly rugose or covered with felt; in several cases concentrical rings also occur around the shoulders (Pl. 5, fig. 93-95). In broken specimens the internal structures, the internal decorations of the tegument, and the changes in thickness of the tegument can be observed. (Pl. 5, fig. 95-96). Fig. 96 shows a thin operculum that starts from an internal layer of the tegument and sits in the middle of the neck. The tegument is thick at the chamber and begins to thin halfway up the chamber towards the pseudostome, and also at the base towards the mucron (Pl. 5, fig. 95). Concentrical rings can occur around the mucron on the base. Instead of a mucron a sudden thinning of the tegument can be observed where normally the mucron is situated. Typical populations occur in sample 21, locality CD-20 at Lamontzée.

Remarks : E. sp. A has a possible affiliation to E. oelandica silurica (TAUGOURDEAU, 1963), but this species needs a better study before any relation can be established.

Dimensions :

		min	Md-σ	Md	Md+σ	max
L :	n = 203	84	112	139	166	210
E :	n = 205	80	95	114	132	145
G :	n = 110	28	46	59	72	91
E/L :	n = 172	0.63	0.68	0.89	0.97	1.33
(A+B)/L :	n = 76	0.71	(0.71)	0.82	0.93	1.00
G/E :	n = 139	0.31	0.46	0.53	0.61	0.68

Occurrence : In the Mehaigne area : rare in formation MB2; rare to frequent (up to 44 %) in formations MB3 and MB4 (middle and late Llandoverian, early Wenlockian) atypical forms occur infrequently in the top of formation MB4 (sample 33), and formations MB5, MB6 and MB7 (middle and late Wenlockian).

Eisenackitina sp. B

Pl. 5, fig. 98-100.

Synonymy : Eisenackitina sp. B in VERNIERS, 1981, fig. 1, pl. 2, fig. 21.

Description : The general shape is cono-ovoid to cono-spheroid with a short neck, a slight flexure, distinct shoulders and a gentle basal edge; the tegument is smooth, rugose or covered with granules or little spines. Biometrically, it is possible on a length-width diagram to separate E. sp. B from E. sp. A which has a similar shape but is much larger; E. sp. B can be seen as a dwarfform of E. sp. A. Infrequently E. sp. B has a concentrical ring ornamentation.

Dimensions : in sample 29 and 34

		min	Md-σ	Md	Md+σ	max
L	: n = 25	87	99	110	(121)	112
E	: n = 25	89	93	100	(108)	107
G	: n = 25	39	47	68	89	91
E/L	: n = 18	0.77	0.84	0.92	0.99	1.04
G/E	: n = 18	0.39	0.41	0.48	0.55	0.60

Occurrence : In the Mehaigne area : early to late Wenlockian; rare to present in the top of member MB4A and in member MB4B, where it occurs together with *E.* sp. A whose range begin much deeper. In the top of member MB4B *E.* sp. A becomes a typical but *E.* sp. B continues being rare to present in formation MB5, and doubtful in formation MB7.

Eisenackitina sp. C

Pl. 5, fig. 103-119; Pl. 6, fig. 120-121.

Synonymy : *Conochitina* n. sp. 1 in LAUFELD, 1971, p. 295, pl. 1 D.

Eisenackitina bursa (TAUGOURDEAU & DE JEKHOWSKY, 1960) in VERNIERS & RICKARDS, 1978, pl. 2, fig. 9 and 10.

Eisenackitina sp. C in VERNIERS, 1981, pl. 2, fig. 22.

Description : A small cono-ovoid form, with nearly never a neck, but a collarette; in many cases, an operculum, often with an elevation in the middle of it, closes the pseudostome; in some flattened specimens, the impression from an operculum is seen inside the neck (Pl. 5, fig. 109); in other specimens no prosome or operculum is observed; the flexure is indistinct and shoulders are seldom observed; the chamber is ovoid and the basal edge gentle to sharp; in some cases, there is a small depression on the tegument in the center of the base which does not connect with the interior; the base is flat or gently convexe; the tegument is thin and usually decorated with fine spines or granules, or an irregular,reticular, rugose ornamentation; this decoration is usually found around the basal edge and the lower part of the chamber, and decreases towards the pseudostome and the centre of the base. Some specimens are smooth. Biometrically, most specimens form a concentrated cluster on a length-width diagram, but some variants also occur : very wide and small forms (Pl. 5, fig. 113), elongated and small forms (Pl. 5, fig. 101), much taller forms with the same shape (Pl. 5, fig. 117-118) and elongated taller forms (Pl. 5, fig. 109). These last two variants have about the same size as *E.* sp. A, but are differentiated from this last species by their thin tegument, the absence of shoulders, and their slight flexure. Typical populations occur in member MB3D, and sample 8, locality IF-9, Pitet, Fallais.

Remarks : *E. bursa* is a lower to middle Devonian form from the Algerian Sahara which needs more study before its affiliation to *E.* sp. C and *E. bursa* can be established.

Dimensions : of sample 19.

			min	Md-σ	Md	Md+σ	max
L	:	n = 38	69	79	91	104	106
E	:	n = 38	66	77	89	(102)	102
G	:	n = 34	32	46	57	67	72
E/L	:	n = 39	0.77	0.78	1.03	1.28	1.72
G/E	:	n = 34	0.43	0.55	0.64	0.75	0.82

Dimensions of large variants in samples 7, 8 and 9.

			min	Md-σ	Md	Md+σ	max
L	:	n = 22	119	123	139	155	173
E	:	n = 22	93	99	109	120	132
G	:	n = 17	40	57	70	82	88
E/L	:	n = 22	0.67	0.69	0.79	0.90	0.99
G/E	:	n = 16	0.36	0.55	0.67	0.78	0.91

Occurrence : In Podolia (USSR) a similar species was found in the basal conglomerate of the Restevo Beds, which on evidence from Chitinozoa, was dated as middle Llandoverian (LAUFELD, 1971). In the same article he mentions that this species under open nomenclature occurs in Dalarna (Sweden) only in middle Llandoverian rocks (M. gregarius and M. convolutus Zones).

In the Mehaigne area: middle Llandoverian to early Wenlockian and basal middle Wenlockian; rare to present in formation MB2 and member MB3A; present to frequent (up to 45 %) in members MB3C and MB3D; rare to present in member MB3E and formation MB4. The larger variant occur mainly during the apogee of E. sp. C in members MB3C and MB3D.

Genus Gotlandochitina LAUFELD, 1974

type species : Gotlandochitina martinssoni LAUFELD, 1974

Gotlandochitina corniculata LAUFELD, 1974

Pl. 9, fig. 220-222.

Synonymy : Gotlandochitina n. sp. in LAUFELD, 1974, p. 85, fig. 47.

pro parte : Gotlandochitina aff. G. corniculata LAUFELD, 1974 in VERNIERS & RICKARDS, 1978, p. 156, fig. 5; non: pl. 1, fig.8.

Gotlandochitina corniculata LAUFELD, 1974 in VERNIERS, 1981, pl. 1, fig. 15.

Remarks : Forms occur with a good resemblance to those described by LAUFELD 1974. The general shape, the long neck, the broad basal edge, and the spines and appendices in longitudinal lines are characteristic of G. corniculata. Similar forms with a short neck are classified as G. aff. G. corniculata.

Dimensions :

		min	Md-σ	Md	Md+σ	max
L :	n = 33	79	97	126	155	178
E :	n = 33	70	(69)	78	87	101
G :	n = 29	28	32	38	45	49
E/L :	n = 26	0.47	0.50	0.66	0.81	1.04
(A+B)/E :	n = 24	0.49		0.84		1.12
(A+B)/L :	n = 23	0.36	0.20	0.55	0.75	1.00

Occurrence : In Gotland (Sweden) it occurs in the upper two thirds of the Högklint Beds (upper part of the early Wenlockian) (LAUFELD, 1974, p. 85).

In the Mehaigne area : middle and/or late Llandoverian and basal early Wenlockian; infrequent atypical forms in members MB3A and MB3C; rare in member MB3E and in the base of formation MB4 (samples 18 and 19).

Gotlandochitina aff. G. corniculata LAUFELD, 1974

Pl. 9, fig. 223-224.

Synonymy : pro parte : Gotlandochitina aff. G. corniculata LAUFELD, 1974 in VERNIERS & RICKARDS, 1978, pl. 2, fig. 8.

Gotlandochitina aff. G. corniculata LAUFELD, 1974 in VERNIERS 1981, pl. 1, fig. 14.

Description : These forms resemble G. corniculata, with the same ornamentation of short spines with elongated bases of about ten rows, parallel to the longitudinal axis, a similar conical to ovoid chamber but with only a short neck or none at all, and a sharp basal edge.

Dimensions :

		min	Md -σ	Md	Md +σ	max
L :	n = 31	72	80	96	113	137
E :	n = 31	45	67	81	93	112
G :	n = 23	24	26	37	48	58
E/L :	n = 21	0.79	(0.72)	0.85	0.97	1.04
(A+B)/E :	n = 9	0.73		0.86		(2.85)
(A+B)/L :	n = 7	0.58	(0.58)	0.68	0.78	0.81

Occurrence : In the Mehaigne area: late Llandoverian and early Wenlockian ranges principally higher and only partially into the G. corniculata levels; rare in member MB3E and formation MB4, mostly around the transition between both units.

Genus Margachitina (EISENACK, 1968)

type species : Margachitina margaritana (EISENACK, 1937)

Margachitina margaritana (EISENACK, 1937)

Pl. 9, fig. 227-229.

Synonymy : Desmochitina margaritana n. sp. in EISENACK, 1937, p. 221, pl. 15, fig. 9-11.

Margachitina margaritana (EISENACK, 1937) in LAUFELD, 1974, p. 102, q.v. complete synonymy.

Margachitina margaritana (EISENACK, 1937) in VERNIERS & RICKARDS, 1978, pl. 2, fig. 15.

Margachitina margaritana (EISENACK, 1937) in VERNIERS, 1981, pl. 2, fig. 31.

Remarks : The encountered specimens conform with the description of EISENACK (1937) and the additional remarks by LAUFELD (1974, p. 102-104).

Dimensions : length without the copula : 65-88-100 μm; width : 68-81-95 μm.

Occurrence : In Gotland (Sweden) in the Lower Visby Beds to the Slite Beds without passing into the Slite Siltstone or the Halla Beds (EISENACK, 1962a, 1962b, 1964; TAUGOURDEAU & DE JEKHOWSKY, 1964; LAUFELD, 1971, 1974): in age from the latest Llandoverian to the base of the late Wenlockian (C. ludgreni Zone) LAUFELD & JEPPSON, 1976). In Scania (Sweden) in the uppermost part of the Cyrtograptus shale (C.lundgreni Zone and G. nassa Zone, late Wenlockian) (LAUFELD et al., 1975). In Estonia (USSR) it occurs in the lower part of the Jaani Beds (early Wenlockian) (KALJO, 1970, p. 149) and never under the Adavare-Jaani boundary (Llandovery-Wenlock boundery) (MÄNNIL, 1970, pers. comm. in LAUFELD, 1971, p. 296). In Podolia (USSR) it occurs in the Restovo Beds which on the basis of a Chitinozoa comparison with Gotland (Sweden) were dated as early Wenlockian (LAUFELD, 1971).

It is also mentioned in the Algerian Sahara in zone 4, which is of a middle to late Wenlockian age (TAUGOURDEAU & DE JEKHOWSKY, 1960 , fig. 2, reviewed by LAUFELD, 1974, p. 103); in the Florida Silurian subsurface (GOLDSTEIN et al., 1969, p. 378-379; CRAMER, 1973, p. 283) and in the Pitinga Member of the Trombetas formation (Brasil); on the basis of graptolites, it is dated as early Llandoverian (LANGE, 1967a, pl. 5, fig. 64; DA COSTA, 1967, p. 109, pl. 3, fig. 29 and DA COSTA, 1971a, p. 249-250, fig. 63); on the basis of Chitinozoa content, LAUFELD (1974, p. 103-104) contests this datation and puts a middle to late Wenlockian age forward for this member. This species was also found by CRAMER (1970, p. 746) in the Ross Brook Formation in Nova Scotia (Canada).

Following the strict definition of M. margaritana given by EISENACK (1968) and LAUFELD (1974), this species is a good index fossil with a range from the uppermost Llandoverian to the middle of the late Wenlockian.

In the Mehaigne area : rare atypical forms in member MB3A (middle or late Llandoverian), rare in one sample of member MB3D, rare throughout formation MB4 and the very base of formation MB5 (late Llandoverian to basal middle Wenlockian).

Genus *Sphaerochitina* EISENACK, 1955

type species : *Sphaerochitina sphaerocephala* (EISENACK, 1955)

Sphaerochitina lycoperdoides LAUFELD, 1974

Pl. 8, fig. 214-215.

Synonymy : *Sphaerochitina lycoperdoides* n. sp. in LAUFELD, 1974, p. 111-112, fig. 110.

Sphaerochitina lycoperdoides LAUFELD, 1974 in LAUFELD et al., 1975, p. 215, fig. 5C.

Remarks : In one sample (77) from formation MB8, eight specimens and in another sample (51) one specimen of this species as described by LAUFELD (1974) and LAUFELD et al., (1975) occur.

Dimensions : length : 119-186 µm; width : 63-83 µm; pseudostome : 22-37 µm; sphaericity ((A+B)/E) : 0.66-1.26 ; relative length of chamber ((A+B)/L) : 0.46-0.84.

Occurrence : In Gotland (Sweden) it occurs from the uppermost part of the Mulde Beds into the Klintebergs Beds, in unit a, b and in undifferentiated lower middle parts (LAUFELD, 1974), with an age of *G. nassa* Zone and *P. ludensis* Zone (late Wenlockian) (LAUFELD & JEPPSON, 1976). In Scania (Sweden) it occurs from the lower part of the Colonus Shale (*P. ludensis* Zone, late Wenlockian), and in North Wales (U.K.) it also occurs in the *P. ludensis* Zone, late Wenlockian (LAUFELD et al., 1975, p. 215).

In the Mehaigne area : rare in formation MB8 (late Wenlockian).

Sphaerochitina sp. A

Pl. 8, fig. 200-205, 208-210.

Synonymy : *Sphaerochitina* sp. F in VERNIERS & RICKARDS, 1978, p. 157, pl. 1, fig. 15.

Sphaerochitina sp. A in VERNIERS, 1981, fig. 1.

Description : A cono-ovoid general shape with a sometimes slightly curved longitudinal axis; rarely a collarette; a short to medium-long conical neck that narrows or widens towards the pseudostome; a sharp flexure and indistinct shoulders; the chamber is ellipsoid to ovoid; there is nearly never a basal edge; the base is almost completely rounded; no mucron is observed; in flattened specimens in the neck near the flexure the impression of a prosome can be observed; the tegument is mildly thick and often covered with a fine felt, fine points or sometimes it is smooth; a typical population occurs in sample 20 at the base of formation MB4 in locality CD-1F,Lamontzée.

Remarks : Specimens with an orally widening neck can show similarities to *Lagenochitina ? macrostoma* (TAUGOURDEAU & DE JEKHOWSKY, 1960) but the population as a whole is different.

Dimensions : length : 102-146-186 µm; width : 61-83-95 µm; relative length of the neck :0.26-0.27;sphericity of the chamber ((A+B)/E) : 1.51-1.53 ; pseudostome-width relation (G/E) : 0.45-0.51-0.53.

Occurrence : In the Mehaigne area: rare to present in members MB3C, MB3D, MB3E and formation MB4 (late Llandoverian? to basal middle Wenlockian).

Sphaerochitina sp. B

Pl. 8, fig. 206-207, 211-213.

Synonymy : Sphaerochitina sp. G in VERNIERS & RICKARDS, 1978, p. 157-158, Pl. 1, fig. 16.

Sphaerochitina sp. B in VERNIERS, 1981, fig. 1.

Description : Small cylindro-conoid general shape, no collarette, a subcylindrical short to medium-long neck, a sharp flexure, no shoulders, a broad conical chamber which passes via a characteristically very sharp basal edge into a convexe base; no mucron or operculum is observed; the tegument is very thin and smooth; a typical population occurs in sample 19 of the base of formation MB4 at locality CD-1A, Lamontzée.

Remarks : As stated in VERNIERS & RICKARDS (1978, p. 158), S. sp. A is distinguished from "S. dubia" EISENACK (1968) by its shorter neck and its smooth tegument. "S. dubia" EISENACK (1968) is a nomen nudum because TAUGOURDEAU & DE JEKHOWSKY (1960) have already used this name for a species from the Algerian Sahara.

Dimensions : length : 65-82-121 μm; width : 67-77-87 μm; pseudostome : 22-29-47 μm; sphericity of the chamber((A+B)/E) : 0.59-1.37-1.70; relative neck length ((A+B)/L): 0.59-0.70-0.82.

Occurrence : In the Mehaigne area : rare to present (up to 9 %) in members MB3C, MB3D, MB3E and in formation MB4 (late Llandoverian to early Wenlockian).

DIV. : CHLOROPHYTA

Cl. : Prasinophyceae

Family : Tasmanaceae SOMMER, 1956

Genus Tasmanites NEWTON, 1875 emend. SCHOPF, WILSON & BENTALL, 1944

type species : Tasmanites punctatus NEWTON, 1875

Tasmanites ? sp.

Pl. 4, fig. 88A-C.

Synonymy : Tasmanites ? sp. in VERNIERS, 1981, pl. 1, fig. 16.

Description : Spherical and flattened forms consisting of half a flattened sphere attached to another smaller half; the tegument is not smooth, but irregular and quite thick (5-10 μm) in all parts of the body; often the specimens show cracks due to bad preservation; the typical form is easily differentiated from Leiosphaeridia sp.; the thick tegument and the spherical shape relate it to the genus Tasmanites, but this particular form was never mentioned and leaves this generic designation doubtful.

Dimensions : Three size-groups with only small differences in size were observed, diameter : 82-129 μm, 134-165 μm and about 200 μm.

Occurrence : In the Mehaigne area in formations MB5 up to MB9; especially frequent in formations MB5, MB8 and MB9 (middle Wenlockian till early or middle ? Ludlovian).

INCERTAE SEDIS

Incertae sedis sp. A

Pl. 4, fig. 87.

Synonymy : *Incertae sedis* sp. A in VERNIERS, 1981, pl. 2, fig. 33.

Description : spherical forms, between 20 and 70 µm in diameter, showing many perforations (2-8 µm) towards the interior, with concentrical, ridge-like ring ornamentations around each hole.

Occurrence : In the Mehaigne area: *Incertae sedis* sp. A is a good regional index fossil; it only occurs in members MB2B, MB3A and MB3B (middle and/or late Llandoverian); when it is present, *Leiosphaeridia* sp. is infrequent or absent.

E. BIOZONATION

Since the biozonation of the Chitinozoa in the Silurian of the Mehaigne area was published (VERNIERS, 1981), some minor taxonomic changes were introduced (a synonymy list is given in the systematical description). Due to the preparation and study of several new samples, additional data on the composition or the extension of the informal assemblage zones is presented here. In most cases the datation of the assemblage zones can now be more precise than the datation in VERNIERS (1981). Indeed, more samples have been studied and several publications have recently appeared : NESTOR (1976 and 1980a, b) on early and middle Llandoverian Chitinozoa from south-western Estonia, PARIS (1981) on Chitinozoa of SW-Europe (Silurian and other ages) and DORNING (1981) on Chitinozoa from the Wenlock and Ludlow type areas in Shropshire, England.This biozonation is informal.

E.1. Assemblage zone A :

Occurs in formation MB1 and is characterized by the presence of *Desmochitina minor* and *Cyathochitina* sp. Although the assemblage is very poor and therefore not well defined, it is indicative of a late Ordovician age (VERNIERS, 1981).

E.2. Assemblage zone B :

Occurs in formation MB2 and member MB3A, and is distinguished by *Conochitina* sp. A (present to very frequent: 30-50 %), by atypical small thinwalled forms of *C. proboscifera* and by *C.* cf. *C. edjelensis elongata* sensu NESTOR, 1980b present to highly frequent in the lower part of B1 and the lower part of B2. A division into two subzones is possible : assemblage subzone B1 occurring in member MB2A with *Incertae sedis* sp. A never present, and assemblage subzone B2 occurring in members MB2B and MB3A with *Incertae sedis* sp. A always present. Because of the presence of *C.* cf. *C. edjelensis elongata* sensu NESTOR, 1980b in subzone B1 and in the base of subzone B2 the age of assemblage subzone B1 is middle Llandoverian or possibly late Llandoverian. NESTOR (1976, 1980b) describes this species in the *M. convolutus* graptolite Zone of the middle Llandoverian in Estonia. In the underlaying *P. gregarius* graptolite Zone, which is also middle Llandoverian, besides the two above mentioned species, he very frequently found *Coronochitina* EISENACK (1965) sp. which were not found in the Mehaigne area. The upwards extension of the former species is not known to us. A middle Llandoverian (*M. convolutus* graptolite Zone) or possibly late Llandoverian age is proposed for subzone B1 and the base of B2.

Assemblage subzone B2 is also characterized by atypical *Conochitina proboscifera* and the absence of *Angochitina longicollis* and *Margachitina margaritana*, indicating a pre-latest Llandoverian-early Wenlockian age. A middle and/or late Llandoverian age is proposed for assemblage subzone B2 (VERNIERS, 1981).

E.3. Assemblage zone C :

Occurs in members MB3C, MB3D, MB3E, formation MB4 and the lower part of MB5. It is characterized by the presence of typical *Conochitina proboscifera* and its variants, except for subzone C4 where forms of this species become atypical but are still frequent (more than 15 % of the specimens in a sample). *Cingulochitina* sp. C, *C.* sp. D, *Angochitina longicollis*, *Eise-*

Chitinozoa assemblage zones and subzones	formations	Section and sequence numbers	Micropal sample number / Chitinozoa species	CYATHOCHITINA SPP.	DESMOCHITINA MINOR	CINGULOCHITINA SPP.	CONOCHITINA SPP.	SPHAEROCHITINA SPP.	CONOCHITINA SP.A	SPHAEROCHITINA SP.A	CONOCHITINA CF. C. EDJELENSIS ELONGATA? IN NESTOR 1980	CONOCHITINA PROBOSCIFERA	EISENACKITINA SPP.	EISENACKITINA SP.C	EISENACKITINA SP.A	SPHAEROCHITINA-ANGOCHITINA-ANCYROCHITINA-GOTLANDOCHITINA GROUP	GOTLANDOCHITINA CORNICULATA	MARGACHITINA MARGARITANA	ANCYROCHITINA SPP.	CINGULOCHITINA SP.E	CINGULOCHITINA SP.A	CONOCHITINA CF C. IKLAENSIS	CINGULOCHITINA SP.C	ANGOCHITINA LONGICOLLIS	CINGULOCHITINA SP.D	SPHAEROCHITINA SP.B	ANGOCHITINA SP.A	GOTLANDOCHITINA SPP.	ANGOCHITINA SPP.	ANGOCHITINA SP.B	CONOCHITINA ACUMINATA	CINGULOCHITINA SP.B	GOTLANDOCHITINA AFF. G. CORNICULATA	CONOCHITINA FLAMMA	DESMOCHITINA OPACA	CINGULOCHITINA SP.F	EISENACKITINA SP.B	CONOCHITINA ARMILLATA?	CONOCHITINA AFF. PROBOSCIFERA	CONOCHITINA SP.D	CONOCHITINA TUBA	CINGULOCHITINA CINGULATA	CONOCHITINA BREVIS BREVIS?	CONOCHITINA SP.C	CONOCHITINA GUTTA	CINGULOCHITINA NODOSA	CONOCHITINA SP.E	CONOCHITINA SP.B	SPHAEROCHITINA LYCOPERDOIDES	CINGULOCHITINA CONVEXA	TASMANITES? SP	INCERTAE SEDIS SP.A	Number of determinated Chitinozoa (species and genera)
E	MB 9	CB- 8 /7	56				p						r			p																									r							r		D	x		138
		CB- 7 /2	55			x	x												x																						x							x					10
		CC- 1 /6	53				x						x			x																																		x	x		9
D3	MB 8	DD-13 /2	54																																					x													1
		ED-13 /4	52				x																															x		x													12
		ED- 6 /3	78				r									r																						r		r	r	D	r				r				x		390
		DD-12 /6	77				r									r			r										r									r		r	r	D	r	r	r		r		r		x		1082
		GC- 9 /4	76																																					x		x									x		2
D2	MB 7	FD- 1 /101	75				r	r											r																			r	r	p	r	D	r	r	r						x		906
		FD- 1 /3	74													•			••									•										•	•	••		•••	••		•						x		68
D1		FC- 8 /13	73				x									x																						x		x	x		x		x						x		27
		FD- 6 /6 top	72																r										r									r		r	r	D	r	r							x		133
D3		HD- 4 /53	71			r	r	r											r																			r		p	r	D	r	r		r	r	r			x		265
		HD- 4 /1	70				r									r			r																			p		p		D	r					r			x		167
		HD- 1 /14m above 40	69			r	p	r											p																			p		p		D	r	r	r		r	r			x		509
		I D-21 /69	51			r	r	p					r						r									r										p		p		f	r	r		r	r	p	r				192
		I D-21 /1 bis	50			r	r	p																														p		f	r	p	r	p			r						156
		I D- 9 /11	68				r	r											r																			r		p		D	r	r	r		r	r			x		421
D2		JD- 3 /29	49			••	••																															••		•••	•		•		•								64
		JD- 2 /1	48				x																															x		x			x	x									9
		JD- 2 /56	47			p	r	r					r			r																						p		f	r	p		r	r		r						181
		HC- 1 /36	46			r																																p		p	r	f	r	r	r								135
		JD- 2 /117	45			r	p						r																									r	r	D	r	p	r	r			r						218
		JD- 2 /124	44				••						•																									•		•••	•			•									49
		JD- 2 /152	43				x																															x		x	x			x									30
		JD- 1 /165	42			•	••												•																			•			•••	••											40
		JD- 1 /96	41			x	x																																			x											3
D1		JD- 1 /43	40				p						cf r		cf r																								r	p	r	D	r			r	r						244
		JD- 1 /1	39			x	x						cf r																										x	x	x			x									16
		HC-25 /218	67				p	r											r																	r		r	f	r	r		p		r						x		104
		HC-25 /75	66																																			p	r	f	r	r	p		r								152
		HC-25 /1	65			r	D	r							cf r				r																	r?		r	p	p	r	r?		r	r						x		324
		HC-10 /18	64				D	r																												r?		r	p	p	r	r	r										278
	MB 7?	HD- 3 /03	36				••								cf •																						r		••	•••	•••										x		38
		HD- 3 /02	35				x								cf x				x																				x												x		14
	MB 6	ED- 2 /110	38			x	x								cf x																								x		x	x											34
		ED- 2 /106	37				x						x																										x	x		x	x								x		14
C4	MB 5	DD- 9A	63									x				x																				x																	5
		CD-22G/115	34				x					x	x					x																		x	x cf x																31
C3	MB 4	CD-22G/78	33				x					x	x		cf x																					x	x																10
		CD-22G/1	32				p	p				p	p	r	p				r																	p	p																119
		CD-22F/17	31							x		x?	x	x	x																					x	x																10
		CD-22E/36	30					•					••														•	•			••	•••																					60
		CD-22E/35	29			r	p	r		r		p	r	r	p			r	r					r	r	r		r	r	r	r	p	r	r	r	p	p																263
		CD-22D/1	28			r	p	r		r		p	r	r	p	f		r					r	p		r		p	r	r	f	r		r	r	r	r																332
		CD-22B/1	27																											x																							1
		CD-22A/2	26			••	••	•				••	•	•	•			•	•				••	•	•	••					•••																						98
		KF- 2E/2	25										x		x				x							x	x																										21
		CD-20 /224	24			•	••	••		••		••			••							•										•																					59
		CD-20 /114	23																x																																		1
		KF- 2D/4	22												x																																						1
		CD-20 /33	21				p	r		r		p	p	r	f				r							r							r																				208
		CD- 1F/198	20			••	••	•		••		••	•	•	•				•				••	••	••	•		•		•			••																				79
		CD- 1A/33	19			p	p	r		r		p	r	p	p	r	r	r	r	r	r	r	p	r	p	p	r				r		r																				493
		CD- 1A/6	18			p		r		r		r		r	r	r	r	r	r			r	f		p	r	r	r	r		r		r																				283
C2	MB 3E	KF- 2C/91	17				•			•		••	•	••	••		••					•	•		•		•						••																				59
		KF- 2C/0	16					x	x			x		x	x		x		x			x	x	x		x							x																				29
		I G- 1 /91	15									x					x																																				2
		I G- 1 /8	14					x				x							x							x					x																						7
		KF- 2B/4	13			p	r	r	r	r		r	r	r	r				r	r		r	f	r	p		r				r		r																				300
		CD-19 /10	12			r	r	r		p		p		r	r								D			p	r				r																						134
		KF- 2A/2	11			p		r					r				r		r	r		r	D		p		r																										191
		BD- 1A	62			••	•					•								•	•		•••		•••						•																						75
	"Pitet"																																																				
C1	MB 3D	CD- 2 /5	10				••	•	••	•		••	•	••	••				•	•		••			•	•						cf •																					98
		I F- 9 /+11,5m	9			r	p	r	r	r		p	r	f	r		cf r		p	p	r	r	r	r		r	r	r	r	r	r																						366
		I F- 9 /- 2,5m	8				p	r	r	p		r	r	f	r		cf r	r	r	p		r	r	p		r	r	r																									240
	MB 3C	BD- 7 /46	61			p	p		r	r		p		p	p	p			r	r	p		r	r	p	p																										(x)	141
		BD- 7 /2	60			r	r	r	r	r		p		f	p				p	r	r	r	r	p	r	r																									x		413
B2	MB 3A	I G-19 /+24,8m	7				p	p	f	p		cf r	r	p	p		cf r	r?	p																																	x	434
		I G-19 /101	6				x		x																																											x	13
		I G-19 /- 5,0m	5						x																																											x	1
	MB 2B	HH- 6E/51	59			•	••	••	••		•••																																										36
		HH- 6D/226	58			•	•	•	•••		••			••		•																																			x	x	42
		HH- 6A/5	57											x																																						x	1
B1	MB 2A	GH-14	4				x	x					x	x	x																																						19
		GH- 9 /144	3				x	x				cf x	x																																								13
		GH- 9 /1	2				x	x	x	x	x	cf x																																									25
A	MB 1	EI -12A	1	x	x	x	x																																														5

% \ number of specimens per sample	>100	99-35	<35
>50%	D	•••	x
30-50%	f		
5-30%	p	••	
<5%	r	•	

fig 8: Stratigraphical range of the Chitinozoa species and assemblage zones and subzones in the Silurian of the Mehaigne area.

nackitina sp. C, and a high frequency of E. sp. A are also characteristic of this zone. The age ranges from late Llandoverian to lower middle Wenlockian. A subdivision can be established on the basis of the presence or frequency of certain species.

E.3.a. Assemblage subzone C1 in members MB3C and MB3D, has frequent Eisenackitina sp. C, Cingulochitina sp. E, and few C. sp. C and C. sp. D. Four species are considered for datation: Conochitina proboscifera has been recorded from middle Llandoverian to late Wenlockian, (LAUFELD, 1971, 1974, 1979b); using graptolite zonation, Angochitina longicollis is recorded from the upper part of the M. gregarius Zone to the lower part of the C. murchisoni Zone (see p. 18), while Margachitina margaritana only appears at the top of the M. crenulata Zone in Gotland (see p. 47), whereas in Wales and the Welsh Borderland it is already present in the M. griestoniensis zone and continues until early late Wenlockian (ALDRIDGE et al., 1979). A late Llandoverian (Telychian) or possibly an early Wenlockian age is proposed for this subzone C1 (VERNIERS, 1981).

E.3.b. Assemblage subzone C2 situated in member MB3E, is characterized by frequent Cingulochitina sp. C and C. sp. D, and can be dated by the presence of the same four species mentioned under assemblage subzone C1 and by the presence of Gotlandochitina corniculata as late Llandoverian or early Wenlockian (VERNIERS, 1981).

E.3.c. Assemblage subzone C3 situated in the entire member MB4A and the basal part of member MB4B (until sample 30 inclusive), has frequent Conochitina proboscifera, C. acuminata and Cingulochitina sp. B Also appearing are Conochitina flamma and Desmochitina opaca, which are only found in the Upper Visby Beds and/or in the Högklint Beds in Gotland, both of early Wenlockian age (LAUFELD, 1974, 1979b). This subzone is attributed the same age, which is confirmed by the presence of early Wenlockian graptolites in horizons belonging to this subzone(VERNIERS & RICKARDS, 1979, VERNIERS, 1981).

E.3.d. Assemblage subzone C4, present in the upper part of member MB4B and in at least the lowest 35 m of formation MB5, is also dated by graptolites as middle Wenlockian. Conochitina proboscifera is often present but loses its typical form, and four species occurring in the Visby Beds and the Högklint Beds of Gotland (LAUFELD, 1974, 1979b) disappear: (Gotlandochitina corniculata, Angochitina longicollis, Conochitina flamma and Desmochitina opaca). The similarity with the Chitinozoa assemblages from the lower Slite Beds of Gotland also indicates a middle Wenlockian age (VERNIERS, 1981).

E.4. Assemblage zone D :

Occurs in formation MB6, MB7 and MB8, and is characterized by the presence of Conochitina sp. D and Cingulochitina cingulata with Conochitina tuba and C. armillata ? occuring throughout. It ranges from a middle to a late Wenlockian age. It can be divided into 3 subzones.

E.4.a. Assemblage subzone D1, is situated in formation MB6 and the lower part of formation MB7 (up to sample 40, inclusive), with C. aff. proboscifera always present, both C. sp. D and Cingulochitina cingulata frequent to present, together with atypical forms from assemblage zone C (Eisenackitina sp. A, E. sp. B and Cingulochitina sp. F). Conochitina brevis brevis? is sometimes frequent. C. acuminata is not present in this subzone contrary to what was stated in VERNIERS (1981). C. gutta and C. sp. C start in this subzone. By comparison to Gotland, Sweden (LAUFELD, 1974) it has a middle to late Wenlockian age. Together with subzone C2, it can easily be correlated to the Slite Beds, the Mulde Beds and the Halla Beds in Gotland. Cingulochitina cingulata, Conochitina gutta and C. tuba occur there in parts of the Slite Beds corresponding in age from the middle of middle Wenlockian to the middle of late Wenlockian (LAUFELD, 1974; VERNIERS, 1981). The graptolites more precisely indicate a middle Wenlockian age for the horizon of sample 37 in the middle of subzone D1 (VERNIERS & RICKARDS, 1978).

E.4.b. Assemblage subzone D2 is situated in the middle of formation MB7 sample 41-49), and has to be considered as a transitional subzone between D1 and D3 with occasionaly rare Conochitina aff. proboscifera, C. sp. E. C. sp. D, and Cingulochitina cingulata which is alternatingly present to dominant. Eisenackitina sp. A, E. sp.B and Cingulochitina sp. F have disappeared from this subzone. Linochitina aff. L. erratica (EISENACK, 1931), which I thought to observe at the top of subzone D2 (VERNIERS, 1981) was not recognized as such in other samples, and because of the absence of good evidence it was classified as Conochitina sp. B. By making a comparison with Gotland this subzone has a middle to late Wenlockian age (see under subzone D1).

E.4.c. Assemblage subzone D3 is situated in the upper part of formation MB7, and in at least the lower part of formation MB8; it was defined as an impoverished assemblage subzone with only Conochitina sp. D and C. armillata? present. Several new samples show that formation MB8 is generally rather poor in Chitinozoa, but some samples (68-71, 77, 78) are quite rich. We can now define subzone D3 by the dominance or presence of Cingulochitina cingulata, and the presence of the same species as in subzone D2: Conochitina armillata?, C. tuba, C. sp. C, C. sp. D, C. brevis brevis? and C. gutta except for C. aff. proboscifera which has disappeared and Conochitina sp. B or C. sp. E which are nearly always present. Furthermore Ancyrochitina and Sphaerochitina are present but rare, whereas in subzone D1 and D2 these genera are almost totally absent. Several typical Sphaerochitina lycoperdoides are also rarely found in this subzone C3 (samples 51,77)

The better defined subzone D3 can also be better dated because of the presence of the sometimes dominating Cingulochitina cingulata. This species only occurs in Gotland up to the uppermost Mulde Beds (LAUFELD, 1974), a level corresponding to the top of the G. nassa graptolite Zone (LAUFELD & JEPPSON, 1976). DORNING (1981) and ROMBOUTS (1980) found the species ranging halfway into the M. ludensis graptolite Zone in the Welsh Borderland (England). The presence of Sphaerochitina lycoperdoides in subzone D3 indicate the same age (G. nassa graptolite Zone and the lower and middle part of the M. ludensis graptolite Zone). In Gotland it only appears for the first time in the uppermost Mulde Beds (G. nassa graptolite Zone) where Cingulochitina cingulata makes its last appearance, and it is also found in the lower parts of the Klinteberg Beds (LAUFELD, 1974) belonging to the M. ludensis graptolite Zone (LAUFELD & JEPPSON, 1976). In Scania it only appears at the base of the Colonus shale (base of M. ludensis graptolite Zone). It was also found in the upper part of the M. ludensis Zone in Northern Wales (LAUFELD et al., 1975), and in the G. nassa Zone and the lower and middle parts of M. ludensis Zone in the Welsh Borderland (ROMBOUTS, 1980). PARIS (1981) found the species in Portugal in the base of the Sazes Formation at a level dated as late Wenlockian, but in the sense of a pre-*M. ludensis* Zone (see also p. 63). The upper part of formation MB7 and the lower half of formation MB8 up to section ED-6 is therefore late Wenlockian in age (*G. nassa* Zone and/or lower and middle part of the *M. ludensis* Zone) as is assemblage subzone D3.

E.5. Assemblage zone E :

This zone is found in 3 samples of formation MB9 and is well characterized by the frequent to dominating *Cingulochitina convexa* accompanied by *Conochitina* sp. B and *C. tuba*. The first species is present in the Hemse Beds of Gotland (LAUFELD, 1974), dated from the upper half of the *P. nilssoni* Zone to the *S. leintwardinensis* Zone (early to middle Ludlovian). This age is proposed for zone E (VERNIERS, 1981).

F. PALAEOECOLOGY

The paleoecology of Chitinozoa has recently been studied more intensively and besides temperature and salinity, a certain bathymetrical control of the generic and specific composition has been proposed (LAUFELD, 1974, 1977, 1979a, 1979b; WRIGHT, 1978; ROMBOUTS, 1980; WRONA, 1980; AL-AMERI, 1980). But before the paleoecology can be fully explained still more studies are needed and the Chitinozoa's biological affinities have to be clarified. Only to mention one aspect in the now most accepted hypotheses, that Chitinozoa are eggs or eggcapsules of some metazoa, one has to consider the possibility of a planctonic, epiplanctonic or a benthonic metazoan mode of life, and these Chitinozoophorans (GRAHN, 1981) could then produce planctonic, epiplanctonic and/or benthonic Chitinozoa. All nine possibilities would have a different influence on the occurrence of Chitinozoa, and this would be further complicated by the Chitinozoa's possible polyphyletic affinities.

Inspite of these restrictions, there is some evidence of the paleoecological distribution of Chitinozoa which will be used for the palaeoecological reconstructions of the Mehaigne area. Because of the specific nature of the sediments in our study area, i.e. turbidites, any palaeoecological conclusions derived from the general composition and the generic or specific composition of the Chitinozoa assemblages will not characterize the environment of the Mehaigne area itself. It will characterize the source-area of the turbidites: the area where the sediments were primarily deposited, and in which the Chitinozoa or their supposed producers, the Chitinozoophorans "lived" and also sedimentated. These sediments with their fossil content were then transported and perhaps modified by the turbidity currents and allochthonously brought into the Mehaigne area.

In a decreasing order of frequency, the organic micropalaeontological residues are composed of thick-walled sphaeromorph acritarchs (here referred to as Leisophaeridia spp.), other acritarchs, Chitinozoa, less frequent fragments of graptolites, some scolecodonts and other very rare groups. The absence of spores is also remarkable. This general composition with an abundance of thick-walled Leiosphaeridia points to a deep shelf environment, according to ALDRIDGE et al.(1981) WRONA (1980). The absence of spores also suggests a greater distance from the shore, or better, a lack of communication with the shoreline.

The generic composition of the Chitinozoa assemblages also provides some information about the environment of the turbidites' source area. The three dominant genera forming 85 % of all specimens are Cingulochitina, Conochitina and Eisenackitina (fig. 3, p. 12). Conochitina is mostly benthic (LAUFELD, 1977, ROMBOUTS, 1980). The ecology of Eisenackitina in the Silurian has not been described. The dominance or high frequency of Cingulochitina has in recent years been forwarded as characteristical of an "open sea", a "deep shelf" or a "continental slope" environment (ROMBOUTS, 1980; AL-AMERI, 1980; WRONA, 1980; DORNING, 1981). Cingulochitina is dominant in some levels of member MB3E, the base of member MB4A and in formations MB7 and MB8 and indicates that these conditions prevailed for at least long periods in the Mehaigne area.

The genera Conochitina and Cingulochitina are mutually exclusive (fig. 3) in an alternating way several times in e.g. formation MB7. But this cyclic pattern is different from the megacyclical variations in the turbidites. There is no genus directly linked to the mineralogy of the sediments. *Conochitina* is often found in high energy levels (formations MB7 and MB4) but it is also found in low energy levels (member MB3A). *Cingulochitina* is sometimes dominant in low energy levels (member MB3E, formation MB8), but in other low energy levels, absent (members MB3C and MB2B). *Eisenackitina* is mostly found in the lower two thirds of the stratigraphical column.

The group of *Ancyrochitina*, *Angochitina*, *Gotlandochitina* and *Sphaerochitina* is never frequently present, but usually occurs in the top of member MB3C up till member MB3D, and also in the top of member MB3E upwards, decreasing in formation MB4. The highest presence is in the top of member MB3E where the energy of the turbidity currents is still quite low and it only increases drastically 15 m higher in the stratigraphical column. Therefore their presence is not linked (or directly linked) to the energy of the turbidity currents. The absence or low frequency of these four genera, well represented in other Silurian areas, can be explained by either selective destruction of those more fragile genera by the turbidity currents, or by the original low frequency of these genera in the turbidites source area.

High frequency of the planctonic species of these genera tend to occur in moderately shallow to moderately deep water and only to a smaller extent in deeper areas (LAUFELD, 1977; ROMBOUTS, 1980; PARIS, 1981). *Margachitina* points to moderately deep conditions (LAUFELD, 1977; AL-AMERI, 1980) and is only definitely present in very small numbers from member MB3D on, and often present in formation MB4, disappearing afterwards. In comparison with the Silurian of Gotland (LAUFELD, 1974), it should also frequently occur in formations MB5 to MB7. According to our hypothesis in VERNIERS (1982a) the waters were deepening at this level, and deeper conditions prevailed in the source area, perhaps too deep for *Margachitina* to live in. *Desmochitina* is described as occurring in moderately deep waters: Benthic Marine Life Zone 4 (BMLZ4) of BOUCOT (1975) and only occurs in formation MB4 where the highest energy for the turbidity currents was recorded in the Mehaigne area.

One might expect that according to the size and form of the different genera, those which were round and rather small (<260 µm) such as e.g. the three dominating genera, would be deposited in the fine-grained, thin-bedded turbidites, and that the other genera would be deposited in other parts of the turbidites. However fig. 3 shows that the presence of the different genera is not linked to a specific regime of energy in the turbidites, to the amount of material transported, nor to a certain mineralogy. The generic composition of the Chitinozoa in the stratigraphical column is thus not influenced by hydrodynamic processes or granulometric sorting.

However, within one single turbiditic sequence[*], a granulometric sorting of the genera most probably does occur. This is shown by a comparison of the micropalaeontological content in samples taken from different intervals[x] from sequences[x] immediately underneath or above . Three such pairs of samples were taken: sample 29 in the Te interval of sequence CD-22E/35 and sample 30 in the basal Tb interval of the above laying CD-22E/36 sequence; sample 37 in the Td interval of sequence ED-2/106 and sample 38 in the Te interval of a sequence ED-2/110 four sequences higher in the column. Sample 35 was taken in the top of the Te interval of sequence HD-3/02 and sample 36 in the Td interval of sequence HD-3/03 lying just above. Although this sampling is small for statistically significant research, some observations are possible. In the Tb and Td intervals of sequence CD-22E/36 and ED-2/106, graptolites have been collected. There is an important change in composition of genera and species for the first two pairs of samples (29, 30 and 37, 38) but less difference in samples 35 and 36. In the first two samples, Cingulochitina increases from 20 % in Te to 80 % in Tb replacing Conochitina and Eisenackitina. The big Conochitina proboscifera and its variants are not present in the Tb interval but are very frequent in the Te interval. The concentration of Chitinozoa is sometimes equal in both types of intervals, sometimes higher in Te and sometimes higher in Tb or Td.

The same is observed for the diversity. Sample 46 is taken from the same interval in the same turbidite sequence as sample 47, but 2.3 km further away. There is a difference in concentration (2.5 X higher in sample 47), but most species occur in both samples and there is no statistically significant difference in frequency. In our four examples no Chitinozoa genus is restricted to one specific interval of the turbidite sequence, and a granulometric sorting is as yet not established. E.g.: the heavy large Conochitina proboscifera occur in the low energy Te interval while the light, small and round Cingulochitina cingulata seem to occur in the high energy Tb interval. There are important changes in generic composition from interval to interval, but their nature is not clear.

To more accurately study the hydrodynamic comportment of Chitinozoa in turbidites, a special study on a succession of turbidite sequences has to be done with a representative sampling taken from all the intervals comparing the composition of the assemblages in each deposit of a turbidity current and analysing the variations within the intervals over short (m) and long distances (km).

According to various recent studies, the specific composition also gives an indication of the paleoecology. E.g.: Angochitina longicollis occurs in members MB3C, MB3D, MB3E and MB4A until the base of member MB4B. According to LAUFELD (1977, 1979a, 1979b) it is restricted to the deepest shelf zones (BMLZ5).

As mentioned before (p.11-13) the diversity of Chitinozoa species and genera in the Mehaigne area is rather high. LAUFELD (1977, 1979a, 1979b) located the optimum living conditions for Chitinozoa, marked by a high

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(x) A turbiditic sequence is the deposit of a turbidity current, and consists of one to five intervals (divisions) with each its characteristic sedimentological features, denominated Ta, Tb, Tc, Td,Te by BOUMA (1962) (see also VERNIERS, 1982a).

abundance and a high diversity, in the deepest shelf conditions. The high diversity of Chitinozoa in the Mehaigne area therefore also points to these deep conditions for the source area of the turbidites.

We can conclude that the general, the generic and the specific composition of Chitinozoa in the Mehaigne area point to deep shelf conditions for the whole period with possibly moderately deep conditions in formation MB4 (early Wenlockian).

Nearly all appendices on *Ancyrochitina* spp., *Gotlandochitina* spp. and *Angochitina* spp. are broken off at their base, possibly due to the incipient metamorphism of the surrounding sediments, to the preparation techniques, but probably also caused by destruction during rough transport in the turbidity current.

As we have seen, the presence of genera throughout the column is not linked to hydrodynamic processes or granulometric sorting by the turbidity currents. Hence, the generic composition reflects the original composition of Chitinozoa in the source area although transport in the turbidity currents may have destroyed the Chitinozoa appendices and reduced the more fragile Chitinozoa genera, such as *Ancyrochitina*, *Angochitina*, *Sphaerochitina* and *Gotlandochitina*. All these observations i.e. the general composition of the microfossil groups, the generic and specific composition of the Chitinozoa, and their diversity, allow us to conclude that in the turbidites' source area outer deep shelf conditions prevailed from middle Llandoverian to early (or middle?) Ludlovian, with possibly moderately deep conditions in the early Wenlockian (formation MB4). The turbidity currents departed from this source area to the Mehaigne area itself, which therefore had to be deeper: bathyal, either on a continental slope or in a geosynclinal trough.

G. CORRELATION WITH OTHER BIOZONATIONS

The biozonation of the Chitinozoa assemblage zones in the Mehaigne area can be correlated with several biozonations in neighbouring areas: the Welsh Borderland (England) on the "England microplate", in Gotland on the "Baltica plate", and in Bretagne, Spain and the Algerian Sahara on the "Gondwana plate" (fig. 9, 10).

DORNING (1981) published the results of a general biozonation in the Wenlock and Ludlow type area of the Welsh Borderland (Shropshire, England). In the Wenlock, two Chitinozoa assemblages are distinguished. An early Wenlockian assemblage is characterized by *Ancyrochitina pachyderma* and *Margachitina*, both moderately present. In the Mehaigne area the former species is not found, but the latter genus ranges throughout the whole assemblage zone C. *Conochitina proboscifera* is common, to both areas and ranges higherup. The middle and late Wenlockian assemblage of the Coalbrookdale Formation and the lower Much Wenlock limestone Formation has *Linochitina* (= *Cingulochitina*) *cingulata*, *Conochitina tuba*, *C. gutta* and at its base *Conochitina proboscifera* in common with assemblage zone D in the Mehaigne area. Hence, a similar biozonation occurs in the Wenlockian of both area. However no common species are found for the Ludlovian, possibly because only three Ludlovian samples are studied in this work.

In Gotland, presently about 1100-1200 km away from the Mehaigne area LAUFELD (1974) described consecutive paleontological events of Chitinozoa with their local range zones in the Silurian succession. He was waiting for a graptolite zonation in Gotland before establishing a formal Chitinozoa zonation. Although these events have not been formally defined as biozones, they can be compared with those in the Mehaigne area. The Chitinozoa assemblages occurring in the Gotland subsurface succession have only been fragmentarily described and may correspond to some of the lower Chitinozoa assemblagezones and subzones in the Mehaigne area (i.e. : A, B1, B2 and C1). Assemblage subzone C2 corresponds to the assemblages in the Lower and Upper Visby Beds, C3 to the assemblages in the Högklint Beds, C4 to the lowest of the six assemblages in the Slite Beds corresponding to members a and b, D1 and D2, to the assemblages in the Slite Beds (from *Conchidium tenuistriatum* Beds upwards) in the Halla and in the Mulde Beds, and D3 corresponds to the assemblages in the Halla and the Mulde Beds. Assemblage zone E can correspond to the three latest of the five assemblages in the Hemse Beds. Although many differences occur, for example in Gotland, the absence of species occuring in the Mehaigne area, and vice versa, the presence of several other species support the correlation of these "biozones".

However, the correlation of our assemblagezones becomes more difficult when we compare them to Chitinozoa biozonations in other regions : i.e. Armorican Massif, Spain and the Algerian Sahara, all on the northern part of the "Gondwana plate". Only three of the biozones proposed for the Armorican Massif and the Iberian peninsula by PARIS (1981) can be recognized in the biozonation of the Mehaigne area. Zone 19 of PARIS (1981), may possibly be related to assemblage zone B. Atypical *Conochitina proboscifera* which PARIS (1981) designated as *C. proboscifera truncata* occur in both zones, forerunners of the more typical populations higher up in the sequence. *Cyathochitina* sp. B also typical in zone 19 is not found in

Fig.9: map of Europe and northern Africa with the position of the areas where Silurian Chitinozoa biozonation were established. The hypothetical limits of the Silurian continental plates are also given.

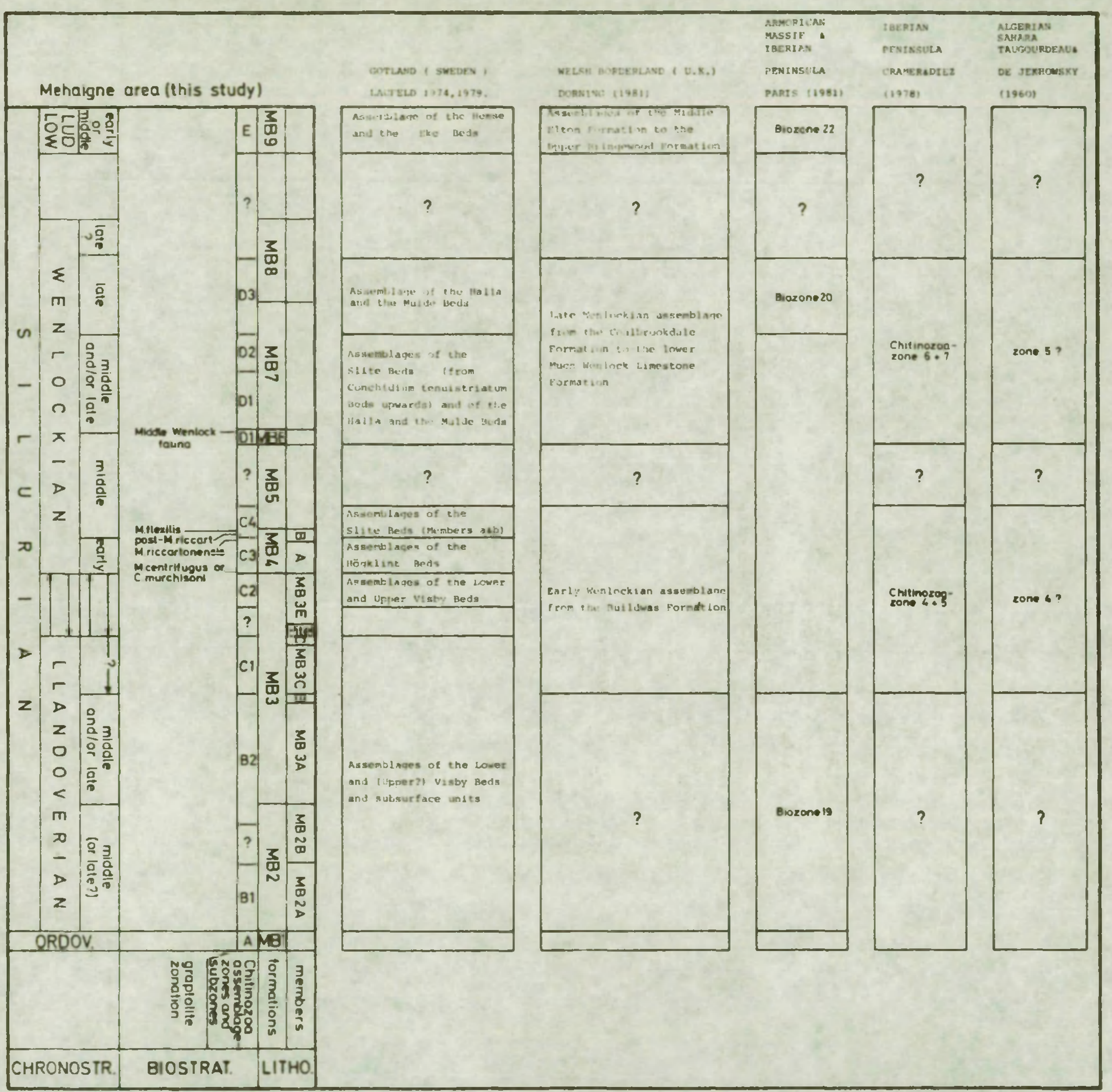

Fig.10: Tentative correlation of the biozonation in the Mehaigne area with biozonations proposed by different authors for other areas.

the Mehaigne area. Both zones are dated late Llandoverian with assemblage zone B most probably stretching into the middle Llandoverian.

Zone 20 of PARIS (1981) with *Sphaerochitina lycoperdoides*, is probably related to assemblage subzone D3 (samples 77 and 51 in D3 contain this species). The other three species occurring in zone 20 are absent in subzone D3. This absence could be explained by their preference for shallower areas (see also p. 57) while the Chitinozoa in the Mehaigne area originate from deeper areas. Zone 20 is dated by graptolites as late Wenlockian (sensu pre-*M. ludensis* Zone) and assemblage subzone D3 by Chitinozoa in this work (see p.54-55) as late Wenlockian (*G. nassa* Zone or basal *M. ludensis* Zone).

Zone 22 of PARIS (1981), with *Angochitina* cf. *echinata* also contains *Cingulochitina* sp. aff. *convexa* and can be related to assemblage zone E. In PARIS (1981) zone 22 is dated by graptolites as "*deubeli*" Zone corresponding to a part of the *M. ludensis* Zone (late Wenlockian). Assemblage zone E is dated by Chitinozoa, as Ludlovian (Gorstian and/or lower part of Ludfordian). For datation of the Chitinozoazones PARIS (1981) uses a slightly different chronostratigraphic division for the Silurian than is internationally accepted. In the division of the Silurian (Wenlock and Ludlow Series), as defined in their respective type sections by BASSETT et al. (1975) and HOLLAND et al. (1963), and internationally accepted in 1980 by the International Commission on Stratigraphy of the Union of Geological Sciences (HOLLAND, 1980 and HOLLAND et al., 1980) one should read the datations of the biozones by PARIS (1981) as follows : biozone 20 : late Wenlockian (pre-*M. ludensis* :i.e. *M. lundgreni* or *G. nassa* Zone); biozone 21 : late Wenlockian, possibly *G. nassa* Zone); biozone 22 : late Wenlockian (equivalent of the *M. ludensis* Zone) and eventually extending in to the lower part of the Ludlovian (Gorstian); biozone 23 : upper Ludlovian and/or lower Pridolian.

CRAMER & DIEZ (1978) proposed a biozonation for the Ordovician to Devonian in the Iberian peninsula. To compare this biozonation with that of the Mehaigne area is more difficult because, if a strict systematical comparison is made,only one species occurs in both areas: *Margachitina margaritana*. The top of Chitinozoa zone 4 and the basal part of zone 5 of CRAMER & DIEZ (ib.) should correspond to assemblage zone C. However, we can compare the Chitinozoa from the Mehaigne area with the illustrations and the published dimensions of the Chitinozoa from the Iberian peninsula and establish possible synonymies. But before the original material has been examined, this synonymy is only tentative. The taller forms of the badly defined "*Conochitina gordonensis*" of CRAMER (1964) could correspond to *C. brevis brevis*? in the Mehaigne area. *C. edjelensis* et al. could correspond to *C.* sp. E, certain *C.* sp. B; *C. elenitae* could perhaps correspond to *C. armillata*? and some specimens of *Eisenackitina oelandica silurica* could correspond to *Eisenackitina* sp. A; *Linochitina cingulata* and *Conochitina proboscifera* in the Spanish material in CRAMER & DIEZ (1978) are not considered synonymous to the species with the same name in the Mehaigne area.

If the proposed synonymy is proved correct, five species are common to both areas. Chitinozoa zone 4 and 5 in Spain could then correspond to assemblage Zone C (*Margachitina margaritana* and *Eisenackitina oelandica* *silurica* = *Eisenackitina* sp. A occur together in both zones). Chitinozoa zones 6 and 7 could possibly correspond to assemblage zone D ("*Conochitina gordonensis*" = *Conochitina brevis brevis*?, *Conochitina edjelensis* et al. = *Conochitina* sp. E and *Conochitina elenitae* = *Conochitina armillata*? are common to both zonations). These correlations are not in contradiction with their ages. Chitinozoa zones 4 and 5 have the latest Llandoverian and a "lower part" Wenlockian age while assemblage zone C has a late Llandovrian, an early Wenlockian and basal middle Wenlockian age. Chitinozoa zones 6 and 7 have an "upper part" Wenlockian and early Ludlovian age while assemblage zone D has a middle to late Wenlockian age. PARIS (1981) also correlated his biozonation of the Iberian Peninsula and the Armorican Massif with the one proposed by CRAMER & DIEZ (1978). The contradiction in ages that PARIS (ib.) observes is only apparent when one considers the international classification of the Wenlockian and Ludlovian. PARIS (ib.) correlates zone 6 of CRAMER & DIEZ (ib.) to his zone 21; both zones have a Wenlockian age. Zone 7 of CRAMER & DIEZ (ib.) is correlated to zone 22; the former zone has an early Ludlovian age, the latter an uppermost Wenlockian age. Zone 9 of CRAMER and DIEZ (ib.) is correlated to zone 23, the former has a Ludlovian, possibly Pridolian age (the new division of the Silurian using the Pridolian stage is still not used by CRAMER & DIEZ, 1978) the latter zone 23 has an upper Ludlovian or lower Pridolian age.

Even if the correlations of the biozonations seem more important than what can be derived from just a superficial reading of the publications, when using the possible synonymous species one can still observe that the correlation of the Mehaigne area with the Armorican Massif and the Iberian peninsula is not as apparent as with Gotland.

A comparison with the biozonations in the Algerian Sahara (TAUGOURDEAU & DE JEKHOWSKY, 1960; POUMOT et al., 1964; MAGLOIRE, 1967 and JARDINE & YAPAUDJIAN, 1968) is more difficult. The Chitinozoa studies in these areas were often pioneer work to show the biostratigraphical value of Chitinozoa, but due to their objectives of petroleum exploration, their studies could not be accurately effectuated on all horizons. With the accuracy now obtained in biostratigraphy with Chitinozoa, the biozonations in the Sahara are very useful for broad-scale correlations within a range of 1000 km but nevertheless cover too long timeunits, e.g. Wenlockian, to be useful to us. These biozonations tend to be inaccurate, as shown in the following litterature survey.

Biozone 3 of TAUGOURDEAU & DE JEKHOWSKY (1960),representing the lower of the three biozones of the Silurian, is tentatively correlated by CRAMER (1973) to the top of the late Llandoverian *M. griestoniensis* and *M. crenulata* Zone, while PARIS (1981) correlates it by comparison with SW-Europe, as probably lowermost Telychian(late Llandoverian, toppart of *M. turriculatus*). Biozone 4 of TAUGOURDEAU & DE JEKHOWSKY (1960) is determined as the middle of late Wenlockian by LAUFELD (1974), probably by comparison with Gotland, while PARIS (1981) considers it as late Ludlovian or basal Pridolian (see also p. 63). In biozone 3 of TAUGOURDEAU & DE JEKHOWSKY (1960) no species seems to be common to the Mehaigne area, except for some *Ancyrochitina* spp. which are undeterminable in the Mehaigne area due to their bad state of preservation. Biozone 4 has only *Margachitina margaritana* in common with assemblage zone C, and biozone 5 has only *Conochitina armillata*? and possibly *Ancyrochitina* sppp. in common with assemblage zone

D. No species are common to the Mehaigne area and the Polignac Bassin, except for some Ancyrochitina spp. (see above) (JARDINE & YAPAUDJIAN, 1968). The same is true of the "Grand Erg Occidental" (Algerian Sahara) studied by MAGLOIRE (1967). Moreover, the ages of the biozones in the Algerian Sahara are not precisely given; only their large timespans, therefore making the comparison in age impossible.

The successive Chitinozoa assemblage zones in the Mehaigne area have very little relation to these of the north-central part of the "Gondwana plate", some relation is seen with the Armorian Massif and Iberian peninsula, while a clear relation exists with the Welsh Borderland (Shropshire, England) on the west side of the "England microplate", and with Gotland on the "Baltica plate".

H. PALEOPROVINCIALISM

As LAUFELD (1979a,p. 79) states, the definition of Chitinozoa paleoprovinces will always be difficult until the palaeoecology of the Chitinozoa is reasonably well understood. Recent research (LAUFELD, 1974,1979a; AL-AMERI, 1980; ROMBOUTS, 1980) shows that the palaeoecology might be more determining of the occurrence of several genera than the presumed palaeoprovincialism. But according to LAUFELD (1979a), a provincialism still does occur, although in the Silurian, the Chitinozoa are less provincial than during the Ordovician and less pronounced than in the Acritarch provinces (cf. CRAMER & DIEZ, 1972a, p. 116). All genera present in the Mehaigne area are nevertheless classified as cosmopolitan (LAUFELD, ib., p. 78-79) and no conclusion on provincialism can be drawn from our study material.

The proposed two (CRAMER, 1971b, p. 62) or three provinces (CRAMER, 1971a, p. 232 and 235; RAUSCHER, 1973) based on the occurrence of genera and species needs redefinition. The Iberian-Sahara "Chitinozoa facies" is characterized by the presence of Cyathochitina spp., and is called the Angochitina eisenackii province because of the dominance of this species in these areas (CRAMER & DIEZ, 1972a, 1972b;CRAMER, DIEZ & CUERDA, 1974). The Baltic Chitinozoa province is characterized by Angochitina and Conochitina (e.g. : C. proboscifera) and called the Angochitina echinata- A. elongata province. The Appalachian Chitinozoa province contains principally Ancyrochitina, Bursachitina = Eisenackitina, Linochitina (= Cingulochitina) and rare Angochitina while Cyathochitina and Conochitina proboscifera are absent. But PARIS (1981) found Cyathochitina spp. as well as Conochitina proboscifera, Angochitina elongata - A. echinata in the Armorian Massif believed to belong to the Appelachian Chitinozoa province, and in the Iberian peninsula. These species were defined as typical of either the Sahara or the Baltic province. And Conochitina proboscifera, presumably typical of the Baltic province, was found in the "intermediate" Appalachian province in Belgium (VERNIERS & RICKARDS, 1978), and in Shropshire and Wales (LISTER, 1968, m.s., DORNING, 1981). It is clear that much more research on the different areas in well-dated sections is needed before the provinces can be precisely defined, if they do exist.

If we compare the Chitinozoa assemblages from the Mehaigne area with those from nearbouring areas on the species level, we see good similarities with the Welsh Borderland (presently 600 km away) and also with more distant areas, presently 1100-1600 km away, such as the Baltic-East-European Platform; especially with the well studied area of Gotland (see the similar biozonations with both areas, p. 60) and also with the more fragmentarily studied areas of Estonia, Saaremaa, Scania and Podolia.

The dissimilarity with the much nearer Armorican Massif, (presently 450-750 km away) or the Montagne Noire (France) (800 km away) is perhaps caused by the lack of a continuous silurian section in France as PARIS (1981) points out. But in all cases the assemblages from the Mehaigne area are much less similar to the assemblages in the sections in NW-Spain (described by CRAMER and coworkers) than to those from the Baltic Platform. Only a few species are common (see p. 63-64).The dissimilarity is much more striking when a comparison is made with the Saharan assemblages. The Mehaigne area therefore seems to be related to the Baltic Chitinozoa province. PARIS (1981, p. 385) considers that during the Silurian the communications between the Baltic Platform and SW Europe were still good. We can give a more accurate picture and conclude that the Mehaigne area's contacts with the Baltic East European Platform on the "Baltica plate" and the British Isles on the "England microplate" were good, but those with the Armorican Massif, the Iberian Peninsula and for sure North Africa on the "Gondwana plate", were apparently much smaller.

I. CONCLUSIONS

The Chitinozoa studied are from a 2100 m thick Silurian sequence of flysch-type sediments from the Mehaigne area in the eastern part of the Brabant Massif. The organic microfossils are extracted from 79 samples of slaty rocks following the usual palynological procedures. All organic microfossil content is recorded, i.e. the Chitinozoa, the thick-walled Leiosphaeridia, other acritarchs and Prasinophyceae, scolecodonts, fragments of graptolites and other groups.

The Chitinozoa are described in the systematical section and illustrated on nine plates. The mean concentration is 1.5 Chitinozoa per gram of rock, ranging from 0.1 to 12.5 and only in 33 samples could more than 100 Chitinozoa be determined due to this low concentration. This generally low concentration is probably secondarily caused by the incipient metamorphism of the rock and/or the surface weathering. At some levels where an increase in the energy of the turbidity currents is observed, an increase in concentration also occurs, while with a decrease of energy a decrease in the concentration is seen. This relation is valid for the major changes. In the smaller megacyclic changes this same tendency persists but it is not as apparent. Hence, the factors influencing the abundance of Chitinozoa and the regime of turbidity currents are at least partially identical.

The diversity of Chitinozoa is high in contrast to the low concentration (1 to 16 species and 1 to 9 genera per sample with a main of 5 genera for samples with more than 100 specimens). It is even higher in middle Llandoverian to early Wenlockian samples than in middle and late Wenlockian levels, but in general it is not linked to either the energy or the amount of material transported by the turbidity currents, the mineral composition of the turbidites, or the concentration of Chitinozoa.

The Chitinozoa are moderately too poorly preserved, ranging from N4 to N5 on the CORREIA (1967) scale and have a reflectance on vitrinite (R med.) between 2.5 % and 5 %: the rank of true antracite ,corresponding to deeper zeolite facies (anchizone) or very low grade metamorphism. But still 86 % of all recognizable Chitinozoa specimens can be determined to the generic, and 71 % to the species level. They belong to 10 genera and 38 species. Their ranges are given in fig. 8. In the genera Ancyrochitina, Gotlandochitina and Angochitina nearly all appendices or large spines have been broken off at the base probably due to rough transport in the turbidity currents. Some perforations, presumably from parasites, and internal pyrite growth are often present. This last points to a higly reducing environment during early diagenesis or even during deposition.

The three dominating genera are Conochitina, Cingulochitina (ex-Linochitina) and Eisenackitina. They account for 85 % of the specimens. The remaining genera are Sphaerochitina, Gotlandochitina, Angochitina, Ancyrochitina, and a very small amount of Margachitina, Desmochitina and Cyathochitina. No new species are presented but 18 presumably new species are left under open nomenclature. They have to be formally defined in better preserved assemblages. In the middle and late Wenlockian, Conochitina and Cingulochitina are mutually exclusive in an alternating cyclic way several times. But this cyclic pattern is different from the megacyclic variations in the turbidites. No genus is directly linked to a specific mineralogy. Conochitina appears to be linked to higher energy levels of the turbidites, and Cingulochitina is sometimes dominant in the lower energy levels, but the opposite can also occur. This shows that when observed on a large scale (tens of meters), the presence of genera is not linked to a specific regime of the turbidity currents, the amount of material transported by these currents, or the mineral composition of the deposit, and therefore that the generic composition is not influenced by hydrodynamic processes or granulometric sorting. At the detailed level of one turbidite a granulometric sorting does occur, but its nature is more complicated than initially suggested, and because of the lack of more studies it has not yet been established. Hence this generic composition reflects the original Chitinozoa composition in the source area of the turbidity currents. Transportation by the turbidity currents was probably responsible for the destruction of appendices and perhaps the reduction of the more fragile Chitinozoa genera such as Ancyrochitina, Sphaerochitina, etc.

The general composition of microfossil groups (abundance of thick-walled Leiosphaeridia, absence of spores), the generic and species composition (e.g. : Cingulochitina (ex-Linochitina) frequently dominating the assemblages, the presence of Angochitina longicollis and the high diversity allow us to conclude that outer deep shelp conditions prevailed in the source area of the turbidites. The turbidites then left this source area descending a slope to deeper conditions in the Mehaigne area itself which therefore had to be from middle Llandoverian to early (or middle ?) Ludlovian bathyal, on either a continental slope or in a geosynclinal trough.

In several places the biozonation defined earlier (VERNIERS, 1981) can be more detailed: assemblage subzone B2 extends into member MB2B, subzone C1 into member MB3C, and subzone C4 goes at least 35 m high into formation MB5. The Chitinozoa assemblages from assemblage zone B and D are described in more detail. These assemblages zones are now dated as : A : Late Ordovician; B1 : middle or late? Llandoverian (M. convolutus graptolite Zone); B2 : middle and/or late Llandoverian; C1 : late Llandoverian (Telychian) or possibly early Wenlockian; C2 : late Llandoverian or early Llandoverian; C3 : early Wenlockian; C4 : middle Wenlockian; D1 : middle and late Wenlockian; D2 : middle or late Wenlockian; D3 : late Wenlockian (G. nassa Zone and/or lower and middle part of M. ludensis zone; E : early (or ?middle) Ludlovian.

Our biozonation can be correlated with similar biozonations in the Welsh Borderland (Shropshire, England), in Gotland (Sweden) and to a lesser degree with the Armorican Massif (France) and the Iberian Peninsula.

According to LAUFELD (1979a), until the paleoecology of the Chitinozoa is fully understood paleoprovincialism for the Chitinozoa will always be difficult to define but it does occur in the Silurian. Nevertheless all genera present in the Mehaigne area are classified as cosmopolitan. When we compare the Chitinozoa assemblages from the Mehaigne area assemblages from neighbouring areas, at the species level we see a good similarity with the Welsh Borderland, presently 600 km away and situated on the "England microplate" of which the Brabant Massif would be the eastern part. There is also a good similarity with more distant areas, presently 1100-1600 km away; with the Baltic-East European Platform, especially with the well studied island of Gotland, and also with Estonia, Saaremaa, Scania and Podalia. These areas all belonged to the "Baltica plate" in Silurian times.

There is a distinct dissimilarity with the much closer Armorican Massif, presently 450-750 km away, and the Montagne Noire (France) 800 km away. This may partially be caused by the lack of a continuous Silurian section in France. The dissimilarity is even more apparent in NW-Spain, presently at the same distance from the Mehaigne area as the Baltic platform. This dissimilarity is even more striking when we make a comparison with the Saharan assemblages.

The Mehaigne area therefore seems related to the Baltic Chitinozoa province. Although PARIS (1981) sees good communication between the Baltic Platform and SW-Europe during the Silurian, a more accurate picture is that the contacts were good between the British Isles, the Brabant Massif and the Baltic platform, but were apparently much smaller with the Armorican Massif and the Iberian Peninsula.

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PLATE 1.

1. *Conochitina proboscifera*; typical form (21,-; 250 x)*.
2. *Conochitina proboscifera*; typical form (21,-; 250 x).
3. *Conochitina proboscifera*, forma *truncata* (21,-; 250 x).
4. *Conochitina proboscifera*, forma *truncata* (28,-; 250 x).
5. *Conochitina proboscifera*, forma *truncata* (28,-; 250 x).
6. *Conochitina proboscifera*, forma *truncata* (17,-; 250 x).
7. *Conochitina proboscifera*, forma *truncata* (28,-; 250 x).
8. *Conochitina proboscifera*, forma *truncata* (18,-; 250 x) partial view on the wide mucron.
9. *Conochitina proboscifera*, forma *truncata* (28,-; 250 x) partial view on a neck with a thin operculum (in section).
10. *Conochitina proboscifera*; small variety from assemblage zone C1 and C2 note the rather thick tegument and the protruding mucron (9,-; 250 x).
11. *Conochitina proboscifera*; small variety from assemblage subzones C1 and C2 (8,-; 250 x).
12. *Conochitina proboscifera*; small variety from assemblage subzones C1 and C2 (9,-; 250 x).
13. *Conochitina proboscifera*; small variety from assemblage subzones C1 and C2 (9,-; 250 x); note the thick tegument and impression of a mucron.
14. Possibly a small variety of *Conochitina proboscifera* in assemblage subzones C1 and C2; note the thick tegument (9,-; 250 x).
15. *Conochitina proboscifera*; small variety from assemblage subzones C1 and C2 (9,-; 250 x).
16. *Conochitina proboscifera*; small variety from assemblage subzones C1 and C2 (9,-; 250 x).
17. *Conochitina proboscifera*; small variety from assemblage subzones C1 and C2 (9,-; 250 x).
18. *Conochitina* aff. *proboscifera*; (40,-; 250 x).
19. *Conochitina* aff. *proboscifera*; (40,-; 250 x).

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* (21,128; 250x) gives the number of the sample (21); the number of the specimen in that sample (128) for counted samples and (-) for reprepared samples; 250 x gives the magnification.

Plate 1

PLATE 2.

20A. *Conochitina armillata* ?; round specimen (42,-; 250 x).

20B. *Conochitina armillata* ?; view of the aboral part with impression of mucron (42,-; 500 x).

21. *Conochitina armillata* ?; (47,-; 250 x).

22. *Conochitina armillata* ?; (47, 204; 250 x).

23. *Conochitina armillata* ?; (46,53; 250 x).

24. *Conochitina armillata* ?; (45,176; 250 x).

25. *Conochitina armillata* ?; (47,186; 250 x).

26. *Conochitina armillata* ?; (43,19; 250 x).

27. *Conochitina armillata* ?; (47,37; 250 x).

28. *Conochitina* sp. C; (47,11; 250 x).

29. *Conochitina* sp. C; (51,58; 250 x).

30. *Conochitina* sp. D; (51,35; 500 x).

31A. *Conochitina* sp. D; (45,11; 250 x).

31B. *Conochitina* sp. D; view of the operculum on top of the pseudostome (45,11; 750 x).

32. *Conochitina* sp. C; (50,128; 250 x).

33. *Conochitina* sp. C; internal mould of a round specimen (probably pyrite) (50,89; 250 x).

34. *Conochitina* sp. D; (46,78; 250 x).

35. *Conochitina* sp. D; (45,173; 250 x).

36. *Conochitina* sp. D; (47,144; 250 x).

37. *Conochitina* sp. D; (45,164; 250 x).

38. *Conochitina* sp. D; (45,66; 250 x).

39. *Conochitina* sp. D; (45,60; 250 x).

40. *Conochitina* sp. D; (46,388; 250 x) variety with hardly any neck.

41. *Conochitina* sp. D; (50,39; 250 x) variety with hardly any neck.

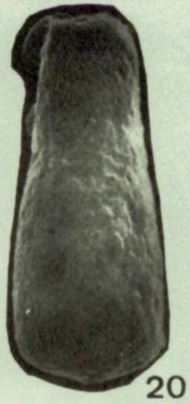
42. *Conochitina* sp. D; (45,179; 250 x) variety with hardly any neck.

43. *Conochitina* sp. D; (45,192; 250 x) variety with hardly any neck.

44. *Conochitina* sp. D; (43,20; 250 x) variety with hardly any neck.

45. *Conochitina* sp. D; (45,170; 250 x).

Plate 2


20A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* 20B


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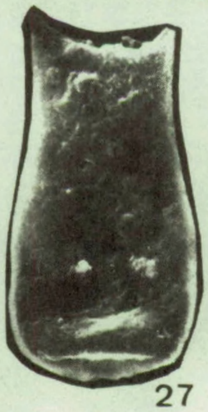
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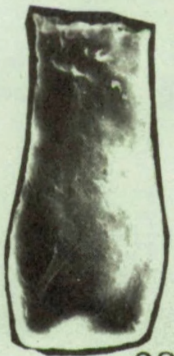
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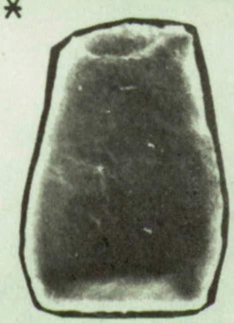
* 30


** 31A


32


33


31B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0 100 200µm

0 50 100µm *

0 50µm **


40


41


42


43


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PLATE 3.

46. *Conochitina brevis brevis* ?; (47,117; 250 x).

47. *Conochitina brevis brevis* ?; (46,7; 250 x).

48. *Conochitina brevis brevis* ?; (45,104; 250 x).

49. *Conochitina brevis brevis* ?; (40,47; 250 x).

50. *Conochitina brevis brevis* ?; (51,158; 250 x).

51. *Conochitina tuba*; (42,39; 250 x).

52. *Conochitina tuba*; (47,34; 250 x).

53. *Conochitina tuba*; (42,32; 250 x).

54A. *Conochitina tuba*; (40,16; 250 x).

54B. *Conochitina tuba*;partial view of fig. 54A where no operculum or prosome is seen; (40,16; 500 x).

55A. *Conochitina gutta*; (51,5; 250 x).

55B. *Conochitina gutta*; (51,5; 500 x).

56. *Conochitina gutta*; (47,127; 250 x).

57. *Conochitina gutta*; (49,64; 250 x).

58. *Conochitina* cf. *C*. *iklaensis*; (9,457; 250 x).

59. *Conochitina* cf. *C*. *iklaensis*; (9,268; 250 x).

60. *Conochitina* cf. *C*. *iklaensis*; (8,300; 250 x).

61. *Conochitina* sp. B; (69,-; 250 x).

62. *Conochitina* sp. B; (51,-; 250 x).

63A. *Conochitina* sp. E; (51,34; 250 x).

63B. *Conochitina* sp. E; partial view of the (broken) tegument at the neck showing the thin tegument (51,34; 1000 x).

64. *Conochitina* cf. *C*. *edjelensis elongata*; (59,-; 250 x).

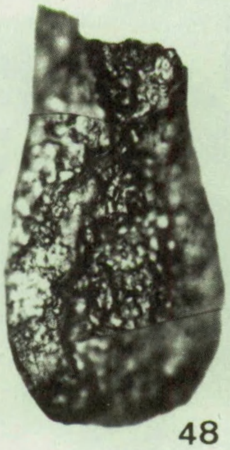
65. *Conochitina* sp. E; (51,37; 250 x).

66. *Conochitina* sp. E; (40,275; 250 x).

Plate 3


46


47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54A


* 54B


55A


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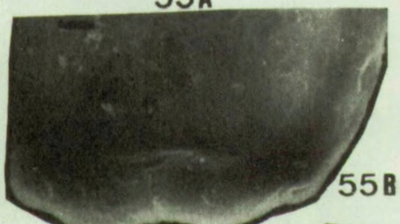
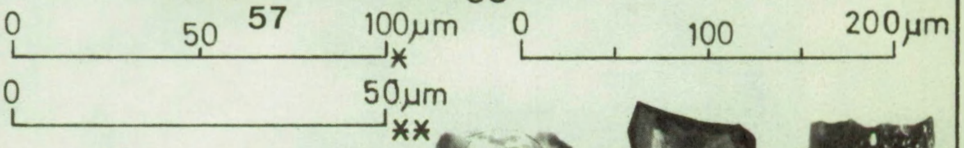
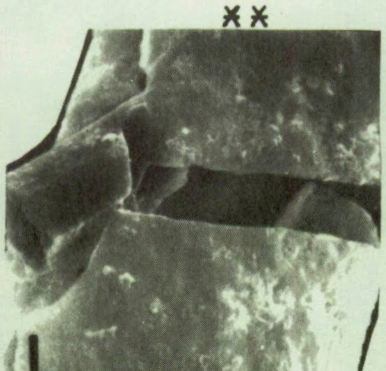

55B *




61


62


63A


** 63B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65


66

PLATE 4.

67. *Conochitina* sp. A; (7,45; 250 x).

68A. *Conochitina* sp. A; (7,1; 250 x).

68B. *Conochitina* sp. A; (7,1; 1000 x) detail of broken tegument at the basal angle and base.

69. *Conochitina* sp. A; (6,11; 250 x).

70. *Conochitina* sp. A; (7,5; 250 x).

71. *Conochitina flamma*; (28,278; 250 x).

72. *Conochitina flamma*; (28,11; 250 x).

73. *Conochitina flamma*; (28,323; 250 x).

74. *Conochitina acuminata*; (28,27; 300 x).

75. *Conochitina acuminata*; (28,14, 500 x).

76. *Conochitina acuminata*; (28,15; 500 x).

77. *Conochitina acuminata*; (9,460; 250 x).

78. *Conochitina acuminata*; (26,46; 250 x).

79. *Conochitina acuminata*; (26,58; 250 x).

80. *Conochitina acuminata*; (26,25; 250 x).

81. *Conochitina acuminata*; (26,28; 250 x).

82. *Conochitina acuminata*; (18,179; 250 x) very small specimen.

83. *Melanosclerites*;(56,-; 500 x).

84. *Cenosphere*; (56,-; 250 x) unique specimen of an artefact formally called "*Linotolypidae*"EISENACK, 1962c, probably coming in from air pollution (REID & ALLITT, 1981).

85. *Conochitina* sp.; (55,1; 250 x).

86. *Conochitina proboscifera*; *forma truncata*; with perforations of probably parasites (28,8; 250 x).

87. *Incertae sedis* sp. A; (7,0; 500 x).

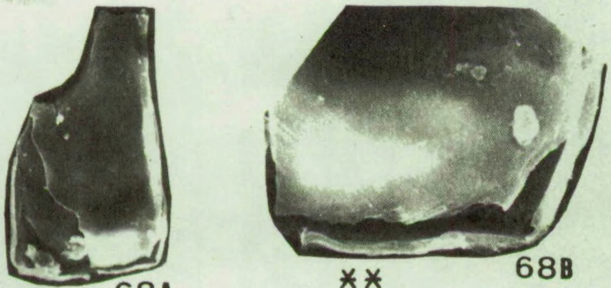
88A. *Tasmanites* ? sp.; (65,3; 250 x).

88B. *Tasmanites* ? sp.; lateral view (65,3; 250 x).

88C. *Tasmanites* ? sp.; lateral view, detail of 88B (65,3; 500 x).

Plate 4


67


68A

68B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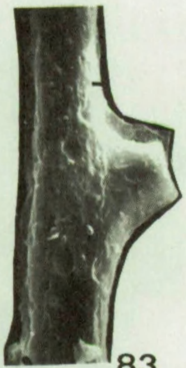
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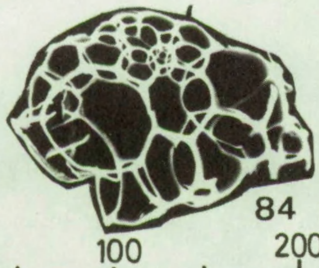
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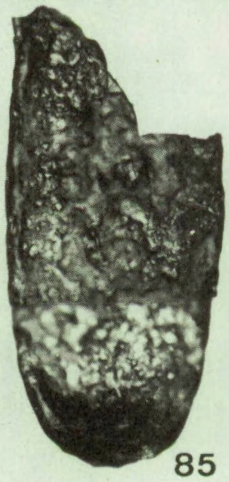
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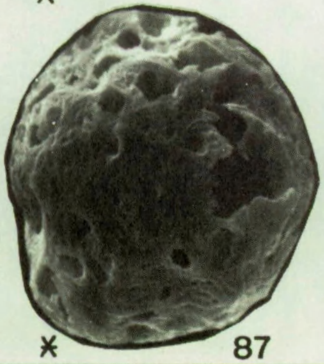
87


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PLATE 5.

89A. *Eisenackitina* sp. A; (round species) (19,3; 250 x).

89B. *Eisenackitina* sp. A; enlarged oblique view on the base (19,3; 500 x).

90. *Eisenackitina* sp. A; round specimen; note the rugose tegument (19,1; 250 x).

91. *Eisenackitina* sp. A; flattened specimen, note the faint concentrical ring ornamentation on the tegument and the protruding mucron (21,21; 250 x).

92. *Eisenackitina* sp. A; (7,37; 250 x).

93. *Eisenackitina* sp. A; note the concentrical ring ornamentation on the chamber around the shoulders as in fig. 94 and 95 (21,209; 250 x).

94. *Eisenackitina* sp. A; (21,105; 250 x).

95. *Eisenackitina* sp. A; note the thick tegument in section at the basal edge, base and mucron and the internal smooth side of the tegument (center) (21,120; 250 x).

96. *Eisenackitina* sp. A; note the thick tegument in section and the very small operculum in the neck (21,205; 250 x).

97. *Eisenackitina* sp. A; (21,113; 250 x).

98. *Eisenackitina* sp. B; (21,209; 250 x).

99. *Eisenackitina* sp. B; note the rugose ornamentation (19,366; 250 x).

100. *Eisenackitina* sp. B; note the concentrical ring ornamentation (19,469; 250 x).

101. *Eisenackitina* sp.; note the operculum and point ornamentation (4,3; 250 x).

102. *Eisenackitina* sp. A; very large specimen (32,116; 250 x).

103. *Eisenackitina* sp. C; (29,8; 250 x).

104. *Eisenackitina* sp. C; with a smooth tegument showing perforations of possibly parasites (7,50; 250 x).

105. *Eisenackitina* sp. C; with a rugose decoration (19,4; 250 x).

106. *Eisenackitina* sp. C; round specimen with a clear operculum (19,7; 250 x).

107. *Eisenackitina* sp. C; felt decoration, operculum (20,4; 250 x).

108. *Eisenackitina* sp. C; felt and point decoration, uplifted operculum (19,399; 250 x).

109. *Eisenackitina* sp. C; point decoration, impression of operculum, very fine collarette (19,502; 250 x).

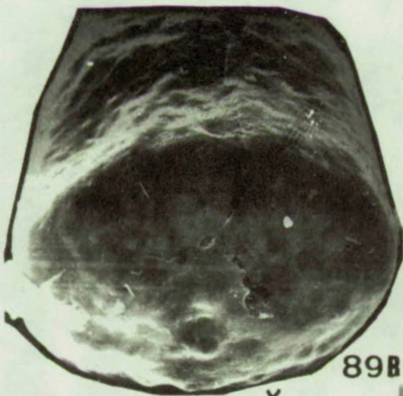
110. *Eisenackitina* sp. C; elongated form with felted decoration around the mucron (19,479; 250 x).

111. *Eisenackitina* sp. C; felt and point decoration (8,370; 250 x).

112. *Eisenackitina* sp. C; point decoration (8,258; 250 x).

Plate 5


89A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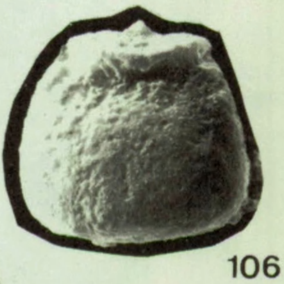
106


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0 100 200μm

0 50 100μm *


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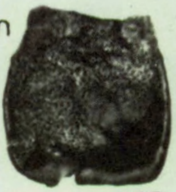
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113

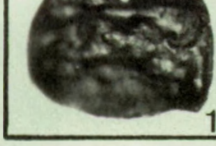
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PLATE 6.

120. *Eisenackitina* sp. C; ornamentation with points and little ridges (19,5; 500 x).

121. *Eisenackitina* sp. C; ornamentation with few small spines (19,5; 500 x).

122. *Cingulochitina cingulata*;(45,3; 500 x).

123. *Cingulochitina* sp. D; (19,18; 500 x).

124. *Eisenackitina* sp. A; (18,27; 500 x).

125. *Cingulochitina* sp. C; (18,44; 500 x).

126. *Cingulochitina convexa*; (56,27; 500 x).

127A. *Cingulochitina convexa*; (56,16; 500 x).

127B. *Cingulochitina convexa*; (56,16; 1000 x).

128. *Cingulochitina odiosa*; (51,75; 250 x).

129. *Cingulochitina* sp. F; large variety (31,13; 250 x).

130. *Cingulochitina* sp. F; large variety (29,329; 250 x).

131. *Cingulochitina* sp. F; small variety (29,291; 250 x).

132. *Cingulochitina* sp. F; small variety (29,48; 250 x).

133. *Cingulochitina* sp. E; (9,19; 250 x).

134. *Cingulochitina* sp. E; (8,280; 250 x).

135. *Cingulochitina* sp. E; (8,283; 250 x).

136. *Cingulochitina* sp. E; chain of 2 specimens (8,442-433; 250 x).

137. *Cingulochitina* sp. E; part of chain of 2 specimens (8,143; 250 x).

113. Eisenackitina sp. C; point and low ridge decoration, small, short specimen (19,375; 250 x).

114. Eisenackitina sp. C; smooth tegument (19,379; 250 x).

115. Eisenackitina sp. C; smooth tegument (20,39; 250 x).

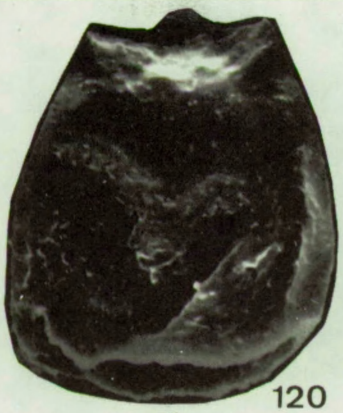
116. Eisenackitina sp. C; rugose decoration; view on the mucron on the base (lower center) (21,95; 250 x).

117. Eisenackitina sp. C; large variety, with operculum and point decoration (8,336; 250 x).

118. Eisenackitina sp. C; large variety, light point decoration with operculum (29,299; 250 x).

119. Eisenackitina sp. C?; smooth tegument (19,439; 250 x).

Plate 6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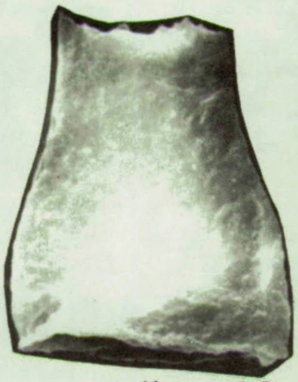
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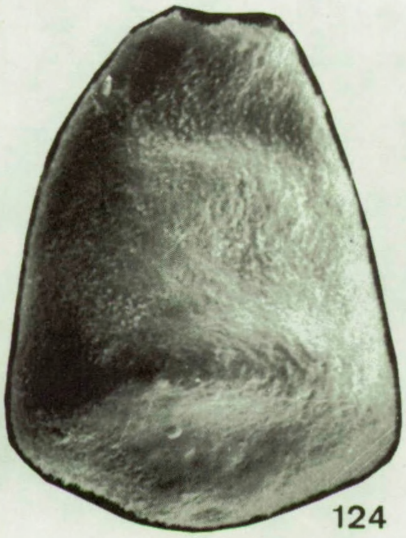
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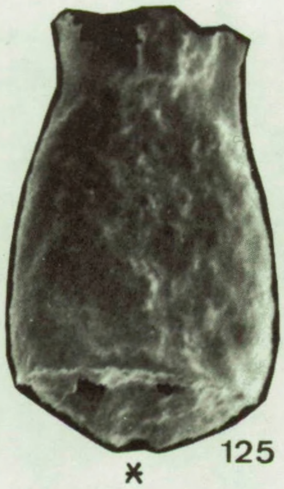
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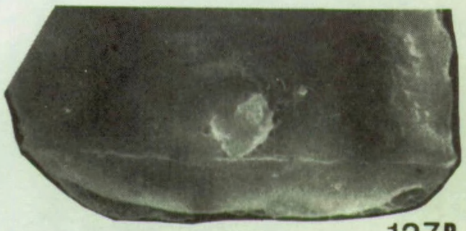
* 127A


** 127B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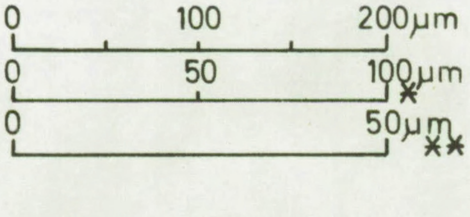


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PLATE 7.

138. *Cingulochitina* sp. A; (9,423; 250 x).
139. *Cingulochitina* sp. A; (9,46; 250 x).
140. *Cingulochitina* sp. A; (9,454; 250 x).
141. *Cingulochitina* sp. A; (19,186; 250 x).
142. *Cingulochitina* sp. A; (9,258; 250 x).
143. *Cingulochitina* sp. B; chain of 2 specimens (29,220-221; 250 x).
144. *Cingulochitina* sp. B; chain with only the base of the second specimen (29,168; 250 x).
145. *Cingulochitina* sp. B; chain with 2 specimens; a slight folding parallel to the longitudinal axis is visible around the neck of the lower specimen (29,331; 250 x).
146. *Cingulochitina* sp. B; (29,283-284; 250 x).
147. *Cingulochitina* sp. B; part of chain of two with the longitudinal folding visible in the neck of both specimens (29,247; 250 x).
148. *Cingulochitina cingulata* (40,0; 500 x).
149. *Cingulochitina* sp. B ?; note the rugose decoration and the very small cingulum at the base near the protruding mucron (10,41; 250 x).
150. *Cingulochitina* sp. B; (1,5; 250 x).
151. *Cingulochitina* sp. B; the longitudinal folding parallel to the longitudinal axis on the chamber (29,243; 250 x).
152. *Cingulochitina* sp. B; (29,70; 250 x).
153. *Cingulochitina* sp. B; (29,314; 250 x).
154. *Cingulochitina* sp. B; (29,134; 250 x).
155. *Cingulochitina* sp. B; chain of two (29,11; 250 x).
156. *Cingulochitina* sp. B; the longitudinal fold-like ornamentation on the neck and body is visible and a section through the tegument at the base with the closed-off mucron (29,12; 500 x).
157. *Cingulochitina cingulata*; (38,7; 250 x).
158. *Cingulochitina cingulata*; (38,21; 250 x).
159. *Cingulochitina cingulata*; (47,182; 250 x).
160. *Cingulochitina cingulata*; (46,46; 250 x).
161. *Cingulochitina cingulata*; (47,23; 250 x).
162. *Cingulochitina cingulata*; (46,57; 250 x).
163. *Cingulochitina cingulata*; (47,56; 250 x).
164. *Cingulochitina cingulata*; (46,36; 250 x).
165. *Cingulochitina cingulata*; (47,158; 250 x).
166. *Cingulochitina cingulata*; (47,156; 250 x).

Plate 7


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200µm
0
50
100µm
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PLATE 8.

191A. *Ancyrochitina* spp.;(group 2) (51,43; 250 x).

191B. *Ancyrochitina* spp.; enlargement showing the base of broken appendices (51,43; 1000 x).

192A. *Ancyrochitina* spp.; (group 3) (7,15; 500 x).

192B. *Ancyrochitina* spp.; enlargement showing the short appendices and broken appendices (7,15; 1000 x).

193. *Ancyrochitina* spp.; (group 1) (9,160; 250 x).

194. *Ancyrochitina* spp.; (group 1) (51,232; 250 x).

195. *Ancyrochitina* spp.; (group 1) (50,77; 250 x).

196. *Ancyrochitina* spp.; (group 2) (18,190; 250 x).

197. *Ancyrochitina* spp.; (group 2) (18,-; 250 x).

198. *Ancyrochitina* spp.; (group 3) (19,51; 250 x).

199. *Ancyrochitina* spp.; (group 3) (18,-; 250 x).

200. *Sphaerochitina* sp. A; (19,36; 250 x).

201. *Sphaerochitina* sp. A; (19,39; 250 x).

202. *Sphaerochitina* sp. A; (19,3; 250 x).

203. *Sphaerochitina* sp. A; (20,27; 250 x).

204. *Sphaerochitina* sp. A; (19,473; 250 x).

205. *Sphaerochitina* sp. A; (17,81; 250 x).

206. *Sphaerochitina* sp. B; (19,29; 500 x).

207. *Sphaerochitina* sp. B; (40,1; 500 x).

208. *Sphaerochitina* sp. A; (19,486; 250 x).

209. *Sphaerochitina* sp. A; (19,503; 250 x).

210. *Sphaerochitina* sp. A; (13,3-6; 250 x).

211. *Sphaerochitina* sp. B; (10,21; 250 x).

212. *Sphaerochitina* sp. B; (8,293; 250 x).

213. *Sphaerochitina* sp. B; (9,44; 250 x).

214. *Sphaerochitina lycoperdoides*; (77,-; 250 x).

215. *Sphaerochitina lycoperdoides*; (51,-; 250 x), partly broken specimen.

216. *Sphaerochitina* spp.; (19,476; 250 x).

217. *Sphaerochitina* spp.; (8,354; 250 x).

218. *Sphaerochitina* spp.; (21,97; 250 x).

219. *Sphaerochitina* spp.; (19,475; 250 x).

167. Cingulochitina cingulata; (47,73; 250 x).

168. Cingulochitina cingulata; (47,188; 250 x).

169. Cingulochitina cingulata; chain of two (40,20; 250 x).

170. Cingulochitina sp. C; fragment of specimen showing the prosome sticking out of the pseudostome (18,554; 250 x).

171. Cingulochitina sp. C; (19,14; 275 x).

172. Cingulochitina sp. C; (12,59; 250 x).

173. Cingulochitina sp. C; (18,186; 250 x).

174. Cingulochitina sp. C; (13,3; 250 x).

175. Cingulochitina sp. C; (12,35; 250 x).

176. Cingulochitina sp. C; (14,3; 250 x).

177. Cingulochitina sp. C; (12,132; 250 x).

178. Cingulochitina sp. C; (18,12; 250 x).

179. Cingulochitina sp. C; (12,58; 250 x).

180. Cingulochitina sp. C; (12,56; 250 x).

181. Cingulochitina sp. C; (12,16; 250 x).

182. Cingulochitina sp. C; (11,105; 250 x).

183. Cingulochitina sp. D; (11,102; 250 x).

184. Cingulochitina sp. D; (19,24; 250 x).

185. Cingulochitina sp. D; (19,193; 250 x).

186. Cingulochitina sp. D; (18,264; 250 x).

187. Cingulochitina sp. D; (12, 151; 250 x).

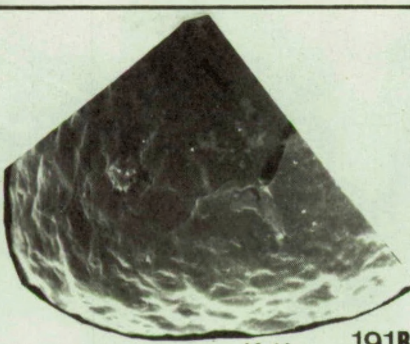
188. Cingulochitina sp. D; (18,178; 250 x).

189. Cingulochitina sp. D; (13,266; 250 x).

190. Cingulochitina sp. D; (12,38; 250 x).

Plate 8


* 191A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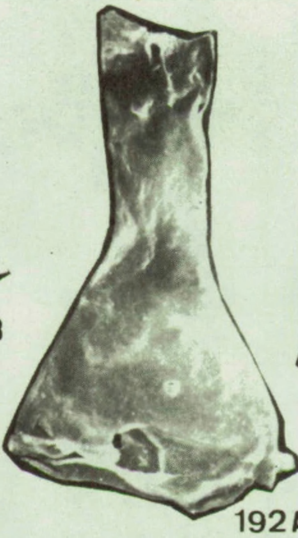
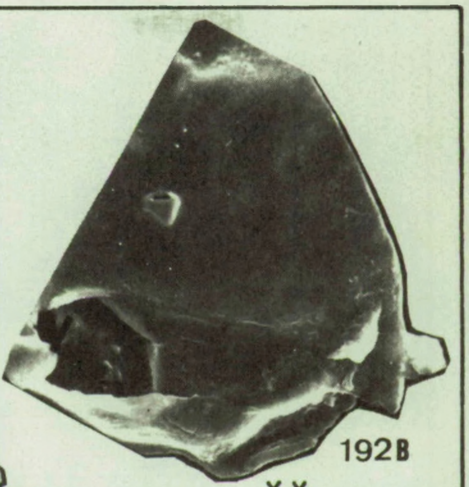

192A


192B **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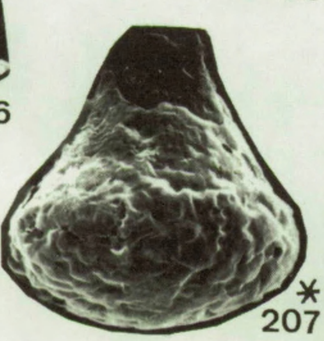
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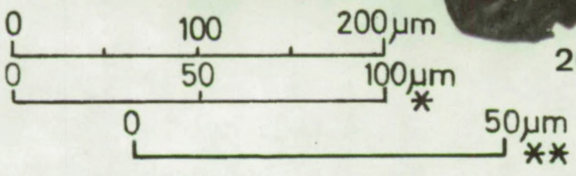


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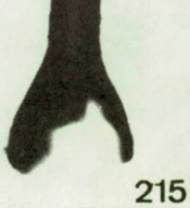
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PLATE 9.

220. *Gotlandochitina corniculata*; (16,8; 250 x).
221. *Gotlandochitina corniculata*; (18,30; 250 x).
222. *Gotlandochitina corniculata*; (16,38; 250 x).
223. *Gotlandochitina* aff. *G. corniculata*; (18,328; 250 x).
224. *Gotlandochitina* aff. *G. corniculata*; (20,2; 250 x).
225. *Desmochitina opaca*; (28,31; 350 x).
226. *Desmochitina opaca*; (28,267; 250 x).
227. *Margachitina margaritana*; (28,134; 250 x).
228. *Margachitina margaritana*; (26,23; 250 x).
229. *Margachitina margaritana*; (28,38; 500 x).
230. *Angochitina longicollis*; (28,44; 250 x).
231. *Angochitina longicollis*; (8,288; 250 x).
232. *Angochitina longicollis*; (28,61; 250 x).
233. *Angochitina longicollis*; (20,19; 250 x).
234. *Angochitina longicollis*; (28,89; 250 x).
235. *Angochitina longicollis*; (8,277; 250 x).
236. *Angochitina longicollis*; (8,269; 250 x).
237. *Angochitina longicollis*; (8,399; 250 x).
238. *Angochitina* sp. B; (20,45; 250 x).
239. *Angochitina* sp. B; (28,144; 250 x).
240. *Angochitina* sp. B; (28,28; 500 x).
241. *Cyathochitina* spp.; (1,6; 250 x).
242. *Desmochitina minor*; (1,1; 250 x).
243. *Angochitina* sp. A; (9,174b; 250 x).
244. *Angochitina* sp. A; (9,181; 250 x).
245. *Angochitina* sp. A; (25,26; 250 x).

Plate 9


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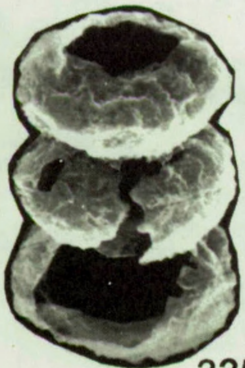
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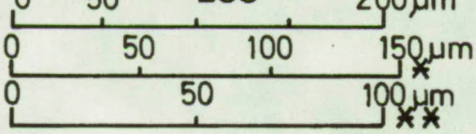


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