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Lower Silurian Graptolites from Southwestern Sardinia

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ABSTRACT – Forty-four graptolite taxa are recognized from Llandovery black shales of Genna Muxerru Formation from SW Sardinia. Most of the taxa are described and illustrated and only some are left in open nomenclature. One family (Normalograptidae) and three species (Neodiplograptus lanceolatus, Glyptograptus cortoghianensis, Streptograptus loydelli) are proposed as new. Six (possibly seven) graptolite biozones have been recognized enabling us to compile the first graptolite zonal scheme for SW Sardinia and to correlate this scheme with those from SE Sardinia and abroad.

RIASSUNTO – [Graptoliti del Siluriano inferiore della Sardegna sud-occidentale] – Negli scisti neri Llandovery della Formazione di Genna Muxerru affiorante nella Sardegna sudoccidentale sono stati identificati quarantaquattro taxa di graptoliti la maggior parte dei quali sono stati descritti ed illustrati. Solo gli esemplari insufficientemente conservati sono stati lasciati in nomenclatura aperta. Una famiglia (Normalograptidae) e tre specie (Neodiplograptus lanceolatus, Glyptograptus cortoghianensis, Streptograptus loydelli) vengono proposte come nuove. Le diverse associazioni identificate sono state riunite in almeno sei biozone che hanno permesso di compilare il primo schema zonale a graptoliti per la Sardegna sudoccidentale e di correlarlo con quello della Sardegna sudorientale, della Boemia e delle Isole Britanniche.

INTRODUCTION AND GEOLOGICAL SETTING

Lower Silurian rocks are not particularly widespread in south-west Sardinia and belong either to autochthonous or to allochthonous/parautochthonous structural units. The autochthonous Lower Silurian rocks are a minor part of the thick post-sardic sequence and were described and formally defined as the Genna Muxerru Formation by Gnoli *et al.* (1990). The formation consists of a rather monotonous sequence of black carbon – and pyrite – rich graptolitic shales, most of them affected by cleavage, complicated faulting and small-scale folding. As a result of contact metamorphism by the nearby granites, the shales are altered locally to chiastolite slates. The Genna Muxerru Formation has a maximum thickness of at least 30 m in its type area, in which only incomplete upper Llandovery (Telychian) strata are as yet well documented by graptolites. Gnoli *et al.* (1990) proposed a slightly lower thickness. The estimated thickness in the isolated exposures of the sequence, representing different graptolite zones, accounts for the greater thickness recognized herein.

The lower boundary of the formation with the top of the underlying Rio San Marco Fm. is never clearly exposed but, at the present stage of our knowledge, there is no evidence of discontinuity in sedimentation between the Ordovician and Siluro-Devonian sequences. Furthermore, the late Hirnan-

tian age of the uppermost member (Girisi Mb.) of the Rio San Marco Fm. (Leone *et al.*, 1991) is in good agreement with the occurrence of the *Par. acuminatus* Biozone in the lowermost beds of the Genna Muxerru Formation. The upper boundary is also poorly exposed and seems to grade into the interbedded dark limestones and shales of the overlying Fluminimaggiore Formation (Gnoli *et al.*, 1990).

Silurian rocks (including black shales) cropping out in the northern part of southwestern Sardinia (Capo Frasca area) are considered to belong to the same formations (owing to the identical lithology) but to be parautochthonous or allochthonous in position. Therefore they are regarded to be, respectively, in a tectonic window below the Arburese Unit or part of a tectonic subunit (Donigala Subunit) of the Arburese Tectonic Unit (Barca *et al.*, 1992).

Llandovery graptolites from SW Sardinia were first reported by Taricco (1922). He listed «*Rastrites*» *peregrinus*, *Diplograptus palmeus*, *Diplograptus ovatus*, *Climacograptus rectangularis* and several monograptids but no illustrations have been given. Quite rich Llandovery graptolite faunas were recorded by Jaeger (1975) and Barca & Jaeger (1990) from SE Sardinia. The latter authors recognised 7 graptolite zones in the Llandovery sequence there.

In SW Sardinia Gnoli *et al.* (1990) documented five graptolite zones representing most of the Llan-



Text-fig. 1 - Detailed maps showing location of the main fossiliferous outcrops. GQX = Genna Quadroxius, CF = Cantoniera Flumini, TM = Terra Murus, GMX = Genna Muxerru, MCB = Monte Cortoghiana Becciu.

doverly, except for its uppermost part. Further collecting of Llandovery graptolites in SW Sardinia has enabled us to describe 44 graptolite taxa here, three of which are new. Some of the species are left in open nomenclature due to insufficient and/or poorly preserved material. Other taxa, represented by material too poor to be described and figured are listed only in the following faunal lists, and are prefixed with a question mark.

Several of the graptolite associations identified have enabled us to recognise at least six graptolite biozones, to compile the first graptolite zonal scheme for SW Sardinia, and to correlate this scheme with those from SE Sardinia and abroad (Text-fig. 2).

A major difficulty in defining zones in SW Sardinia is that the upper and/or lower limits of the zones cannot be delimited accurately due to poor exposure and, often, strong tectonic deformation. No

continuous section going through any two adjoining graptolite zones is available. Furthermore, the graptolite assemblages came from often rather thin, commonly lenticular bodies of less tectonically affected shales. In these conditions it is impossible to use taxon range-zones based on particular index-species only. A very precise system of various taxon range-zones is appropriate for good, well exposed, continuous sections with common and well-preserved graptolites. This, however, is not the case in SW Sardinia.

We have recognised assemblage zones, graptolite zones distinguished by their total graptolite content with particular importance attached to some characteristic short-ranged, age-diagnostic species. Zones are named after a widely used zonal-index taxon. At some locality the index species may be absent. The most important feature is the presence of a zone-diagnostic graptolite assemblage.

Zonal boundaries of an assemblage zone are subjective and far from precisely defined. Major inaccuracy, however, may result from insufficient exposure, lower graptolite abundance and/or poor preservation, and due to tectonic deformation of the fossiliferous beds. In practice, assemblage zones are recognisable in the field, and can be easily correlated, although not with the greatest accuracy.

LOCALITIES AND GRAPTOLITE ASSEMBLAGES

Twelve fossiliferous localities containing lower, middle, and upper Llandovery graptolites have been collected from three outcrop areas in SW Sardinia (Text-fig. 1). Most of the Llandovery is documented by the present material. Only the *Monograptus sedgwickii* Zone (upper middle Llandovery) and *Monograptus spiralis* - *Stomatograptus grandis* zones (uppermost Llandovery) have not yet been recorded (Text-fig. 2).

The lowermost Llandovery (Rhuddanian) is well exposed at several localities at Monte Cortoghiana Becciu (MCB 1-4) in the Barbusi - Caput Aquas area. The lower and middle Llandovery is exposed, although it is very badly affected by cleavage, at many places in the vicinity of Fluminimaggiore. Graptolites well enough preserved to be determined were found at Genna Quadroxius (GQX), Cantoniera Flumini (CF), and Terra Murus (TM A-C). Upper Llandovery strata (Telychian) are widely exposed at Genna Muxerru hill, SW of Gonnosfandiga (GMX A, F, P).

MONTE CORTOGHIANA BECCIU (MCB) (Text-fig. 1c)

In a road-cutting and in the fields E and SE of Monte Cortoghiana Becciu, thinly-bedded siliceous

black shales are weakly affected by tectonics. They are exposed at four places and yield rich assemblages of well preserved graptolites of the *Parakidograptus acuminatus* Zone. The fossiliferous localities are labelled MCB 1-4, on Text-fig. 1 c.

List of graptolites (a = abundant, u = uncommon, r = rare):

MCB 1 - road cutting.	
<i>Normalograptus angustus</i> (Perner)	- u
<i>Normalograptus</i> sp. B	- r
<i>Normalograptus trifilis</i> (Manck)	- r
? <i>Normalograptus normalis</i>	- r
<i>Neodiplograptus lanceolatus</i> n. sp.	- a
<i>Akidograptus ascensus</i> Davies	- a
? <i>Parakidograptus acuminatus</i>	- r

MCB 2 - field SE of Monte Cortoghiana Becciu.

<i>Normalograptus angustus</i> (Perner)	
<i>Normalograptus trifilis</i> (Manck)	
<i>Neodiplograptus lanceolatus</i> n. sp.	
<i>Akidograptus ascensus</i> Davies	
<i>Parakidograptus acuminatus</i> (Nicholson)	

MCB 3 - field SE of Monte Cortoghiana Becciu.

<i>Normalograptus angustus</i> (Perner)	- u
<i>Normalograptus normalis</i> (Lapworth)	- u
<i>Normalograptus trifilis</i> (Manck)	- a
<i>Neodiplograptus lanceolatus</i> n. sp.	- a
<i>Neodiplograptus parajanus</i> (Štorch)	- u
<i>Neodiplograptus</i> cf. <i>parajanus</i> (Štorch)	- r
<i>Glyptograptus cortoghianensis</i> n. sp.	- r
<i>Cystograptus ancestralis</i> Štorch	- u
<i>Akidograptus ascensus</i> Davies	- u
<i>Parakidograptus acuminatus</i> (Nicholson)	- u
(some fragments of dendroid graptolites were recorded).	

MCB 4 - field SSE of Monte Cortoghiana Becciu

<i>Normalograptus angustus</i> (Perner)	- u
<i>Normalograptus normalis</i> (Lapworth)	- r
<i>Normalograptus medius</i> (Törnquist)	- u
(in a restricted interval)	
<i>Normalograptus trifilis</i> (Manck)	- a
<i>Normalograptus</i> sp. A	- r
<i>Neodiplograptus lanceolatus</i> n. sp.	- a
<i>Neodiplograptus parajanus</i> (Štorch)	- u
<i>Neodiplograptus</i> cf. <i>parajanus</i> (Štorch)	- r
<i>Neodiplograptus diminutus apographon</i> (Štorch)	- r
<i>Glyptograptus cortoghianensis</i> n. sp.	- r
<i>Cystograptus ancestralis</i> Štorch	- u
<i>Akidograptus ascensus</i> Davies	- r
<i>Parakidograptus acuminatus</i> (Nicholson)	- a

chrono stratigraphy		SW- Sardinia					graptolite zonal schemes of some selected areas		
series	stage	lithostratigraphy	biostratigraphy (graptolite zones)	stratigraphic intervals dated by graptolites			SE-Sardinia	Bohemia (Prague Basin)	British Isles
				Monte Cortoghiana Becchi	Fluminimaggiore area	Genna Muxerru			
LLANDOVERY		TELYCHIAN					after Barca-Jaeger (1990)	after Štorch (1991)	after Rickards (1976)
			?				<i>spiralis</i>	<i>grandis</i>	(?)
			<i>griestoniensis</i>				<i>griestoniensis</i>	<i>spiralis</i>	<i>crenulata</i>
			? <i>crispus</i>				? <i>crispus</i>	<i>tullbergi</i> formerly <i>crenulata</i>	
			<i>turriculatus</i>				<i>turriculatus</i>	<i>griestoniensis</i>	<i>griestoniensis</i>
							<i>linnaei</i>	<i>crispus</i>	<i>crispus</i>
			?				?	<i>triangulatus</i>	<i>turriculatus</i>
			<i>convolutus</i>				<i>convolutus</i>	<i>linnaei</i>	<i>maximus</i>
								<i>sedgwickii</i>	<i>sedgwickii</i>
			?				<i>gregarius</i>	<i>convolutus</i>	<i>convolutus</i>
AERONIAN		Genna Muxerru Formation	<i>triangulatus</i>					<i>simulans</i> formerly <i>pribyli</i>	<i>argenteus</i>
			<i>vesiculosus-cyphus</i>				?	<i>pectinatus - turriculatus</i>	<i>magnus</i>
								<i>cyphus</i>	<i>tringulatus</i>
			<i>acuminatus</i>				<i>vesiculosus</i>	<i>acuminatus - ascensus</i>	<i>cyphus</i>
									<i>acinales</i>
									<i>atavus</i>
RHUDDANIAN									<i>acuminatus</i>



well dated interval



poorly dated interval

Text-fig. 2 - Stratigraphy and correlation of the Llandovery of SW Sardinia.

TERRA MURUS (TM) (Text-fig. 1a)

Small exposures occur in road-cuttings and in pastures ENE of Fluminimaggiore. Soft, argillaceous, partly bleached, carbon-rich shales are heavily tectonised, disrupted by numerous thin quartz-veins and/or partly silicified. Furthermore, they are often affected by cleavage. Brown-black phosphorite nodules, up to 20 cm in diameter, were recorded rarely. Graptolites are abundant locally but are mostly damaged by faulting and cleavage. They represent the lower Llandovery (*Parakidograptus acuminatus* - *Coronograptus cyphus* zones) and lower-most middle Llandovery (*Demirastrites triangulatus* Zone).

TM A - small exposure in the sloping pasture below the road

Normalograptus cf. *normalis* (Lapworth)
 ? *Neodiplograptus* sp.
Rhaphidograptus toernquisti (Elles & Wood)
Demirastrites triangulatus (Harkness)

TM B - road-cutting just above the crossroads

Normalograptus angustus (Perner)
Akidograptus ascensus Davies
Parakidograptus acuminatus (Nicholson)

TM C - road-cutting on road to Mason Porcus, 100 m above TM B

Normalograptus normalis (Lapworth)
 ? *Neodiplograptus elongatus*
Cystograptus vesiculosus (Nicholson)
Rhaphidograptus toernquisti (Elles & Wood)
Coronograptus cf. *cyphus* (Lapworth)
 ? *Atavograptus atavus*

CANTONIERA FLUMINI (CF) (Text-fig. 1a)

In the road-cutting above the Cantoniera W of Fluminimaggiore to Corti Baccas (CF), soft brown-grey shales are exposed, with graptolites deformed by cleavage parallel to the bedding. They are lower Llandovery in age. The graptolites can be referred to *Normalograptus normalis* (Lapworth) and, rarely, to ? *Cystograptus vesiculosus*.

GENNA QUADROXIUS (GQX) (Text-fig. 1a)

Small exposures on a bushy slope, below the HV electric line N of the road from Fluminimaggiore to Portixeddu, of soft, partly bleached, weathered shales, very badly affected by cleavage, contain common but mostly indeterminable graptolites of middle Llandovery age. Some better-preserved

specimens found at several localities indicate the presence of the *Demirastrites triangulatus* to *Demirastrites convolutus* zones. The presence of the *Coronograptus cyphus* Zone is also probable. The graptolites listed probably comprise several assemblages which have not yet been separated in this tectonically complex locality.

Normalograptus cf. *normalis* (Lapworth)
Neodiplograptus cf. *thuringiacus* (Kirste)
Rhaphidograptus toernquisti (Elles & Wood) - a
 (well determinable)
Petalograptus sp. A
Atavograptus cf. *gracilis* Hutt - a
 ? *Coronograptus cyphus*
 ? *Pristiograptus regularis*
Monograptus lobiferus (Mc Coy) - a
 ? *Monograptus* ex gr. *austerus*
Campograptus cf. *millepeda* (Mc Coy)
 ? *Demirastrites triangulatus*
 ? *Demirastrites pectinatus*
 ? *Demirastrites convolutus*
Rastrites cf. *approximatus* Perner
 ? *Rastrites peregrinus*

GENNA MUXERRU (GMX) (Text-fig. 1b)

In road-cuttings on the steep slopes above Riu Guturru and Riu Piras, in the vicinity of Genna Muxerru hill S of Gonnosfanadiga, are cropping out black carbon-rich and pyrite-rich shales, to a greater or lesser extent affected by cleavage. Several metres of black very fine-grained greywacke are locally present (GMX A). Locally, the sequence is weakly influenced by contact metamorphism which has altered the graptolitic shales to chistolitic spotted slates. Rarely, the graptolites are partly infilled by pyrite and are preserved in partial relief.

GMX A - road cutting on the slope to the W of Riu Guturru Creek, just opposite the top of Genna Muxerru. Graptolites are preserved in black very fine-grained greywackes.

Petalograptus tenuis (Barrande)
 ? *Pseudoplegmatozograptus obesus*
Pristiograptus variabilis (Perner)
Monograptus cf. *marri* Perner
Monograptus proteus (Barrande)
Streptograptus cf. *storchi* Loydell
 ? *Streptograptus exiguus*
Spirograptus turriculatus (Barrande)
 (uncommon, and mostly fragmentary, dendroids - *Dictyonema* sp. - and minute, probably orbiculoid, brachiopods are present).

GMX F - road-cutting on W slope of Genna Muxerru hill, above Riu Piras.

Petalograptus tenuis (Barrande)
 ? *Petalograptus altissimus*
Pristiograptus cf. *bjerringus* (Bjerreskov) - a
Pristiograptus variabilis (Perner) - from the lower
 part of the exposure.
 ? *Pristiograptus pristinus*
Monograptus cf. *marri* Perner
Monograptus planus (Barrande)
 ? *Streptograptus plumosus* (= *primulus* Bouček &
 Přibyl) - from the lower part of the exposure.
Spirograptus turriculatus (Barrande) - a
 ? *Spirograptus minor* - rare in the lower part of the ex-
 posure.
Rastrites carnicus Seelmeier - from the lower part of
 the exposure.
Rastrites cf. *schauei* Štorch & Loydell
 (rare dendroid rhabdosomes of *Dictyonema* sp. and
 flattened orthoconic nautiloid shells are present).

GMX F - road-cutting about 60 m below the ex-
 posure described above.

Monograptus cf. *arcuatus* Bouček
Monograptus veles (Richter) - a
 ? *Monograptus crispus*
 ? *Streptograptus exiguus*

GMX P - eastern slope of Genna Muxerru, rocky ex-
 posure about 60 m above Riu Guturru Fenugu.

Retiolites geinitzianus angustidens (Elles & Wood) - a
Pristiograptus initialis Kirste - u
 ? *Monograptus arcuatus* - r
Monograptus cf. *contortus* Perner - r
Monograptus pragensis pragensis (Přibyl) - r
Monograptus priodon (Bronn) - u
Monograptus cf. *speciosus* Tullberg - u
 ? *Monograptus* sp. (with flexuous rhabdosome) - u
Monoclimacis griestoniensis (Nicol) - a
Streptograptus loydelli n. sp. - a
 (uncommon flattened nautiloid shells and one
 conulariid theca were recorded).

BIOSTRATIGRAPHY AND CORRELATION

Parakidograptus acuminatus Zone

The lowermost Llandovery is represented in SW Sardinia by a rich graptolite assemblage of the *acuminatus* Zone which is one of the best yet known. In some areas, e.g. in Bohemia (Štorch, 1986), Germany (Stein, 1965; Jaeger, 1988), and Sweden (Nilsson, 1984), an independent *Akidograptus ascensus* Zone is recognised in the lower part of the *acuminatus* Zone. *Par. acuminatus* appears there well above the first occurrence of *A. ascensus* although the accompanying assemblage changes gradually through the whole interval.

In SW Sardinia the *acuminatus* Zone represents the whole of the interval although. *A. ascensus* is much more abundant than *Par. acuminatus* in the lower part of the zone, the reverse obtaining in the upper part. The *Par. acuminatus* Zone is treated as an assemblage zone by us.

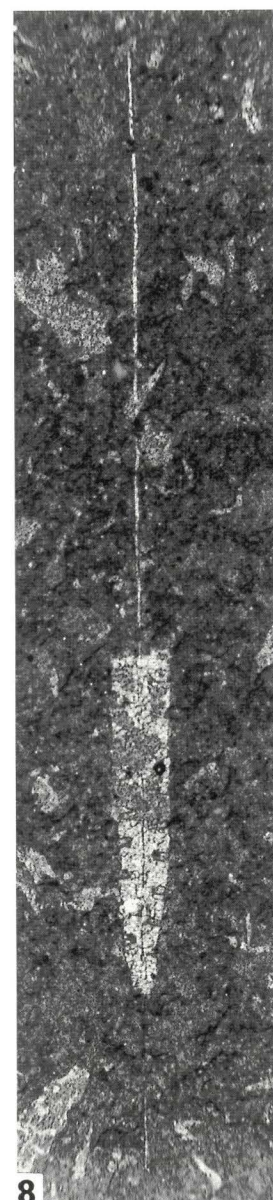
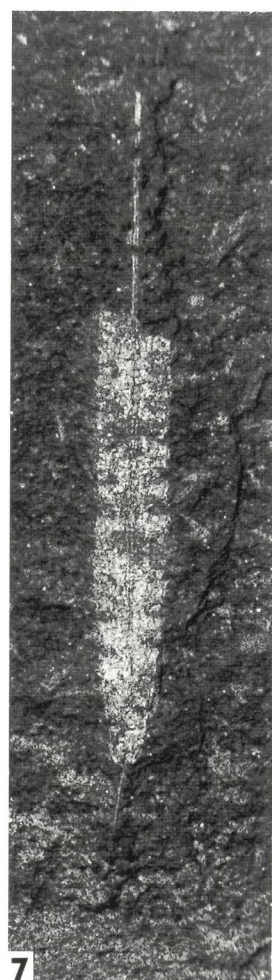
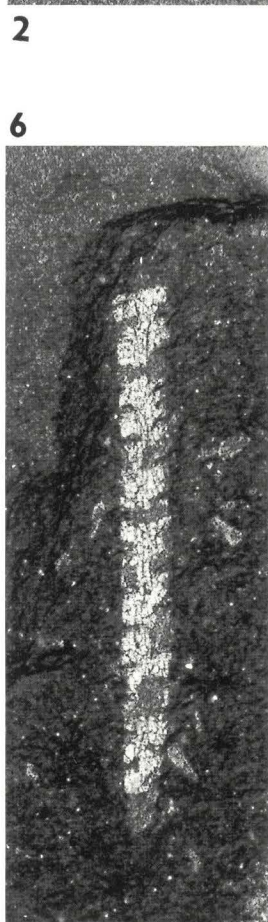
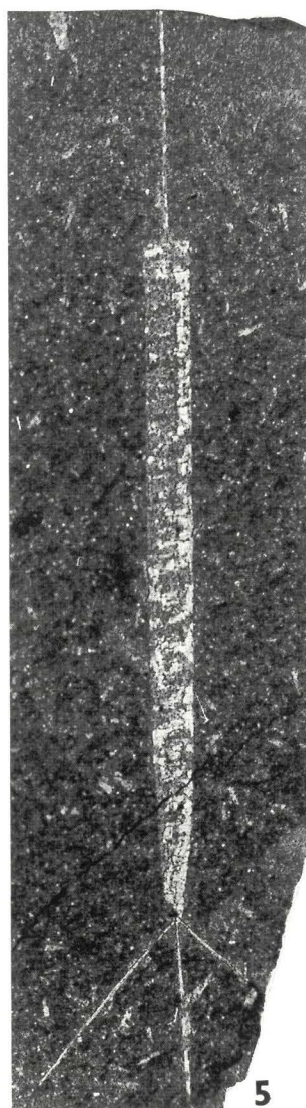
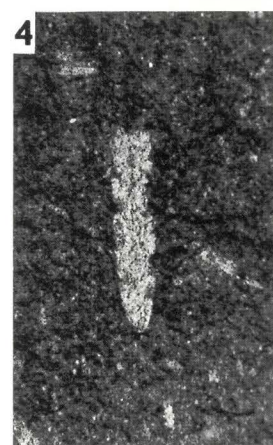
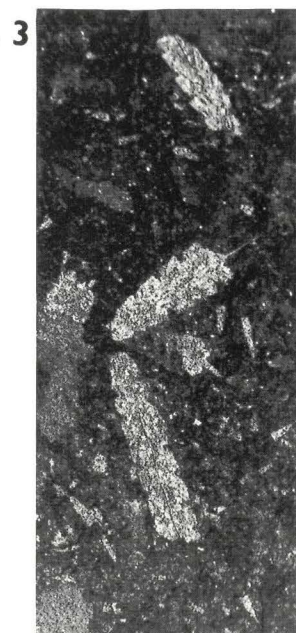
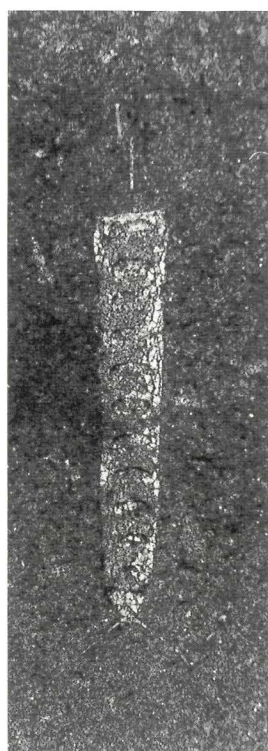
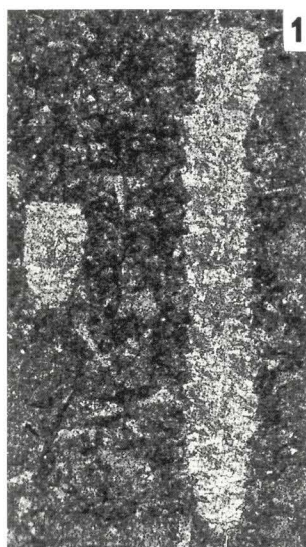
The lower, probably not the lowermost, part of the zone is considered to be exposed at MCB 1, where the graptolitic shales crop out just beside the upper Ordovician mudstones, being separated only by a thin tectonised interval. There *A. ascensus* is common whilst *Par. acuminatus* has not yet been recorded with certainty. The presence of *Norm. trifilis* indicates, in accordance with the graptolite associations and sections described by Štorch (1986), Stein (1965), and Rickards (1988), the middle rather than the lowermost part of the *acuminatus* Zone (*sensu* Rickards 1988) and/or the upper *ascensus* Zone (*sensu* Štorch, 1988a).

The graptolite assemblage of MCB 3, characterised by common *Par. acuminatus* and *Norm. trifilis*, and by the appearance of *Cyst. ancestralis* and *Neodipl. parajanus*, is nearly identical to that of Bohemian *ascensus/acuminatus* boundary beds. The beds exposed by MCB 4 correspond to the upper part of the Bohemian *acuminatus* Zone based upon

EXPLANATION OF PLATE 1

- Fig. 1 - *Neodiplograptus diminutus apographon* (Štorch), n. 22464.
 Figs. 2, 5 - *Normalograptus trifilis* (Manck), 2) n. 22486, 5) n. 22402.
 Figs. 3, 4, ?6 - *Normalograptus angustus* (Perner), 3) n. 22485, specimens up and down the picture; 4) n. 22470, ?6) n. 22489.
 Fig. 7 - *Normalograptus* cf. *normalis* (Lapworth), n. 22466.
 Figs. 3, 8 - *Normalograptus normalis* (Lapworth), 3) n. 22485, rhabdosome in the centre; 8) n. 22475a.

All specimens from the *acuminatus* Zone of Monte Cortoghiana Becciu (MCB 3 - figs. 5, 7, 8; MCB 4 - figs. 1-4, 6). Figs. 1-4, 6-8, x 5; fig. 5, x 3.



the occurrence of *Neodipl. diminutus apographon* and the gradual retreat of *Neodipl. lanceolatus* and *A. ascensus*.

Neodipl. lanceolatus sp. n. is a common and characteristic species restricted to the *acuminatus* Zone (in the present sense) of the whole of Gondwanan Europe. It is common in Bohemia (Storch, 1983, 1986), Germany (Schauer, 1971), Spain (Jaeger & Robardet, 1979), and in SW Sardinia. It was assigned to *Neodipl. modestus* by the above authors.

The Sardinian graptolite assemblage of the *acuminatus* Zone is most similar to the coeval assemblage in Bohemia. The same species are dominant and/or common (*Norm. angustus*, *Norm. trifilis*, *Neodipl. lanceolatus*, *A. ascensus*, *Par. acuminatus*) and the same species are uncommon or rare (*Cyst. ancestralis*, *Neodipl. parajanus*, *Neodipl. diminutus apographon*, minute glyptograptids). The thickness of the *acuminatus* Zone in SW Sardinia is greater than that in the other sequences of Gondwanan Europe. At Monte Cortoghiana Becciu (MCB 1-4), where both the lowermost part and the uppermost part of the zone remain unknown, the thickness exceeds 2-3 m.

Cystograptus vesiculosus - *Coronograptus cyphus* Zone

Higher parts of the lower Llandovery (Rhuddanian) are partly exposed at Terra Murus (TM C) and, probably, at Genna Quadroxius (GQX). There *C. cf. cyphus* occurs together with *Cyst. vesiculosus* on the same bedding plane. Another fragmentary monograptid, similar to *A. atavus* occurs, as well as common *Norm. normalis*, and rare *Rh. toernquisti* and ? *Neodipl. elongatus*. We refer the assemblage containing the index species of the two adjoining zones to the combined *Cyst. vesiculosus* - *C. cyphus* Zone (assemblage zone).

In SE Sardinia Jaeger (1975) and Barca & Jaeger (1990) combined the *Cyst. vesiculosus* Zone with the *Par. acuminatus* Zone into one zone defined by the first occurrence of *Cyst. vesiculosus*. In their *Cyst. vesiculosus* Zone the index species was accompanied by *Par. acuminatus*, *A. ascensus*, *Norm. angustus* (= *Cl. scalaris miserabilis*) and *Neodipl. lanceolatus* (= *Dipl. modestus* in their sense). The assemblage is typical of the *Par. acuminatus* Zone except for the supposed presence of *Cyst. vesiculosus*. The material referred by Jaeger (1976) and Barca & Jaeger (1990) to *Cyst. vesiculosus* may, however, represent *Cyst. ancestralis*, which commonly accompanies *Par. acuminatus* and *A. ascensus*. *Cyst. vesiculosus* and *Cyst. ancestralis* could well be confused if determined on the basis of juvenile, fragmentary or poorly preserved specimens. Our specimens of *Cyst. vesiculosus* have been found in a clearly different association.

Demirastrites triangulatus Zone

The basal part of the middle Llandovery (Aeronian) is poorly exposed at Terra Murus (TM A). The zonal-index species, *Dem. triangulatus*, is associated with few other species and, despite the absence of the usual highly diverse assemblage characteristic of this interval, we have been able to recognise the *Dem. triangulatus* Zone (assemblage zone).

Barca and Jaeger (1990) recognised the *C. gregarius* Zone in the middle Llandovery of SE Sardinia. We have not yet found *C. gregarius* in SW Sardinia and have named the interval after the well-determined and widely used zonal-index species *Dem. triangulatus*.

Demirastrites convolutus Zone

Much of the middle Llandovery is exposed at Genna Quadroxius. Partly weathered and bleached shales, very badly folded, faulted and cleaved, contain common, but poorly preserved, graptolites which yield little data allowing recognition of zonal assemblages. Some specimens referred to *Dem. triangulatus*, *Dem. pectinatus*, *M. ex gr. austerus*, *Rh. toernquisti* and *Pet. ex gr. ovatoelongatus* (sp. A) indicate the presence of the *Dem. triangulatus* and *Dem. pectinatus* zones. Other species (*Neodipl. cf. thuringiacus*, *M. lobiferus*, *Camp. cf. millepeda*, ? *Dem. convolutus*, *R. cf. approximatus*, ? *R. peregrinus*) provide evidence of the presence of the *Dem. convolutus* Zone. We thus are able to recognise the *convolutus* Zone in SW Sardinia as were Barca and Jaeger (1990) in SE Sardinia.

Spirograptus turriculatus Zone

The lowermost part of the upper Llandovery (Telychian) is exposed extensively at Genna Muxerru (GMX A, F). The shales are often so cleaved that the graptolites are indeterminable, except for the characteristically spirally coiled *S. turriculatus*. There are three stratigraphic levels recognisable by their graptolite assemblages.

The graptolite assemblage from GMX F locality may be compared with that from the richly fossiliferous boundary beds between the *R. linnaei* and *S. turriculatus* zones in Bohemia. The lowest beds of GMX F may, on the basis of the presence of *R. carnicus* and *R. cf. schaueri*, correspond to the uppermost part of the *linnaei* Zone.

The overlying beds, probably the boundary beds between the *linnaei* and *turriculatus* zones, are characterised by a mixed assemblage of species known either from the *linnaei* Zone or from the *turriculatus* Zone. *Monograptus planus*, *Pristiograptus variabilis*, ? *Streptograptus plumosus* (= *primulus*), ? *Spirograptus minor*, and *Rastrites cf. schaueri* continue

from the underlying *linnaei* Zone. However, the occurrence of easily determinable *Spirograptus turriculatus* accompanied by *Petalograptus tenuis* indicate the *turriculatus* Zone.

The graptolite assemblage of the GMX A locality corresponds to that of the upper *turriculatus* Zone of Bohemia. It is characterised by *Monograptus proteus*, ? *Streptograptus exiguus* and *Streptograptus* cf. *storchi* (= *runcinatus sensu* Bouček, 1953). *Spirograptus turriculatus* is common. The assemblage corresponds approximately with that from the upper part of *turriculatus* Zone in Wales, described by Loydell (1991).

Small, unnamed exposure near to GMX F (60 m below GMX F) yielded abundant *Monograptus veles*, rare *Monograptus* cf. *arcuatus* and ? *Streptograptus exiguus*. This assemblage may indicate a slightly higher horizon, corresponding to the *M. crispus* Zone. So far, one fragment assigned to ? *Monograptus crispus* has been found.

The graptolite lists for the three localities provide evidence for the presence of the whole of the *turriculatus* Zone (we recognise an independent *R. linnaei* Zone for the underlying stratigraphic interval) at Genna Muxerru.

The *linnaei* and *crispus* zones, although indicated by some taxa, have not yet been used formally in the stratigraphic chart proposed for the Llandovery of SW Sardinia.

Monoclimacis griestoniensis Zone

The uppermost documented graptolite-bearing horizon in SW Sardinia is exposed at GMX P locality at Genna Muxerru. The rich graptolite assemblage is indicative of the *Mcl. griestoniensis* Zone. *Retiolites geinitzianus angustidens*, *Pristiograptus initialis*, *Monograptus* cf. *contortus*, and *Monograptus pragensis pragensis* appear together with the zonal-index species, *Monoclimacis griestoniensis*. They all appear for the first time in the *griestoniensis* Zone as in other European graptolite sequences. According to present knowledge, *M. pragensis pragensis* is restricted to *griestoniensis* Zone. The assemblage agrees well with that listed by Bouček (1953) from the *griestoniensis* Zone of Bohemia (Prague Basin).

PRESERVATION, DEFORMATION, AND BIOMETRIC MEASUREMENTS

The preservation of the material varies from simply flattened (Monte Cortoghiana Becciu) and well determinable to those compressed and deformed by cleavage (Genna Quadroxius). The specimens are silver-coloured on black bedding planes or have very low relief infilled by black oxide, on glossy grey bedding planes affected by cleavage (Genna Muxerru

GMX P). Dark siltstones to fine greywackes at Genna Muxerru (GMX A) contain low relief rhabdosomes preserved as light chloritic films within a black, almost massive rock.

Well documented affects of tectonic deformation (Schauer, 1971; Rickards, 1970; Hutt, 1974, a.o.) have been accounted for in the graptolite descriptions and determinations. White or black bars in text-figures and plates indicate lineation on the bedding plane when present.

All parameters and dimensions measured in our specimens are illustrated on Text-fig. 3 to show the sense in which the terms are used.

SYSTEMATIC DESCRIPTIONS

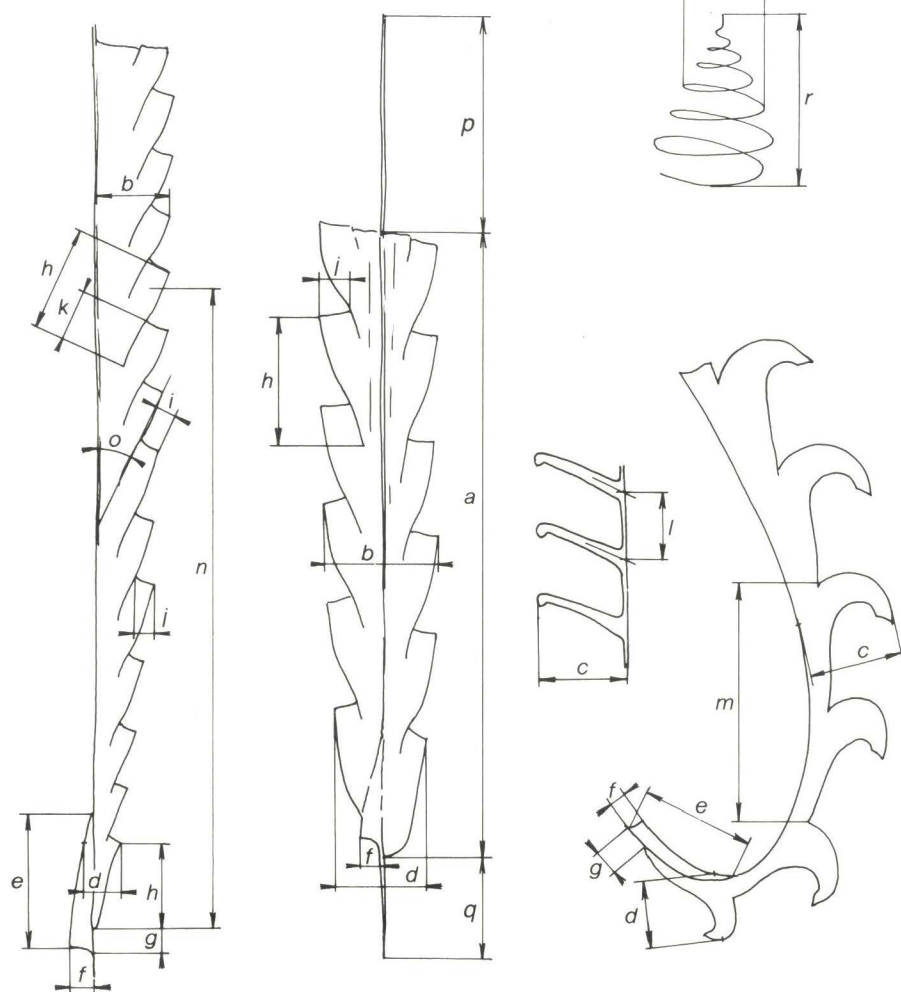
The classification employed here is based mainly on the cladistic classification of the Diplograptacea Lapworth, 1873 (Mitchell, 1987). By examination of the early astogeny of graptolite rhabdosomes he has obtained the first, hopefully not artificial, classification which can be widely accepted by graptolite specialists.

Problems with the new classification arose with tradition families, which were denoted by Mitchell from their family status to the subfamily level. Subfamilies such as *Petalograptinae* Bulman, *Retiolitinae* Lapworth, *Plectograptinae* Bouček & Münch, a.o., were abolished and genera which we consider not to be closely related, like *Plectograptus* Moberg & Törnquist and *Petalograptus* Suess, as well as *Rastrites* Barrande and *Barrandeograptus* Bouček, were placed into the same subfamily. Subfamilies were denoted as informal groups of genera by Mitchell (1987). Such groups of genera could well have obtained the status of Tribi, the taxonomic units widely used, for example, in the classification of recent insects. Such units, however, are not widely employed in palaeontological classifications.

We prefer to retain the original status of diplograptacean subfamilies and families, though emended after Mitchell (1987).

Melchin and Mitchell (1991) revised the diagnosis of the genus *Glyptograptus* Lapworth. Three-dimensional specimens of the type species *Glyptograptus tamariscus tamariscus* (Nicholson) from arctic Canada (Melchin, 1987) show that the proximal development is of Pattern I in *Glyptograptus*, instead of Pattern H proposed by Mitchell (1987). On the basis of its early astogeny of Pattern I, *Glyptograptus* Lapworth is probably not related to *Normalograptus* Legrand with Pattern H astogeny.

Here the genus *Glyptograptus* Lapworth is moved into the subfamily *Petalograptinae* according to the new diagnosis given by Melchin and Mitchell



Text-fig. 3 - The measurements made of graptolite rhabdosomes treated in the systematic part of this paper. a) length of the rhabdosome; b) width (dorso-ventral) of the rhabdosome; c) thecal height (in isolated, non-overlapping thecae); d) initial width of the rhabdosome (at the level of the first thecal aperture or the apertures of the first thecal pair); e) length of the sicula; f) width of the sicular aperture; g) the distance between the sicular aperture and the point of origin of th 1' (if measurable); h) thecal length; i) width of the thecal aperture; j) proportion of the total width of the rhabdosome which is occupied by thecal aperture or apertural excavation; k) thecal overlap; l) thecal distance (in isolated rastritid thecae); m) 2TRD (two thecae repeat distance); n) proximal thecal count (thecal count in the initial 10 mm of the rhabdosome); o) angle of thecal inclination; p) length of the virgula (nema); q) length of the virgella; r) total height of the spiral of trochoidal rhabdosomes of *Spirograptus*; s) whorl diameter in a spirograptid rhabdosome.

(1991). It may represent the most primitive morphotype, from which the genera *Pseudorthograptus* and *Petalograptus* developed by the subsequent loss of thecal geniculation, change of the rhabdosomal cross section, and development of the ancora. The earliest member of the *tamariscus* Group, the type of *Glyptograptus*, is known from the lower *acuminatus* Zone and clearly precedes both related genera.

The subfamily Glyptograptinae of Mitchell (1987) lost its nominal genus and it is renamed here and used at the Family level.

For economy of space, synonymies of widely recognised species are limited to the most important references. The last full synonymy list is referred to. Graptolites questionably determined, due to insufficient material, are left in open nomenclature. Such graptolites are referred to original description of the species only.

Specific diagnoses are given for the newly

described species. Diagnoses for widely recognised graptolites are not included. Diagnoses of the higher taxonomic units (genera, subfamilies, families) are included only when recently, and/or herein, emended.

The species described and illustrated are listed below

Fam. Normalograptidae nov. fam.

Genus *Cystograptus* Hundt, 1942; emend. Rickards 1970

Cystograptus vesiculosus (Nicholson, 1868)

Cystograptus ancestralis Štorch, 1985

Genus *Neodiplograptus* Legrand, 1987

Neodiplograptus diminutus apographon (Štorch, 1983)

Neodiplograptus lanceolatus n. sp.

Neodiplograptus parajanus (Štorch, 1983)

Neodiplograptus thuringiacus (Kirste, 1919)

Genus *Normalograptus* Legrand, 1987; emend. herein

Normalograptus angustus (Perner, 1895)

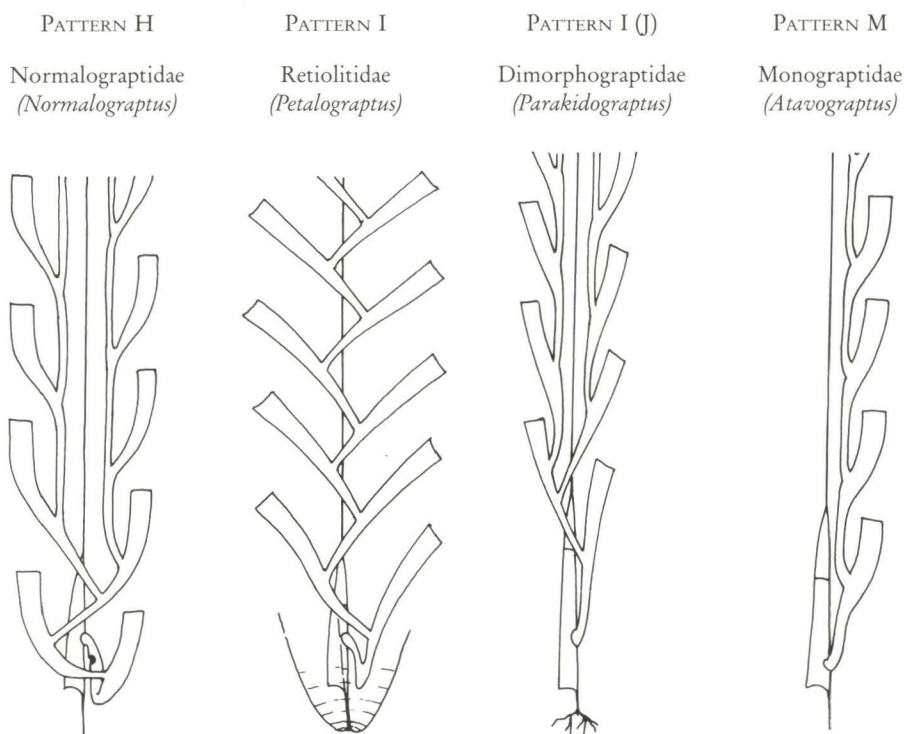
Normalograptus medius (Törnquist, 1897)

Normalograptus normalis (Lapworth, 1877)

Normalograptus trifilis (Manck, 1923)

- Normalograptus* sp. A
Normalograptus sp. B
 Fam. Dimorphograptidae Elles & Wood, 1908; emend. Mitchell, 1987
 Subfam. Akidograptinae Li & Ge, 1981; emend. herein
 Genus *Akidograptus* Davies, 1929
Akidograptus ascensus Davies, 1929
 Genus *Parakidograptus* Li & Ge, 1981
Parakidograptus acuminatus (Nicholson, 1867)
 Subfam. Dimorphograptinae Elles & Wood, 1908; emend. herein
 Genus *Rhaphidograptus* Bulman, 1936
Rhaphidograptus toernquisti (Elles & Wood, 1906)
 Fam. Retiolitidae Lapworth, 1873; emend. Mitchell, 1987
 Subfam. Petalograptinae Bulman, 1955; emend. herein
 Genus *Glyptograptus* Lapworth, 1873; emend. Melchin & Mitchell, 1991
Glyptograptus cortoghianensis n. sp.
 Genus *Petalograptus* Suess, 1851; emend. herein
Petalograptus tenuis (Barrande, 1850)
Petalograptus sp. A
 Subfam. Retiolitinae Lapworth, 1873; emend. Lenz & Melchin, 1987
 Genus *Retiolites* Barrande, 1850
Retiolites geinitzianus angustidens Elles & Wood, 1908
 Fam. Monograptidae Lapworth, 1873
 Genus *Atavograptus* Rickards, 1974
Atavograptus cf. *gracilis* Hutt, 1975
 Genus *Coronograptus* Obut & Sobolevskaya, 1968; emend. Rickards, 1976
Coronograptus cf. *cyphus* (Lapworth, 1876)
 Genus *Pristiograptus* Jaekel, 1889
Pristiograptus cf. *bjerringus* (Bjerreskov, 1975)
Pristiograptus initialis Kirste, 1919
Pristiograptus variabilis (Perner, 1897)
 Genus *Monograptus* Geinitz, 1852; emend. Bulman, 1970
Monograptus cf. *arcuatus* Bouček, 1931
Monograptus cf. *contortus* Perner, 1897
Monograptus lobiferus (McCoy, 1850)
Monograptus cf. *marri* Perner, 1897
Monograptus planus (Barrande, 1850)
Monograptus pragensis pragensis (Přibyl, 1943)
Monograptus priodon (Bronn, 1835)
Monograptus proteus (Barrande, 1850)
Monograptus cf. *speciosus* Tullberg, 1883
Monograptus veles (Richter, 1871)
 Genus *Monoclimacis* Frech, 1897
Monoclimacis griestoniensis (Nicol, 1850)
 Genus *Campograptus* Obut, 1949; emend. herein
Campograptus cf. *millepeda* (McCoy, 1850)
 Genus *Streptograptus* Yin, 1937; emend. Loydell, 1990
Streptograptus loydelli n. sp.
Streptograptus cf. *storchii* Loydell, 1991
 Genus *Spirograptus* Gürich, 1908, emend. Loydell, Štorch & Melchin, in press.
Spirograptus turriculatus (Barrande, 1850)
 Genus *Demirastrites* Eisel, 1911; emend. herein
Demirastrites triangulatus triangulatus (Harkness, 1851)
 Genus *Rastrites* Barrande, 1850; emend. herein
Rastrites cf. *approximatus* Perner, 1897
Rastrites carnicus Seelmeier, 1936
Rastrites cf. *schaueri* Štorch & Loydell, 1992

Specimens are housed in the University of Modena (Collections of the Palaeontological Institute under the numbers n. 22400 - n. 22599 and n. 24000 - n. 24128).



Text-fig. 4 - Astogenetic patterns of Silurian graptolites (modified after Mitchell, 1987, and Melchin & Mitchell, 1991).

Family NORMALOGRAPTIDAE nov. fam.

Diagnosis (modified after Mitchell, 1987) – Biserial rhabdosome with asymmetrical, usually narrow proximal end and simple sicula. Primordial astogeny of Pattern H (see Mitchell, 1987). First two thecae closely adpressed to the sicula and lacking mesial spines. Thecae glyptograptid, climacograptid or pseudoclimacograptid, median septum straight to complexly folded.

Remarks – The Family comprises two generic groups which differ in median septum and thecal shape. The first group comprises the nominal genus *Normalograptus* Legrand, 1987, the genera *Neodiplograptus* Legrand, 1987; *Cystograptus* Hundt, 1942, and *Pseudoglyptograptus* Bulman & Rickards, 1968, and former glyptograptids with Pattern H astogeny. The second group, characterised by an undulating median septum and sharply geniculate thecae with apertures commonly hooded by overhanging genicular flanges, comprises *Lithuanograptus* Paškevičius, 1976; *Paraclimacograptus* Přibyl, 1947; *Metaclimacograptus* Bulman & Rickards, 1968, and *Clinoclimacograptus* Bulman & Rickards, 1968.

Genus CYSTOGRAPTUS Hundt, 1942;
emend. Rickards, 1970

Type species (subsequently designated by Jones & Rickards, 1967) – *Diplograptus vesiculosus* Nicholson, 1868; from the Llandovery of Dumfriesshire, Scotland.

Diagnosis – After Rickards, 1970.

CYSTOGRAPTUS VESICULOSUS (Nicholson, 1868)
Pl. 5, fig. 3; text-fig. 5 I

- 1868 *Diplograptus vesiculosus* NICHOLSON, p. 57, pl. 3, fig. 11.
1907 *Diplograptus* (*Orthograptus*) *vesiculosus* Nich. - ELLES & WOOD, p. 229, pl. 28, figs. 8a-d, text-figs. 151a-f.
1967 *Cystograptus vesiculosus* (Nicholson) - JONES & RICKARDS, text-figs. 3d, 6, 8a-d.

- 1970 *Cystograptus vesiculosus* (Nicholson) - RICKARDS, p. 44, pl. 1, fig. 11; pl. 2, figs. ?12, 14.
1974 *Cystograptus vesiculosus* (Nicholson) - HUTT, p. 45, pl. 4, fig. 15; pl. 5, figs. 4, 5; text-fig. 9, figs. 4, 5.
1978 *Orthograptus vesiculosus* Nicholson - YE, p. 465, pl. 176, fig. 1.
1985 *Cystograptus vesiculosus* (Nicholson) - ŠTORCH, p. 96, pl. 2, figs. 1, 5, 7; pl. 5, figs. ?2, 7, 8; text-figs. 3E-G, ?H.
1988 *Cystograptus vesiculosus* (Nicholson) - ÖBUT *et al.*, p. 28, pl. 1, fig. 4-7. (See for further reference list).

Holotype – By monotypy. Figured Nicholson (1868, pl. 3, fig. 11); from the Llandovery of Dumfriesshire, Scotland.

Material – One proximal end and one long distal fragment, both flattened.

Horizon and locality – *Cyst. vesiculosus* - *C. cyphus* Zone at Terra Murus (TM C).

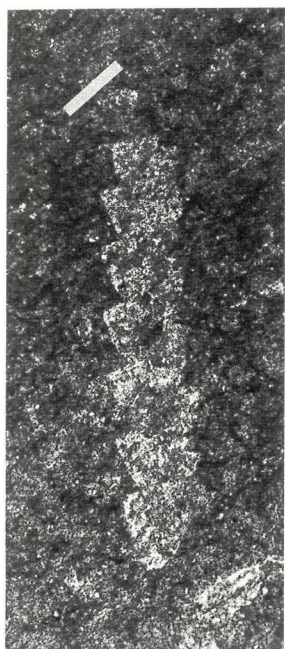
Description – The rhabdosome is several cm long when complete. The blunt proximal end has a large sicula which possesses a 1.5 mm long virgella. Thl¹ grows downwards for 0.4 mm below the sicular aperture and then turns upwards. The first theca has a convex free ventral wall. Its aperture, about 1.1 mm distal to the sicular aperture, faces distally. Thl² appears to grow outwards and slightly downwards, crossing the sicula at the level of its aperture so that no part of sicula remains free. Thl² also has a conspicuously convex free ventral wall. The width of the rhabdosome is 2 mm at the level of the first thecal pair. The rhabdosome attains a width of 2.7 mm at the level of the 9th thecal pair. The maximum width of our distal fragment is 3.6 mm.

Subalternate to almost opposite thecae have a characteristic appearance in flattened rhabdosomes. Their length and overlap are not measurable. Their apertures face distally. Apertural excavations are shallow, or seemingly, not developed. Thecae number 8.5 in 10 mm in our proximal fragment and 6.5 in 10 mm in our distal fragment. The distal fragment possesses undulating, parallel margins. The virgula is expanded and attains a width of 0.7 mm distally.

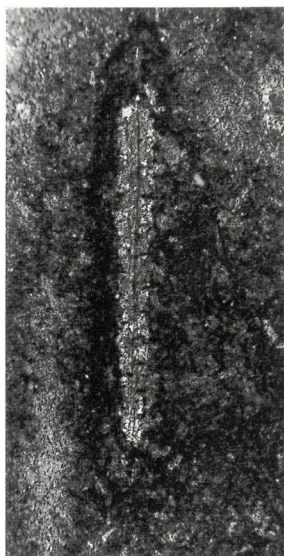
EXPLANATION OF PLATE 2

- Fig. 1 - *Glyptograptus cortoghianensis* n. sp., n. 22586a, holotype.
Figs. 2, 6 - *Normalograptus angustus* (Perner), 2) n. 22572, 6) n. 22574/1.
Fig. 3 - *Cystograptus ancestralis* Storch, n. 24090/1.
Figs. 4, 7, 8 - *Neodiplograptus lanceolatus* n. sp., 4) n. 22560, 7) n. 22477, 8) n. 22405a, holotype.
Fig. 5 - *Normalograptus normalis* (Lapworth), n. 22575.

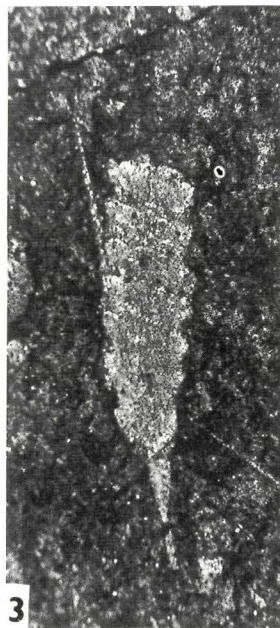
All specimens from the *acuminatus* Zone of Monte Cortoghiana Becciu (MCB 2 - fig. 4; MCB 3 - figs. 7, 8; MCB 4 - Figs. 1-3, 5, 6). Fig. 1, x 8.5; Fig. 2, x 4; figs. 3-5, x5; fig. 6, x 9; figs. 7, 8, x 3.



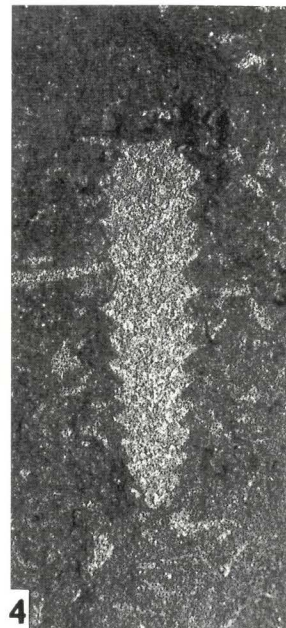
1



2



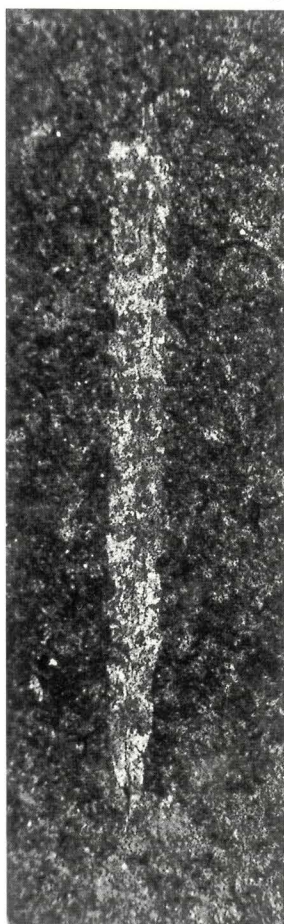
3



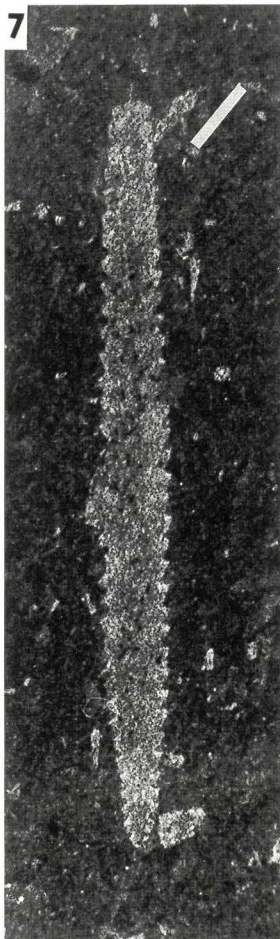
4



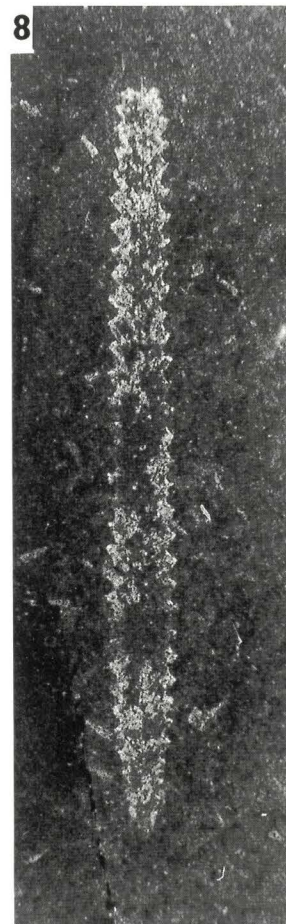
5



6



7



8

Remarks – The wider rhabdosome and lower thecal count in our specimens, when compared with the topotypic material described by Elles & Wood (1907), Jones & Rickards (1967), Rickards (1970) and Hutt (1974) are caused by their intense flattening. The overall shape, proximal development, expanded virgula and thecal style agree well with previous descriptions.

CYSTOGRAPTUS ANCESTRALIS Štorch, 1985

Pl. 2, fig. 3; pl. 3, figs. 2-4, 7, 8; text-fig. 5 C, J-M

? 1965 ?*Diplograptus* (*Diplograptus*?) sp. A STEIN, p. 178, fig. 24a.

1985 *Cystograptus*? *ancestralis* sp. n. ŠTORCH, p. 97, pl. 4, figs. 1, 3-5; text-fig. 3A-D.

Holotype – Specimen no. PŠ 73/1 figured by Štorch (1985, pl. 4, fig. 1; text-fig. 3A); from the *acuminatus* Zone of the Želkovice Formation, Praha-Řepy, Bohemia. Housed in the Czech Geological Survey, Prague.

Material – 14 flattened, mostly complete specimens.

Horizon and locality – *Par. acuminatus* Zone at Monte Cortoghiana Becciu (MCB 3 and 4).

Description – Up to 20 mm long rhabdosome with wide, rounded proximal end and parallel-sided median and distal portions. The initial width is 1.7-1.9 mm (max. 2.1 mm) at the level of thl^1 - l^2 apertures. Maximum width of the rhabdosome is 2.5-2.9 (min. 2.1) mm and is attained at the level of 3rd-4th thecal pair. Sicular with deeply concave, and up to 0.4 mm wide (when flattened) aperture, is about 3 mm long. Slender virgella is 0.2-0.5 mm long.

The first theca (thl^1) grows down below the sicular aperture then turns upwards. The length of the recurved part of the first theca, with convex ventral wall, is 1.4-1.6 mm. Thl^2 appears to grow out from about the level of the sicular aperture, it also has a convex ventral wall, thus forming the characteristically rounded proximal end of the rhabdosome.

Thecae in general appear glyptograptid. They have short, convex supragenicular walls and straight, distally facing apertures. Sub-alternate to nearly opposite thecal excavations occupy one-quarter to one-fifth of the total rhabdosome width. The thecal spacing is 10.5-11 in 10 mm. The 2TRD of $th2^1$ varies between 1.7 and 2.2 mm.

The median septum appears at about the level of the 4-5th thecal pair. During astogeny a probably uniaxially expanded nema, in some specimens twisted, appeared. It resembles the flat, uniaxial and often twisted nema (or virgula) of some petalograptids. The three-vaaned nematularium typical of

Cystograptus vesiculosus (Nicholson) and *Cystograptus penna* (Hopkinson) has not yet been observed in Sardinian or Bohemian material. Also it is not yet clear whether the nema expands within the thecate portion of the rhabdosome or more distally.

Remarks – *Cystograptus ancestralis* Štorch is tentatively assigned to the genus *Cystograptus* Hundt because of its general features, large sicular, rounded proximal end, nearly opposite thecae which resemble those of *Cystograptus vesiculosus* (Nicholson), and expanded nema. In contrast to *Cyst. vesiculosus* and *Cyst. penna* (Hopkinson), *Cyst. ancestralis* probably possesses glyptograptid thecae with apparently distally facing apertures. *Cyst. ancestralis* may represent an ancestral form which gave rise to both the more specialized, above mentioned species occurring at slightly higher horizons.

Such an evolutionary process would involve enlargement of the sicular and the development of a larger and three-vaaned nematularium. The nature of the change in thecal shape is not clear but may have involved sigmoidal curvature combined with prolongation of the metathecal tube.

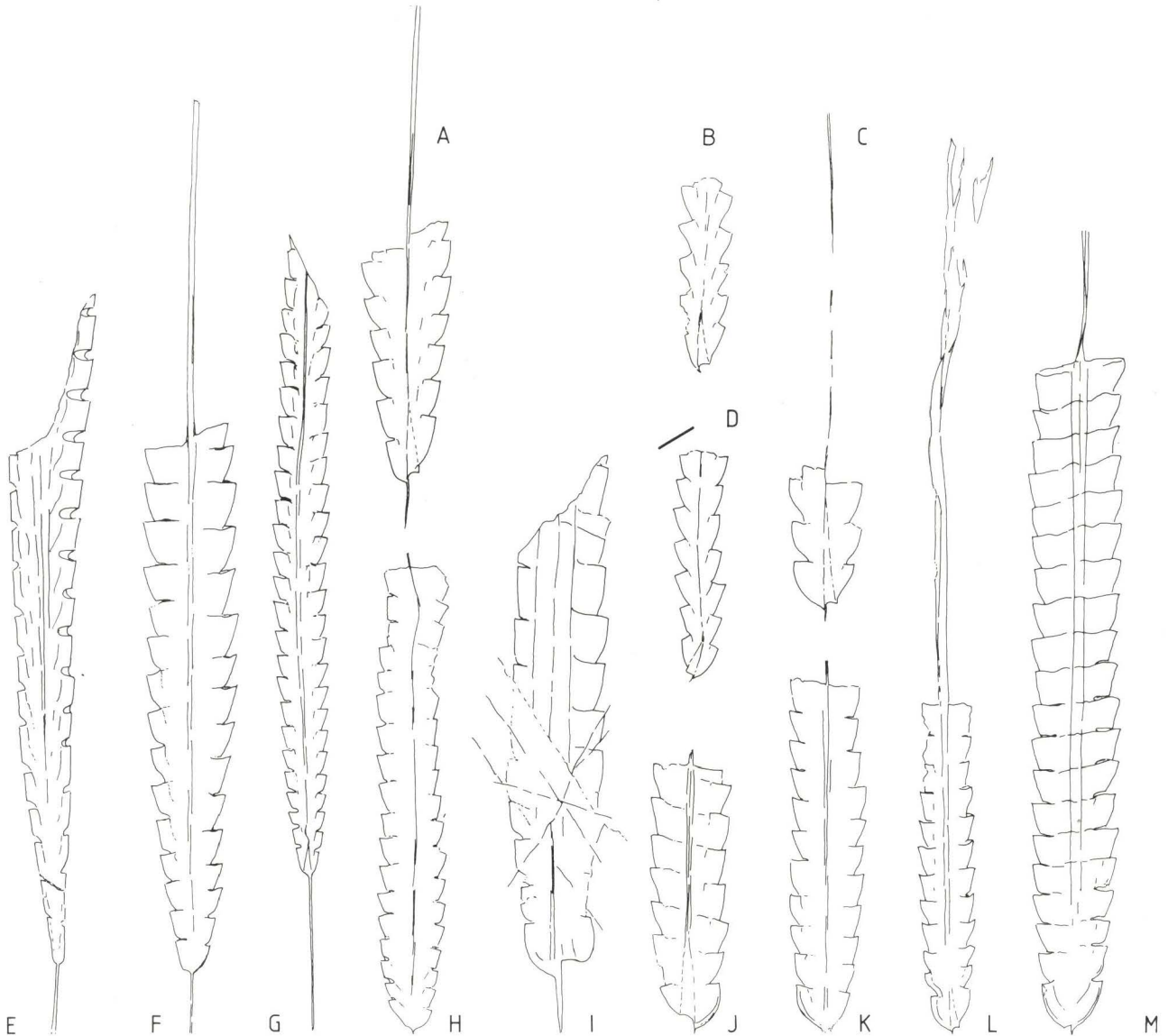
Cyst. tumidicaulis Hsü has entirely different thecae, a minute rhabdosome and resembles neodiplograptids of the *thuringiacus* group. *Cyst. praepenna* Obut et Sobolevskaya, from the Siberian area, occurs at the same stratigraphic level as *Cyst. ancestralis* (*acuminatus* Zone). It has a narrower rhabdosome, with a more tapered proximal end of glyptograptid appearance (0.8 mm wide at the level of thl^2 aperture), with more alternate, glyptograptid thecae and a long virgella. *Cyst. praepenna* is even more glyptograptid-like than *Cyst. ancestralis*, and resembles forms like *Glyptograptus chongqiangensis* Ye a.o.

Cystograptus ancestralis has also been recorded from the *acuminatus* Zone of Bohemia (Štorch, 1985), from the *ascensus* - *acuminatus* Zone boundary beds, and occurs also perhaps in the *acuminatus* Zone in Germany (Stein, 1965).

Genus NEODIPLOGRAPTUS Legrand, 1987

Type species (by original designation) – *Diplograptus magnus* Lapworth, 1900; from Rhyader, Wales.

Diagnosis (modified after Legrand 1987) – Rhabdosome ovoid to nearly rectangular in cross-section, more or less tabular. Thecae strongly sigmoidal (nearly climacograptid), with nearly semicircular apertural excavations proximally. Distal thecae become glyptograptid, with much less pronounced genicula. Rhabdosome usually septate. Sicular simple, often possesses prominent nema. $Th2^1$ is dicalyal.



Text-fig. 5 - A, F, G - *Neodiplograptus parajanus* (Štorch); A) n. 22471, F) n. 22473, G) n. 22403. B, D - *Glyptograptus cortoghianensis* n. sp.; B) n. 22483, D) n. 22586a = holotype. C, J-M - *Cystograptus ancestralis* Štorch; C) n. 22481, J) n. 24090/1, K) n. 22468, L) n. 22469, M) n. 22490. E - *Neodiplograptus thuringiacus* (Kirste); n. 24076. H - *Neodiplograptus diminutus apographon* (Štorch); n. 22464. I - *Cystograptus vesiculosus* (Nicholson); n. 24083.
Specimens on figs. A-D, F-H, J-M from the *acuminatus* Zone of Monte Cortoghiana Becciu (MCB 3 - figs. A, C; MCB 4 - figs. B, D, F-H, J-M); specimen on fig. E from the *convolutus* Zone of Genna Quadroxius (GQX); specimen on fig. I from the *vesiculosus - cyphus* Zone of Terra Murus (TM C). Figs. A-F, H-K, M: x 5; figs. G, L: x 2.5.

NEODIPLOGRAPTUS DIMINUTUS APOGRAPHON
(Štorch, 1983)

Pl. 1, fig. 1; text-fig. 5 H

1983 *Diplograptus diminutus apographon* subsp. nov. ŠTORCH, p. 163, pl. 1, figs. 1, 2; text-figs. 2A-D.

Holotype - The specimen no. PS 72/1 figured by Štorch (1983, pl. 1, fig. 1; text-fig. 2C) from the Želkovice Formation at Řepy, Bohemia. Housed in Czech Geological Survey, Prague.

Material - 3 flattened rhabdosomes.

Horizon and locality - *Par. acuminatus* Zone at Monte Cortoghiana Becciu (MCB 4).

Description - The longest rhabdosome measures 13.5 mm. The proximal end is characteristically rounded. The sicula appears to be 1.6 mm long and its apex attains the level of the aperture of the 3rd thecal pair. The sicular aperture is 0.15 mm wide. A virgella has not been observed.

Thl¹ grows downwards, and then, just below the sicular aperture, turns upwards. Both thl¹ and thl² have convex ventral walls, thus forming a nearly rounded proximal end. The initial width of the rhabdosome is 1.2-1.3 mm. The maximum width – 2.05 mm – is attained at the 5-6th thecal pair. The short supragenicular walls of more distal thecae are inclined at an angle of about 10-15° to the rhabdosome axis. The geniculum is not strong. Thecal apertures face distally.

Shallow apertural excavations occupy less than one-sixth of the total rhabdosome width. The most proximal excavations may resemble those of normalograptids. Thecae number 14-15 in 10 mm proximally (7-7.5 in the initial 5 mm), and about 13 in 10 mm distally (6.5 in the most distal 5 mm). The 2TRD of th2¹ is 1.2 mm. The median septum is complete. The nema is short and slender.

Remarks – *Neodiplograptus diminutus apographon* (Štorch) may be separated from the type subspecies by its considerably wider rhabdosome, lower thecal count and, perhaps also, by its more inclined supragenicular walls and shallower apertural excavations.

NEODIPLOGRAPTUS LANCEOLATUS n. sp.

Pl. 2, figs. 4, 7, 8; text-fig. 6 A-C

- 1971 *Diplograptus modestus* Lapworth, 1876 subsp. indet. – SCHAUER, p. 34, pl. 6, figs. ?4, 5; pl. 7, fig. 4.
 1979 *Diplograptus (Diplograptus) modestus* cf. *modestus* Lapworth - JAEGER & ROBARDET, pl. 2, figs. 3, 6; text-fig. 9b, c.
 ? 1983 *Diplograptus modestus* Lapworth - GE & WU, pl. 2, fig. 12.
 1983 *Diplograptus modestus* Lapworth - MU et al., pl. 3, figs. 10, 11.
 1983 *Diplograptus modestus modestus* Lapworth - ŠTORCH, p. 162, pl. 1, figs. 3, 5, 6; text-figs. 2E-I.
 1984 *Diplograptus modestus* Lapworth - LI, p. 342, pl. 13, figs. 7-9.
 ? 1990 *Diplograptus modestus* Lapworth - GE, p. 45, pl. 1, fig. 13, pl. 2, figs. 23, 24.

Holotype – Complete, flattened specimen no. 22405a (pl. 2, fig. 8; text-fig. 6 A); from the *acuminatus* Zone at Monte Cortoghiana Becciu. Housed in the University of Modena (Collections of the Palaeontological Institute).

Material – Over 50 flattened complete specimens.

Horizon and locality – *Par. acuminatus* Zone at Monte Cortoghiana Becciu (MCB 1-4).

Diagnosis – Rhabdosome lanceolate, about 30 mm long, rapidly widening from 1.1-1.3 mm to a maximum of 3-3.5 mm and narrowing again distally in more mature specimens. Thecae strongly geniculate most proximally and intermediate bet-

ween glyptograptid and orthograptid distally, numbering 12-14 in 10 mm most proximally and 10-11 in 10 mm distally. Straight or concave thecal apertures are nearly perpendicular to the thecal axis. Thecal excavations shallow, occupying one-seventh to one eighth of the total width of the rhabdosome. Virgella thin and short, nema short, thread-like.

Description – The rhabdosome is up to 40 mm long (commonly 20-30 mm) with a maximum width of 2.9-3.9 mm (commonly 3-3.5 mm) which is attained at about the level of the 9-11th thecal pair. The initial width is 1.1-1.3 mm at the 1st thecal pair and widens to 1.7-2.1 mm at the 3rd thecal pair. Distally, the width commonly decreases again to 2.1-3.1 mm and the rhabdosome becomes lanceolate in general shape.

The sicula is up to 1.6-2.5 mm long and its apex reaches just below the level of the apertures of the 3rd thecal pair. The sicular aperture, 0.3-0.4 mm wide when flattened, possesses a short (up to 0.5 mm) and thin virgella. Thl¹ grows downwards to 0.1-0.2 mm below the sicular aperture and then turns and grows upwards and outwards. Thl² grows upwards and outwards for its entire length and crosses the sicula 0.1-0.2 mm above the aperture, thus leaving a small part of its ventral wall free. The distance between the sicular aperture and the aperture of thl¹ is 0.7-0.9 mm.

Thecae are somewhat variable in appearance due to diagenetic flattening. Commonly they are orthograptid in shape, having long and almost straight intertheal septa inclined at 30-50° to the rhabdosomal axis. The thecae overlap for three-fifths to two-thirds of their length. Straight or concave thecal apertures open into shallow, orthograptid-like excavations which occupy one-seventh to one-eighth of the total rhabdosome width. The thecal aperture is almost perpendicular to the thecal axis. Thecae number 12-14 in 10 mm most proximally and 10-11 (rarely 12) in 10 mm distally. The 2TRD of th2¹ is 1.3-1.6 mm. In some specimens, slightly different diagenetic deformation shows that at least the proximal thecae were geniculate, with shallow, nearly semicircular excavations. Supragenicular walls are 0.3-0.4 mm long and are inclined towards the rhabdosome axis.

The median septum seems to be complete. The virgula is prolonged distally into a several mm long thread-like nema. the rhabdosome has always been found in biprofile orientation on the bedding plane, a result of its flat, tabular cross-section.

Remarks – One of the most characteristic and abundant species of the *A. ascensus* - *Par. acuminatus* Zone of Gondwanan Europe has previously been

assigned to *Diplograptus modestus* Lapworth, 1876. As shown by the recent revision of the type material of *Neodipl. modestus* (Lapworth), the two forms are clearly different.

The thecae of *Neodipl. lanceolatus* sp. n. are thinner, longer and less geniculate than those of *Neodipl. modestus*. They overlap for $3/5-2/3$ in contrast to $1/3-1/2$ in the latter species. Thecal excavations are shallower in *Neodipl. lanceolatus* and occupy only $1/7-1/8$ of the total width of the rhabdosome. The virgella is shorter and less prominent in *Neodipl. lanceolatus* as is its thread-like nema. Another characteristic feature of the new species is its lanceolate, distally narrowing rhabdosome.

Neodipl. modestus may have a more restricted palaeogeographical distribution than previously thought. Recently the typical specimens of *Neodipl. modestus* have been figured by Rickards (1988, fig. 1 n) and Melchin (1989, fig. 6G). References to *Neodipl. modestus* in Gondwanan Europe are actually to *Neodipl. lanceolatus* (Prague Basin, Bohemia; Thuringia, Germany; Sardinia; Sierra Morena, Spain).

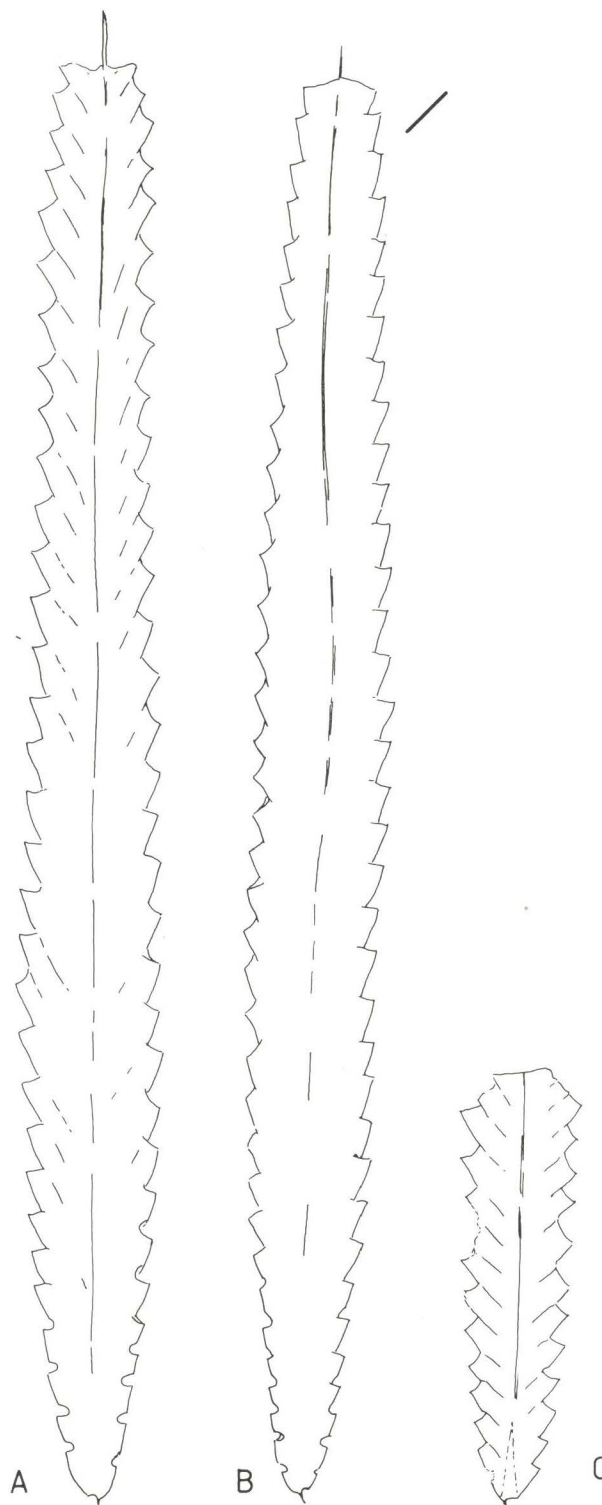
Another species, undoubtedly related to *Neodipl. lanceolatus*, is *Neodipl. fezzanensis* (Desio, 1940). It has a larger rhabdosome which is narrower proximally and often broader distally. The thecae of *Neodipl. fezzanensis* are probably more geniculate proximally and the virgula (nema) is more prominent (see Legrand, 1970).

The Saharian material of *Neodipl. fezzanensis* was assigned to about the level of *C. cyphus* Zone by Legrand (1970). Specimens of *Neodipl. fezzanensis* from Bohemia (Štorch, 1983) come from the same zone. It is thus a much younger taxon than *Neodipl. lanceolatus* which is known from the *A. ascensus* - *Par. acuminatus* zones of Europe and, possibly, of China (see Mu *et al.*, 1983; Li, 1984). We consider that *Neodipl. lanceolatus* is a probable ancestor of *Neodipl. fezzanensis*, which evolved by enlargement of the rhabdosome (except the proximal end, which slightly diminished). The virgula (nema) and median septum are more prominent in *Neodipl. fezzanensis*, and thecae appear to be more geniculate, but the latter difference could be due to a different mode of flattening of the rhabdosome.

NEODIPLOGRAPTUS PARAJANUS (Štorch, 1983)
Pl. 3, figs. 1, 5, 6; text-fig. 5 A, F, G

cf. 1965 *Diplograptus* (*Diplograptus*) sp. B - STEIN, p. 179, fig. 24 b.
1983 *Diplograptus parajanus* sp. n. - ŠTORCH, p. 168, pl. 4, figs. 1-3; text-fig. 3 A, B.

Holotype - Complete flattened specimen no. PŠ 54b figured by Štorch (1983, pl. 4, fig. 2; text-fig.



Text-fig. 6 - A-C - *Neodiplograptus lanceolatus* sp. n.; A) n. 22405a = holotype, B) n. 22477, C) n. 22560. Specimens from the *acuminatus* Zone of Monte Cortoghiana Becciu (MCB 2 - fig. C; MCB 3 - figs. A, B). All figs. x 5.

3A); from the basal *acuminatus* Zone of Želkovice Formation, Praha-Řepy, Bohemia. Housed in the Czech Geological Survey, Prague.

Material – 11 flattened specimens, most of them complete.

Horizon and locality – *Par. acuminatus* Zone at Monte Cortoghiana Becciu (MCB 3 and MCB 4).

Description – The thick-walled, proximally tapering rhabdosome attained a length of over 40 mm (commonly about 30 mm). Scalariform and sub-scalariform views of the rhabdosome have not yet been recorded, suggesting a somewhat flattened original cross-section.

The proximal end is subrounded. Thl^1 grows down, below the sicular aperture, and then turns abruptly upwards. Thl^2 originated from thl^1 at about the level of sicular aperture. The rhabdosome is 1.2-1.3 mm wide at the level of the apertures of thl^1 - l^2 , then widens to 1.8-2.0 mm (at the level of the 4th thecal pair). The maximum width of 2.5-2.8 mm is attained at the level of about the 10-11th thecal pair. Little of the sicula is exposed. It has a 0.3 mm wide, concave aperture (when flattened) and a commonly over 5 mm long, rather prominent virgella. The length of the sicula has not yet been determined.

The thecae alternate. The median septum is complete and prominent, slightly undulating at the level of the 2nd and 3rd thecal pairs. Proximal thecae are strongly geniculate – in some specimens of glyptograptid appearance, in older (more mature) rhabdosomes they appear to be climacograptid. The thecal excavations are asymmetrical in both cases. The thecal apertures are nearly straight, facing distally. Distal thecae are glyptograptid (with flowing genicula) to orthograptid, with supra-genicular walls inclined at about 15° to the rhabdosome axis. The thecal inclinations occupy up to one-third of the complete width of the rhabdosome proximally, and less than one-quarter distally. The thecae number 10.5-11 most proximally, and 7.5-8 in 10 mm distally. The 2TRD of $th2^1$ is 1.7-1.9 mm. A robust, up to 0.35 mm wide nema extends for over 20 mm from the thecate part of the rhabdosome.

Remarks – This is one of many species of the widely distributed «*thuringiacus* Group» (Štorch, 1983) of Neodiplograptids. *Neodiplograptus parajanus* (Štorch) differs from the other, mostly stratigraphically younger, species of the group – *Neodipl. thuringiacus* (Kirste), *Neodipl. tcherskyi* (Obut & Sobolevskaya), *Neodipl. elongatus* (Churkin & Carter), *Neodipl. rickardsii* (Ye), and *Neodipl. fastigatus* (Ye) – by its tapered but distinctly wider, subrounded proximal end, fewer proximal glyptograptid to climacograptid thecae, and almost orthograptid distal thecae.

Neodipl. parajanus (Štorch) is one of the oldest species of this group. Outside of SW Sardinia it has been recorded by one of us (PŠ) from the *acuminatus* Zone of Bohemia (Prague Basin, Řepy), Austria (Carnic Alps, N. of Zollner See near Hoher Trieb), and perhaps by Stein (1965) from Germany (Frankenwald, Döbra). Other similar species are known from the *acuminatus* Zone of China (Jin *et al.*, 1982). *Glyptograptus chongquiensis* Ye has glyptograptid thecae throughout the whole rhabdosome whilst *Diplograptus nitidus* Ye is narrower (2.1 mm in contrast to 2.5-2.8 mm), less tapering proximally, and possesses an even more robust nema.

NEODIPLOGRAPTUS cf. PARAJANUS (Štorch, 1983)
Pl. 4, fig. 1

Material – 3 complete flattened rhabdosomes.

Horizon and locality – *Par. acuminatus* Zone at Monte Cortoghiana Becciu (MCB 3 and 4).

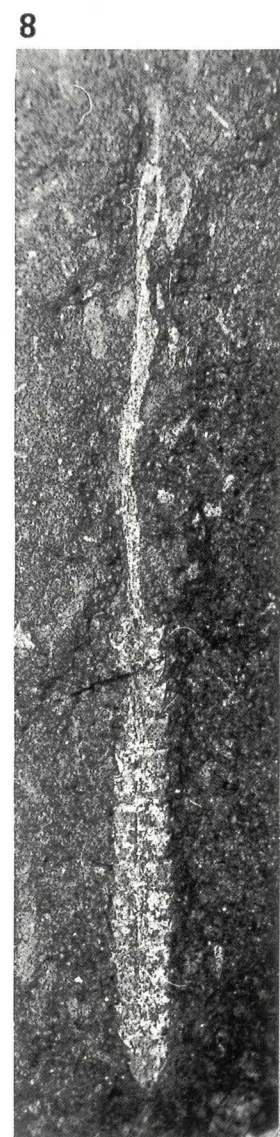
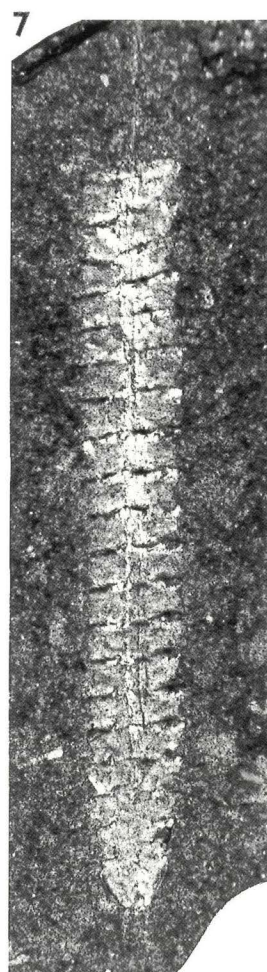
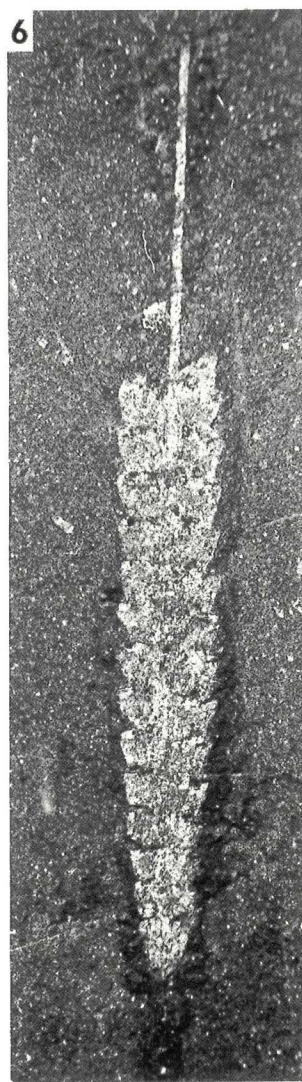
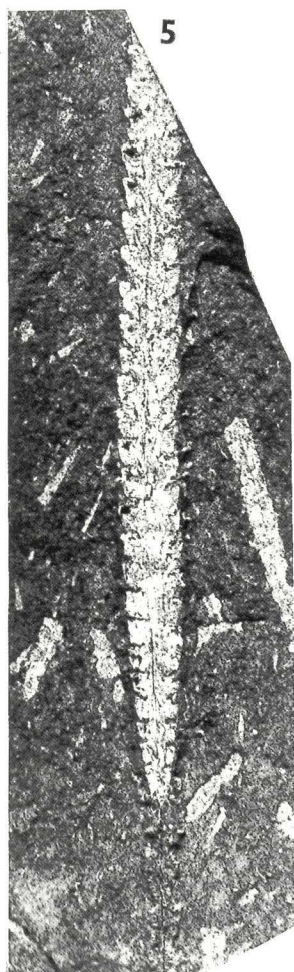
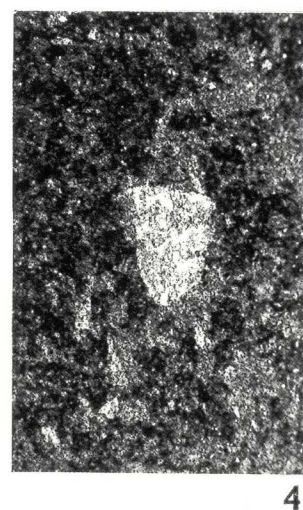
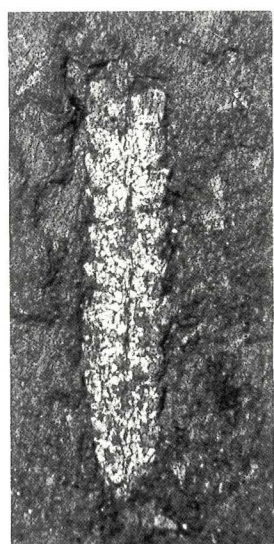
Description – Proximally tapering rhabdosome, 20 + mm in length, possesses a short (0.5-1 mm) virgella and a stout, over 10 mm long, distally projecting nema. The sicula is over 1.3 mm long and is 0.4 mm wide at its aperture. Thl^1 grows down, below the level of the sicular aperture before turning upwards. Thl^2 grows upwards for its entire length. The rhabdosome widens from an initial 1.3 mm to 1.75 mm at the 3rd thecal pair. Thecae are of more or less glyptograptid appearance. They are strongly geniculate, with shallow asymmetrical excavations and proximally inclined supra-genicular walls. The

EXPLANATION OF PLATE 3

Figs. 1, 5, 6 – *Neodiplograptus parajanus* (Štorch), 1) n. 22471, 5) n. 22403, 6) n. 22473.

Figs. 2-4, 7, 8 – *Cystograptus ancestralis* Štorch, 2) n. 22468, 3) n. 22481, 4) n. 22480, 7) n. 22490, 8) n. 22469.

All specimens from the *acuminatus* Zone of Monte Cortoghiana Becciu (MCB 3 - figs. 1, 3, 6; MCB 4 - figs. 2, 4, 5, 7, 8). Figs. 1-4, 6, 7, x 5; figs. 5, 8, x 3.



median septum is complete and prominent. Thecae number 11 in the initial 10 mm and 8.5-9 in 10 mm distally.

Remarks – The specimens differ from *Neodipl. parajanus* in their less robust rhabdosomes and in their thecal shape which remains more or less glyptograptid distally. The nema is less robust and shorter in *Neodipl.* cf. *parajanus*. Our specimens differ from *Neodipl. elongatus* (Churkin & Carter) by their wider proximal end and higher thecal count. They have a similar thecal shape, gradually tapering rhabdosome and short virgella.

NEODIPLOGRAPTUS THURINGIACUS (Kirste, 1919)
Text-fig. 5 E

- 1919 *Diplograptus thuringiacus* Eisel - KIRSTE, p. 135, not figured.
1952 *Diplograptus* (s. str.) *thuringiacus* Eis. - MÜNCH, p. 58, pl. 4, figs. 10a-c.
1965 *Diplograptus* (*Diplograptus*) *thuringiacus* Eisel MS in Münch - STEIN, p. 169, figs. 18a, b.
1971 *Diplograptus thuringiacus* Eisel - SCHAUER, p. 34, pl. 6, figs. 9, 10; pl. 7, fig. 1. (See for further synonymy list).
1975 *Diplograptus thuringiacus* Eisel - BJERRESKOV, p. 27, pl. 4 C, text-fig. 10 A.
1983 *Diplograptus thuringiacus* Eisel - ŠTORCH, p. 166, pl. 3, figs. 1-5; text-fig. 3 E-G.

Type - Not yet designated. The type material come from Eisel's collection, Altmannsgrün, Germany.

Material – One incomplete, flattened rhabdosome and one fragment.

Horizon and locality – ? *Dem. convolutus* Zone at Genna Quadroxius (GQX).

Description – The distinctive, proximally tapering rhabdosome is at least 22 mm long. The slender proximal end is 0.6 mm wide at the level of thl^1 - l^2 apertures, and 1 mm wide at the level of the 3rd thecal pair. The rhabdosome widens to about 2.5 mm distally. The small sicula is not recognisable in our specimens. It possesses a stout, 0.15 mm wide, and more than 1.9 mm long (broken) virgella. Proximally the thecae are strongly sigmoidal, geniculate, having nearly semicircular apertural excavations which occupy about one-quarter of the total width of the rhabdosome. Alternate to subalternate thecae number about 10 in 10 mm proximally, and 9.5 in 10 mm distally. The prominent median septum appears at the level of the 5th thecal pair or earlier.

Remarks – Our specimens have been assigned to *Neodipl. thuringiacus* (Kirste) because of their robust, proximally tapering rhabdosome with narrow

proximal end and robust virgella. The thecae are of similar shape to closely related species [*Neodipl. elongatus* (Churkin & Carter), *Neodipl. gijiangensis* (Ye), *Neodipl. tcherskyi* (Obut & Sobolevskaya) a.o.].

Genus NORMALOGRAPTUS Legrand, 1987; emend.

Type species (by original designation) – *Climacograptus scalaris normalis* Lapworth, 1877; from the Birkhill Shales, Dob's Linn, Scotland.

Diagnosis (modified after Legrand, 1987) – Rhabdosome nearly circular in cross-section; scalariform views are consequently common. More or less complete median septum is straight. Proximal end narrow but blunt, sicula simple, often furnished with a prominent virgella, and rarely, with antivirgellar spines. $Th2^1$ dicalycal. Alternating climacograptid thecae have angular or strongly sigmoidal curvature, parallel and straight supra-genicular walls, and symmetrical thecal excavations. Strong thecal geniculation decreases slightly distally.

NORMALOGRAPTUS ANGUSTUS (Perner, 1895)
Pl. 1, figs. 3, 4, ?6; pl. 2, figs. 2, 6;
text-fig. 7 A?, B, C, E, F

- 1895 *Diplograptus* (*Glyptograptus*) *euglyphus* Lapworth, var. *angustus* mihi PERNER, p. 27, pl. 8, fig. 14a, b.
1906 *Climacograptus scalaris* (Hisinger) var. *miserabilis* var. nov. ELLES & WOOD, p. 186, pl. 26, fig. 3a-h; text-fig. 120a-e.
1949 *Climacograptus angustus* (Perner) - PŘIBYL, p. 7, pl. 2, figs. 2-9.
1963 *Climacograptus angustus* (Perner) - SKOGLUND, p. 40, pl. 3, figs. 1, 2, 4-6; pl. 4, fig. 7; pl. 5, fig. 6.
1970 *Climacograptus miserabilis* Elles & Wood - RICKARDS, p. 28, pl. 1, figs. 3-5, 10.
1974 *Climacograptus miserabilis* Elles & Wood - HUTT, p. 20, pl. 1, figs. 1, 2; text-fig. 8, fig. 1.
1975 *Climacograptus angustus* (Perner) - BJERRESKOV, p. 23, text-fig. 9A.
1983 *Climacograptus miserabilis* Elles & Wood - WILLIAMS, p. 615, text-figs. 3f-i, ?j; 4f-i; 5a, b.
1988 *Scalarigraptus angustus* (Perner) - RIVA, p. 232, figs. 3a-u.
1989 *Scalarigraptus angustus* (Perner) - ŠTORCH, p. 178, pl. 2, figs. 3-5, 8; text-figs. 2E-J.

Holotype – By monotypy. The specimen no. L 27507 figured by Perner (1895, pl. 8, fig. 14a, b); from Králův Dvůr Formation, Králův Dvůr, Bohemia. Housed in the National Museum, Prague.

Material – 16 more or less complete, flattened rhabdosomes.

Horizon and locality – *Par. acuminatus* Zone at Monte Cortoghiana Becciu (MCB 1-4) and Terra Murus (TM B).

Description – The minute rhabdosome is rarely over 10 mm in length. The initial dorso-ventral wid-

th at the level of the apertures of the 1st thecal pair is 0.6-0.8 mm. The width increases rapidly to about the level of 3rd thecal pair. The maximum width of 0.8-1.1 mm is attained at the 4-6th thecal pair.

The proximal development is poorly shown in Sardinian specimens. the sicular aperture, 0.2 mm wide, possesses an up to 1.5 mm long virgella. The sicula appears to be over 1.2 mm long. Thl¹ grows down below the sicular aperture and then abruptly turns up. It reaches to 0.7-0.8 mm above the level of the sicular aperture.

Thecae are strongly sigmoidal, with sub-parallel supragenicular walls. genicula are less sharp than those in other, related normalograptids. Thecae have a glyptograptid appearance in some specimens. Asymmetrical thecal apertural excavations occupy one-quarter, or slightly more, of the total width of the rhabdosome. The thecae number 10-11 (rarely 12) in 10 mm. The 2TRD of th2¹ varies between 1.5 and 1.8 mm. The rhabdosome possesses a complete median septum and bears a 2.5-9 mm long, distally projecting nema.

Remarks – The species clearly differs from other Silurian and topmost Ordovician normalograptids by its minute dimensions. Both the Sardinian and Bohemian material of *Norm. angustus* (Perner) of early Silurian age agree well with the topmost Ordovician material of Perner (1895) except for their slightly smaller dimensions. They are narrower proximally (0.6-0.8 mm as oppose to 0.8-1.0 mm) and distally (0.8-1.1 mm in contrast to 0.9-1.2 mm). Similar dimensions are exhibited by the specimens from the British Silurian, described by Rickards (1970), Hutt (1974) and Williams (1983) as *Climacograptus miserabilis* Elles & Wood. Williams (1983) placed *Cl. angustus* in the synonymy of *Cl. miserabilis* but later Riva (1988) and others considered *Climacograptus miserabilis* Elles et Wood as a junior synonym of Perner's species, assigned to the recently erected genus *Normalograptus*.

NORMALOGRAPTUS MEDIUS (Törnquist, 1897)
Pl. 5, figs. 1, 7; text-fig. 7 D, O

- 1897 *Climacograptus medius* n. sp. TÖRNQUIST, p. 7, pl. 1, figs. 9-15.
1906 *Climacograptus medius* Törnquist - ELLES & WOOD (*pars*), p. 189, pl. 26, fig. 4a-e; text-fig. 122a, c (non pl. 26, fig. 4f; text-fig. 122b = *Norm. trifilis* Manck).
1965 *Climacograptus medius* Törnquist - STEIN, p. 163, text-fig. 16a-g.
1970 *Climacograptus medius* Törnquist - RICKARDS, p. 30, pl. 1, fig. 2.
1974 *Climacograptus medius* Törnquist - HUTT, p. 19, pl. 1, fig. 3.
1975 *Climacograptus medius* Törnquist - BJERRESKOV, p. 24, text-fig. 9C.

1983 *Climacograptus medius* Törnquist - WILLIAMS, p. 616, text-fig. 5f-i. (See for further reference list).

Lectotype – Designated Přibyl (1948, p. 16). The specimen figured by Törnquist (1897, pl. 1, fig. 9) from the *Rastrites* Beds of Nyhamn, Sweden.

Material – 14 flattened, mostly complete rhabdosomes.

Horizon and locality – *Par. acuminatus* Zone at Monte Cortoghiana Becciu (MCB 4).

Description – Most rhabdosomes are 10-20 mm long. The proximal end is robust and rounded, and the distal part is wide and nearly parallel-sided. Dorso-ventral width is 1.0-1.5 mm at the level of the first thecal pair, 1.5-2.2 mm at the level of 3rd thecal pair and then slowly reaches the maximum width of 2.1-2.7 mm at the level of 5-7th thecal pair.

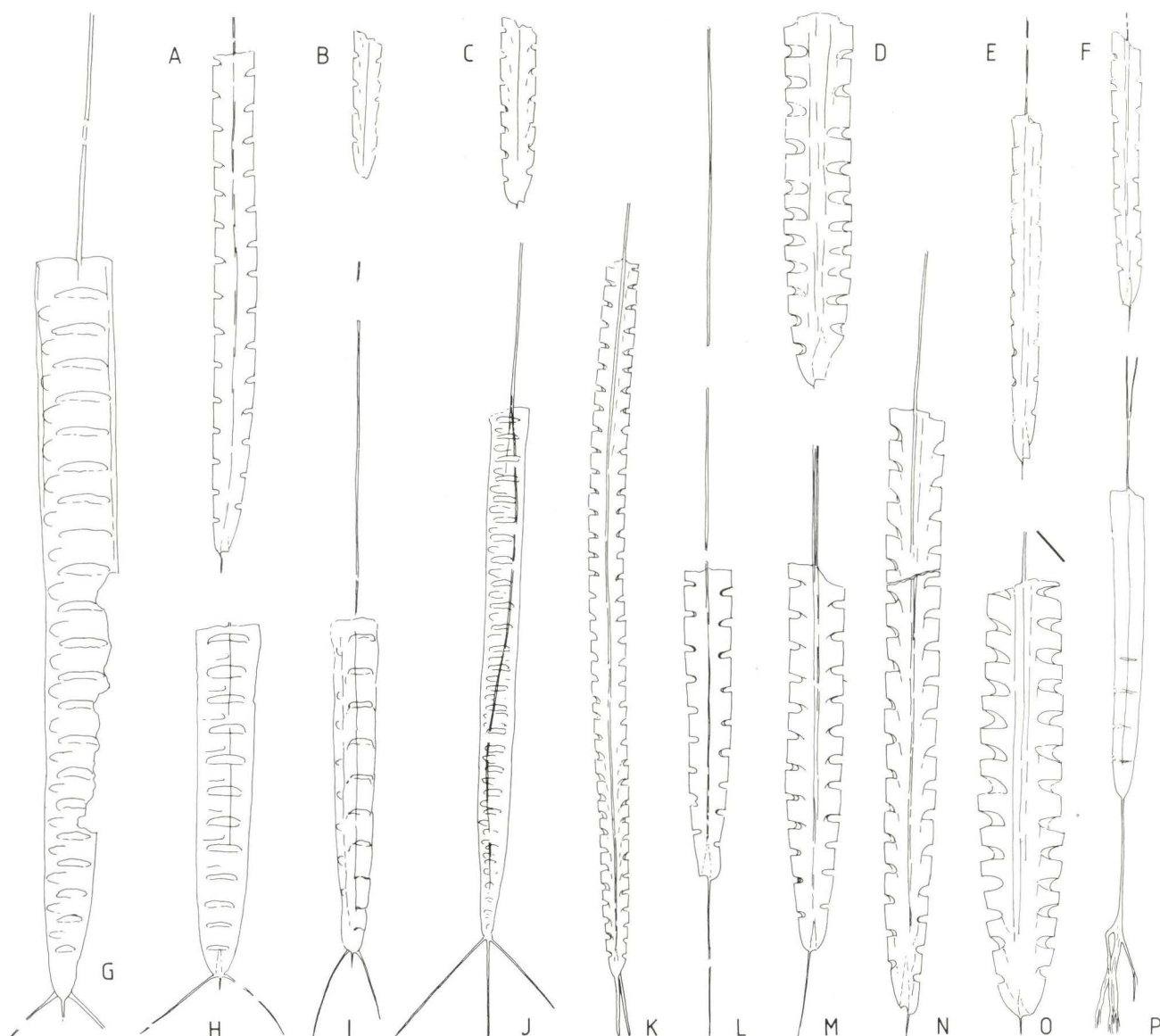
Thl¹ grows down to slightly below the sicular aperture and then, together with thl², grows outwards and upwards, forming the characteristically blunt, rounded proximal end. The length of the sicula remains unknown. the sicular aperture is 0.25-0.35 mm wide and possesses a short virgella.

The climacograptid thecae have short, straight supragenicular walls which are normally parallel-sided but in some proximal thecae are slightly inclined towards the proximal end of the rhabdosome. The apertures open into deep excavations which occupy nearly one-third of the total width of the rhabdosome and, in some specimens, are nearly as long as the supragenicular walls. The apparent depth of the excavations depends on the orientation of the flattened rhabdosome. Thecae number 12-13 in 10 mm most proximally (exceptionally 11 in 10 mm) and 10-11 in 10 mm distally. The median septum appears to begin at the 3rd-4th thecal pair. The rhabdosome has a 10-19 mm long, distally projecting nema.

Remarks – The Sardinian specimens characterised by a wide rhabdosome with a blunt proximal end and deep and wide apertural excavations match those described by Hutt (1970), Williams (1983) a.o. The greater width of the rhabdosome from Sardinia can be explained by their more intense flattening.

NORMALOGRAPTUS NORMALIS (Lapworth, 1877)
Pl. 1, figs. 3, 7?, 8; pl. 2, fig. 5; pl. 5, fig. 8; text-fig. 7 L, M?, N

- 1877 *Climacograptus scalaris* var. *normalis* LAPWORTH, p. 138, pl. 6, fig. 31.
1906 *Climacograptus scalaris* (Hisinger), var. *normalis* Lapworth - ELLES & WOOD, p. 186, pl. 26, fig. 2a-g; text-fig. 119a-d.
1922 *Climacograptus scalaris* His. sp. var. *normalis* Lapworth - GORTANI, p. 104, pl. 17, fig. 23.



Text-fig. 7 - A?, B, C, E, F - *Normalograptus angustus* (Perner); A?) n. 22489, B) n. 22470, C) n. 22485, E) n. 22574/1, F) n. 22580. D, O - *Normalograptus medius* (Törnquist); D) n. 22587/3, O) n. 22588. G-J - *Normalograptus trifilis* (Manck); G) n. 22557, H) n. 22486, I) n. 22482, J) n. 22402. K - *Normalograptus* sp. A; n. 22474. L, M?, N - *Normalograptus normalis* (Lapworth); L) n. 22475a, M?) n. 22466, N) n. 22575. P - *Normalograptus* sp. B; n. 22500a.
All specimens from the *acuminatus* Zone of Monte Cortoghiana Becciu (MCB 1 - fig. P; MCB 2 - fig. G; MCB 3 - figs. F, I, J, L, M; MCB 4 - figs. A-E, H, K, N, O). Figs. A-I, L-P: x 5, figs. J, K: x 2.5.

- 1929 *Climacograptus scalaris* var. *normalis* Lapworth - DAVIES, p. 8, text-fig. 29.
1948 *Climacograptus scalaris* v. *normalis* Lapworth - WAERN, p. 449, pl. 26, fig. 1; text-fig. 5.
1965 *Climacograptus scalaris normalis* Lapworth - STEIN, p. 157, pl. 14c; text-figs. 13, 14a-e.
1970 *Climacograptus normalis* Lapworth - RICKARDS, p. 28, pl. 1, figs. 1, 7, 8; text-fig. 13, figs. 7, 8.
1974 *Climacograptus normalis* Lapworth - HUTT, p. 19, pl. 1, figs. 8, 9; pl. 2, figs. 1-4.
1976 *Hedrograptus normalis* (Lapworth) - SENNIKOV, p. 133, pl. 4, figs. 12, 13.
1983 *Climacograptus normalis* Lapworth - KOREN *et al.*, p. 133,

- pl. 37, figs. 1, 6-11; pl. 38, fig. 1-5; pl. 39, fig. 7; text-fig. 48.
1983 *Climacograptus normalis* Lapworth - WILLIAMS, p. 611, text-figs. 3a-e, 4a-e, 7g. (See for further reference list).

Holotype - By monotypy. The specimen no. BU 1136 figured by Lapworth (1877, pl. 6, fig. 31); from the Birkhill Shale at Dob's Linn, Scotland. Housed in Collections of Birmingham University.

Material - 8 more or less complete flattened specimens.

Horizon and locality – *Par. acuminatus* Zone at Monte Cortoghiana Becciu (MCB 3 and 4), *Cyst. vesiculosus* - *C. cyphus* Zone at Terra Murus (TM C), and unknown zone at Genna Quadroxius (GQX).

Description – The rhabdosome has a tapered proximal part and is parallel-sided distally. It is about 20 mm long. Dorso-ventral width is 0.85-0.95 mm at the level of the 1st thecal pair, and 1.1-1.35 mm at the level of 3rd thecal pair. The maximum width of the flattened specimens from Genna Quadroxius is greater. The sicula aperture is 0.2-0.25 mm wide, with an up to 4.5 mm long virgella.

Thecae are climacograptid, sharply geniculate, with nearly semicircular apertures which occupy more than one-quarter of the total dorso-ventral width of the rhabdosome. The supragenicular walls of the alternate to subalternate thecae are almost vertical (i.e. parallel-sided). Thecae number 10.5-12.5 in 10 mm proximally and 9.5-10.5 in 10 mm distally. The 2TRD of th_2^1 is 1.6-1.8 mm. The thecal count varies greatly in tectonically compressed specimens from Genna Quadroxius. The median septum appears to be complete. The maximum length of the nema is 16 mm.

Remarks – Our specimens tend to be broader than those described by Rickards (1970) and Hutt (1974) from Britain. They could be confused with *Norm. trifilis* (Manck) when the latter's lateral spines are not preserved and the rhabdosome is exceptionally narrow. *Norm. medius* (Törnquist) has a much more robust rhabdosome with larger apertural excavations and a blunter proximal end. *Norm. rectangularis* (McCoy) and *Norm. praemedius* (Waern) have a tapering proximal end.

NORMALOGRAPTUS TRIFILIS (Manck, 1923)

Pl. 1, figs. 2, 5; pl. 5, fig. 5; text-fig. 7 G-J

- 1906 *Climacograptus medius* Törnquist - ELLES & WOOD (*pars*), p. 189, pl. 26, fig. 4f; text-fig. 122b (non pl. 26, fig. 4a-e; text-fig. 122a, c).
- 1923 *Climacograptus trifilis* spec. nov. MANCK, p. 288, text-fig. 32.
- 1965 *Climacograptus trifilis* Manck - STEIN, p. 165, text-fig. 17a-d. (See for further reference list).
- 1971 *Climacograptus trifilis trifilis* Manck - SCHAUER, p. 26, pl. 3, figs. 1-3; pl. 5, figs. 4-6.
- 1975 *Climacograptus trifilis trifilis* Manck - BJERRESKOV, p. 23, text-fig. 9b.
- 1983 *Climacograptus trifilis* Manck - WILLIAMS, p. 618, text-fig. 5c.

Holotype – By monotypy. The specimen figured by Manck (1923; text-fig. 32); from an unknown locality and horizon of Llandovery of Thuringia.

Material – Over 60 flattened, mostly complete specimens.

Horizon and locality – *Par. acuminatus* Zone at Monte Cortoghiana Becciu (MCB 1-4).

Description – The rhabdosome is over 30 mm long, apparently nearly circular in cross-section, tapering proximally. The width of the rhabdosome increases from 0.85-1.0 mm at the level of the apertures of the first thecal pair to 1.1-1.4 mm at the 3rd thecal pair. The width is the same for both normal and scalariform views. The maximum width of 1.7-2.0 mm is attained at about the level of the 10th thecal pair. Late adult rhabdosomes attain a width of 2.2 mm in their distal parts.

The sicula, with its thickened apertural rim, is not exposed. Measurement of the sicula length was not possible. The sicula is provided by a long, stout virgella and two basal spines of similar size. The virgella is commonly 8-10 mm long (in some specimens it is even longer). The two basal (antivirgellar) spines are over 3 mm (commonly 8 mm) long, straight or slightly curved at the base. They grow symmetrically in both lateral directions of the biserial rhabdosome. Their original angle of divergence (80-110°) is thus preserved in scalariform views of the rhabdosome, which are consequently common, in contrast to normal, biprofile views of the rhabdosome in which the lateral spines are broken or flexed. Subscalariform views of the rhabdosome exhibit a much lower angle of divergence between the spines.

Both the long virgella and the long basal spines developed during early astogeny. Specimens with 3 thecal pairs already possessed over 2 mm long spines and a somewhat longer virgella.

Thecae are climacograptid, clearly alternating, with strong genicula and semicircular, slightly asymmetrical apertural excavations which occupy less than one-quarter of the total rhabdosome width. The length of th_1^1 free ventral wall is 1.4-1.5 mm, whilst the length of the supragenicular walls of distal thecae is 0.85-0.9 mm. Thecae number 10.5-12 in 10 mm proximally and 8-9 in 10 mm distally. The 2TRD of th_2^1 is 1.5-1.6 mm. The median septum appears to be complete. A stout virgula extends into an up to 20 mm long nema.

Remarks – *Normalograptus trifilis* (Manck) differs from other normalograptids in its possession of a long virgella and two basal (probably antivirgellar) spines which originated from the apertural rim of the sicula and grow ventrally, perhaps in a plane of symmetry with the virgella.

The two forms of spinosity of *Norm. trifilis*

discussed by Stein (1965) have been found, both at Sardinian and Bohemian localities, by us. The first one is the typical *Norm. trifilis* with a 5+ mm long virgella (commonly up to 10 mm long), which has lateral spines of variable but comparable length. The second form has a shorter, less than 1 mm long, virgella and over 8 mm long lateral spines. This form could be related to «*Climacograptus*» *longifilis* Manck (see Schauer, 1971) or «*Climacograptus*» *trifilis kirstei* Hemmann. In Sardinia the two forms come from the same horizon (even the same bedding planes), in contrast to Bohemia, where the latter one is the younger one. As the other parameters are identical in the two forms, we have assigned them to one species.

Normalograptus trifilis is a characteristic species of the middle part of *acuminatus* Zone (*sensu* Rickards, 1988) of Europe. It is known from Wales and Scotland (Elles & Wood, 1906; Williams, 1983), Germany (Stein, 1965; Schauer, 1971), Denmark and Sweden (Bjerreskov, 1975; Nilsson, 1984), Bohemia (Štorch, 1982), and Spain (Gutierrez-Marco & Robardet, 1991).

NORMALOGRAPTUS sp. A (aff. *TRIFILIS*)

Pl. 4, fig. 8; text-fig. 7 K

Material – Two flattened complete rhabdosomes.

Horizon and locality – *Par. acuminatus* Zone at Monte Cortoghiana Becciu (MCB 4).

Description – Two long rhabdosomes (33 and 40 mm), with a peculiar proximal development, have been found in our material. They are normally oriented on the bedding plane and are similar to the adult rhabdosomes of *Norm. trifilis* in terms of thecal shape, dimensions, thecal count, and maximum width of the rhabdosome. Thecal count is 10.5-11 in 10 mm proximally and 9-9.5 in 10 mm distally. The initial width of 1.1 mm increases to 1.3 mm at the level of the 3rd. thecal pair, and to 2.2 mm distally. The sicula and virgella are not recognisable. Finger-like lateral spines are blunt, 0.2 mm wide (not flattened) and 1.3-3.4 mm long.

There is as yet insufficient material to recognise whether these specimens represent a new taxon or are abnormal specimens of *Norm. trifilis* (Manck).

NORMALOGRAPTUS sp. B

Text-fig. 7 P

Material – One complete flattened rhabdosome.

Horizon and locality – Lower part of *Par. acuminatus* Zone at Monte Cortoghiana Becciu (MCB 1).

Description – The rhabdosome is preserved in scalariform view. It is 9.3 mm long and widens from 0.6 mm to 1 mm. The maximum width is attained near its distal end. The thecal count is about 6 in 5 mm (12 in 10 mm). The proximal end possesses a prominent virgella which forks 3.7 mm away from the sicular aperture into a ramose, 3.5 mm long and 1.15 mm wide structure. Distally the rhabdosome is prolonged into an over 10 mm long nematularium which attains a width of 0.4 mm near its distal end.

Remarks – The specimen described here resembles *Norm. angustus* (Perner) in its general dimensions. Further determination is complicated by the scalariform orientation of the rhabdosome. *Norm. sp. B* is distinguished from most, roughly coeval species by its small *angustus*-like rhabdosome with furcated virgellar structure. The closest specimens were described by Müller (1975, 1977) from the *acuminatus* Zone of the Silurian of Thuringia. Both his specimens and our *Normalograptus* sp. B are similar also to *Glyptograptus avitus* Davies. They differ in the type of virgellar bifurcation and in thecal morphology.

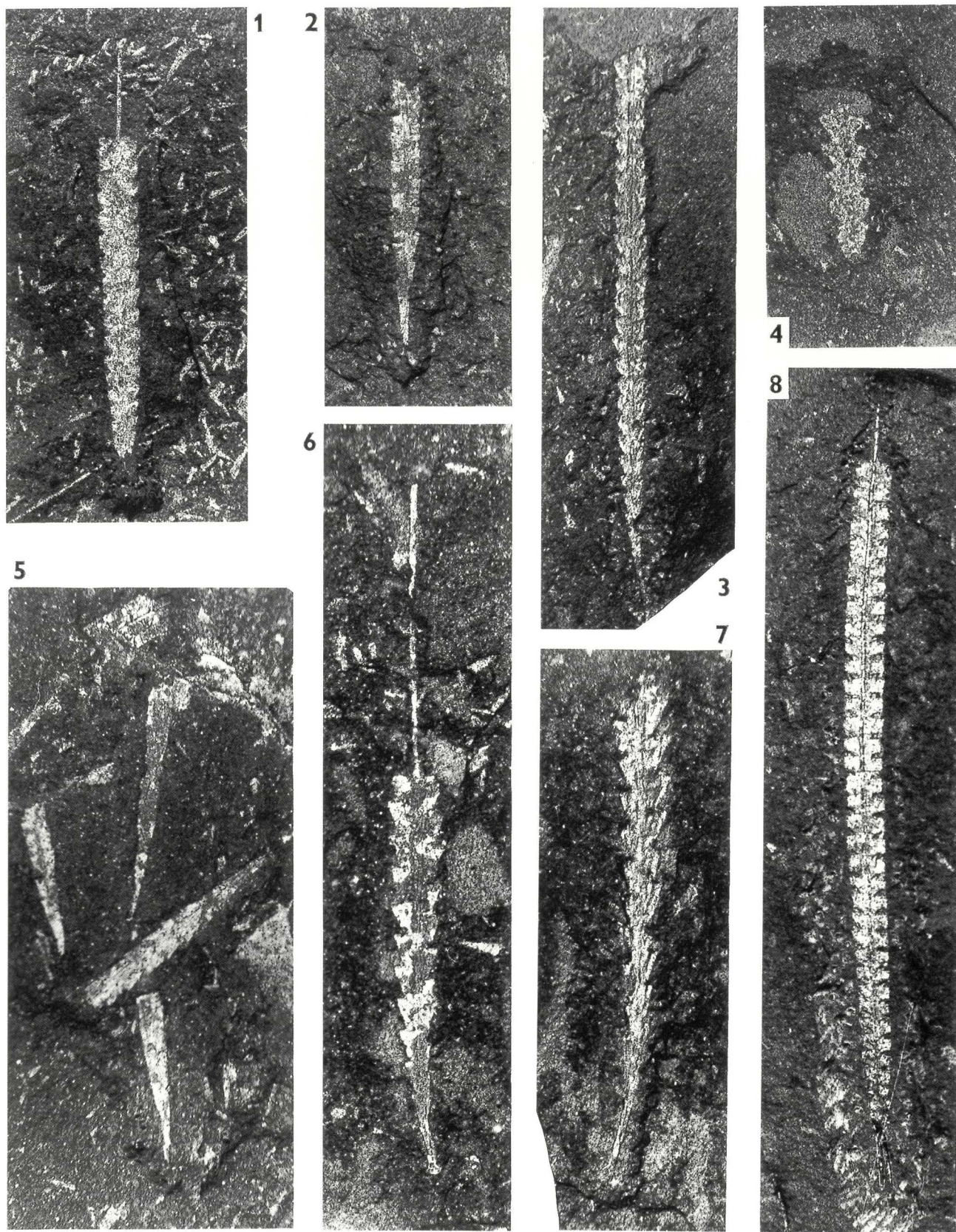
Family DIMORPHOGRAPTIDAE Elles & Wood, 1908; emend. Mitchell, 1987

Diagnosis (modified after Mitchell, 1987) – Biserial, proximally more or less uniserial rhabdosomes with thl^2 reduced or absent. Astogeny of Pattern I (see Mitchell, 1987). Sicula commonly with

EXPLANATION OF PLATE 4

- Fig. 1 - *Neodiplograptus* cf. *parajanus* (Štorch), n. 22487
 Figs. 2, 5 - *Akidograptus ascensus* Davies, 2) n. 22467, 5) n. 22475a.
 Figs. 3, 6, 7 - *Parakidograptus acuminatus* (Nicholson), 3) n. 22478, 6) n. 22476, 7) n. 22404.
 Fig. 4 - *Glyptograptus cortoghianensis* n. sp., n. 22483.
 Fig. 8 - *Normalograptus* sp. A, n. 22474.

All specimens from the *acuminatus* Zone of Monte Cortoghiana Becciu (MCB 3 - figs. 1, 2, 5, 6; MCB 4 - figs. 3, 4, 7, 8). Figs. 1, 3, 8, x 3; figs. 2, 4-7, x 5.



ancora. Straight median septum developed in the biserial part of the rhabdosome. Thecae climacograptid to orthograptid.

Subfamily AKIDOGRAPTINAE Li & Ge, 1981; emend.

Diagnosis – Biserial rhabdosome with extremely protracted proximal end, with complete early thecal development of Pattern I. The long, prominent sicula is completely exposed on one side and usually provided with a simple ancora. From the reverse view the sicular apex is mostly covered by an upwardly growing dicalycal thl². Thecae are sharply geniculate (nearly climacograptid) to orthograptid.

Genus AKIDOGRAPTUS Davies, 1929

Type species (by original designation) – *Akidograptus ascensus* Davies, 1929; from the Llandovery of Dob's Linn, Scotland.

Diagnosis – After Li & Ge, 1981.

AKIDOGRAPTUS ASCENSUS Davies, 1929

Pl. 4, figs. 2, 5; text-fig. 8 C, D

- 1929 *Akidograptus ascensus* sp. nov. DAVIES, p. 9, text-figs. 22-24.
 1962 *Akidograptus ascensus* Davies - TOMCZYK, p. 91, pl. 4, fig. 1; pl. 7, fig. 1.
 1964 *Akidograptus ascensus* Davies - YANG, p. 634, pl. 1, figs. 6-11.
 ? 1964 *Akidograptus giganteus* sp. nov. YANG, p. 635, pl. 1, fig. 13.
 1965 *Diplograptus (Akidograptus) ascensus* Davies - STEIN, p. 176, pls. 14f, 15b; text-figs. 22a, d; 23a-c.
 1967 *Akidograptus ascensus* Davies - OBUT *et al.*, p. 73, pl. 6, figs. 8, 9.
 1971 *Akidograptus ascensus* Davies - SCHAUER, p. 53, pl. 11, figs. 4-6; pl. 12, figs. 6-10.
 ? 1973 *Akidograptus cultus* sp. nov. MIKHAYLOVA, p. 18, pl. 4, figs. 6, 7.
 1974 *Akidograptus ascensus* Davies - HUTT, p. 55, text-fig. 9, figs. 9, 10.
 1975 *Akidograptus ascensus* Davies - BJERRESKOV, p. 42, text-fig. 13 D, E.
 ? 1980 *Akidograptus ascensus cultus* Mikhaylova - KOREN *et al.*, p. 169, pl. 53, fig. 4; pl. 54, figs. 2-6; text-fig. 57a-c.
 1981 *Akidograptus ascensus* Davies - LI & GE, p. 227, pl. 1, figs. 1, 2.
 1983 *Akidograptus ascensus* Davies - ŠTORCH, p. 297, pl. 2, figs. 5-9; text-fig. 1 B, C, F, H.
 1983 *Akidograptus ascensus* Davies - WILLIAMS, p. 629, text-figs. 9f-h, 10j-n. (See for further synonymy list)

Holotype – The specimen no. SM A10021 figured by Davies (1929, text-fig. 23); from the *acuminatus* Zone of Birkhill Shales at Dob's Linn, Scotland. Housed in the Sedgwick Museum, Cambridge.

Material – 19 flattened, mostly complete specimens.

Horizon and locality – *Par. acuminatus* Zone at Monte Cortoghiana Becciu (MCB 1-4) and Terra Murus (TM B).

Description – The rhabdosome is commonly about 10 mm long (max. 13.5 mm), with a protracted proximal end with a completely exposed sicula. The sicula seems to be about 1.5 mm long, with a straight, 0.25 mm wide aperture when flattened. It is provided with a virgella which bifurcates into two or three lateral, about 0.3 mm long spines 0.1-0.2 mm away from its apertural margin. It is regarded as a simple ancora.

Thl¹ starts to grow upwards from a point 0.3-0.4 mm above the sicular aperture. The length of the free ventral wall of thl¹ is 1.6-2.0 mm, thus the distance between thl¹'s aperture and the sicular aperture is 1.9-2.3 mm. Thecae are alternate to subalternate distally, and grow almost parallel to the rhabdosome axis. genicula are enhanced by flattening so that some specimens show thecae of climacograptid appearance. Shallow apertural excavations take up less than one-quarter of the total rhabdosome width. Apertures are straight or slightly everted. The thecae number 9.5-11 in 10 mm. Supragenicular walls are inclined at an angle of up to 10° to the rhabdosome axis. The 2TRD of th² is 2.0-2.3 mm.

The rhabdosome widens from 0.6-0.7 mm at the level of the aperture of thl² to a maximum width of 0.9-1.2 mm, which is attained at the level of about the 6th thecal pair. The median septum is complete. The virgula extends several mm away from the distal end of the thecate part of the rhabdosome.

Remarks – *Akidograptus ascensus* Davies is distinguishable from the species of the genus *Parakidograptus* by its strongly geniculate thecae and smaller dimensions. The new species of *Akidograptus* described by Li & Ge (1981), *A. antiquus*, *A. anhuiensis* and *A. parallelus*, are not discussed due to their inadequate figures and description only in Chinese. *A. ascensus* is an important species which marks the base and lower to middle parts of the *acuminatus* Zone throughout the world.

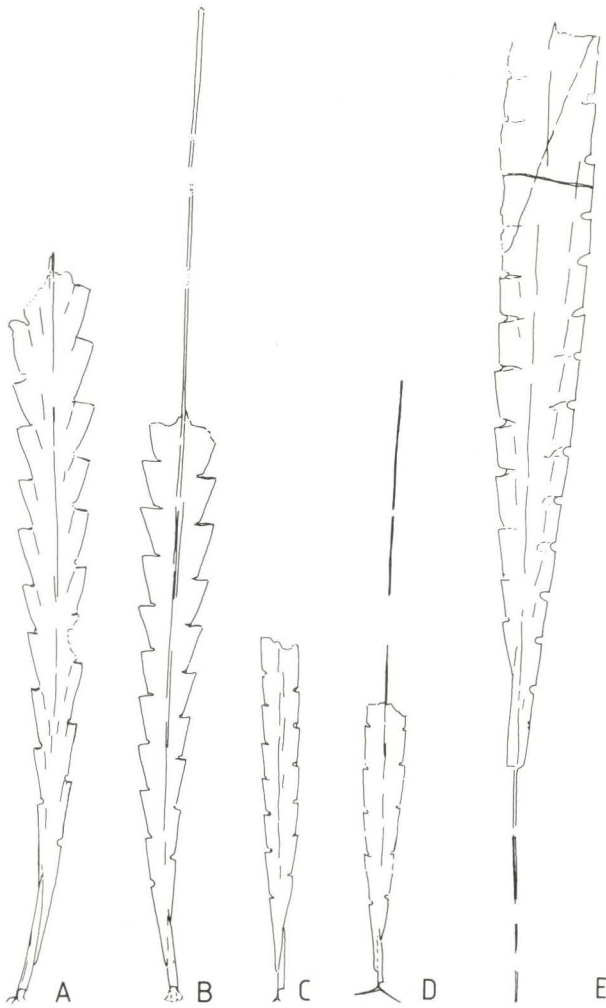
Genus PARAKIDOGRAPTUS Li & Ge, 1981

Type species (by original designation) – *Diplograptus acuminatus* Nicholson, 1867, p. 109, pl. 7, figs. 16, 17; from the Llandovery of Scotland.

Diagnosis – After Li & Ge, 1981.

PARAKIDOGRAPTUS ACUMINATUS (Nicholson, 1867)

Pl. 4, figs. 3, 6, 7; text-fig. 8 A, B



Text-fig. 8 - A, B - *Parakidograptus acuminatus* (Nicholson); A) n. 22404, B) n. 22476. C, D - *Akidograptus ascensus* Davies; C) n. 22467, D) n. 22484. E - *Rhaphidograptus toernquisti* (Elles & Wood); n. 24080. Specimens on figs. A-D from the *acuminatus* Zone of Monte Cortoghiana Becciu (MCB 3 - figs. B, C; MCB 4 - figs. A, D); specimen on fig. E from the *vesiculosus* - *cyphus* Zone of Terra Murus (TM C). All figs. x 5.

1984 *Parakidograptus acuminatus* (Nicholson) - LIN & CHEN, p. 219, pl. 6, figs. 7, 8.

Type specimen - According to Strachan (1971, p. 49) the type specimen figured by Nicholson has not been found.

Material - 22 flattened, mostly complete specimens and one in low relief.

Horizon and locality - *Par. acuminatus* Zone at Monte Cortoghiana Becciu (MCB 2-4) and Terra Murus (TM B).

Description - The rhabdosome is wedge-shaped, slightly curved in a sabre-like manner in some adult specimens, and has a typically protracted proximal end. Most specimens attain a length of 10-20 mm. Some are over 30 mm (max. 42 mm) long. The width of 0.6-0.7 mm, recorded at the level of the aperture of $th1^2$, increases to 1.6-2.0 mm at the level of about the 10th thecal pair.

The sicula is prominent, approximately 2 mm long, completely exposed in obverse view. From the reverse view the apex is covered by the dicalycal $th1^2$. The sicular aperture is provided with a short root-like structure which could be considered as a primitive ancora. It is preserved in most specimens. $Th1^1$ is 2-2.6 mm long (extremes are 1.8-2.8 mm), and originates 0.6-0.85 mm above the sicular aperture and grows upwards almost parallel with the rhabdosome axis. The distance between $th1^1$'s aperture and the sicular aperture is 2.6-3.6 mm.

The thecae are simple tubes with indistinct genicula and straight, distally facing or slightly introverted apertures. Inclination of the ventral walls is about 5-10° in the proximal thecae. Distally the free ventral walls often become slightly convex and the angle of inclination increases up to about 30°. The distal part of the rhabdosome has a characteristic saw-like appearance with prominent wedge-shaped apertural excavations which occupy one-quarter to one-third of the total rhabdosome width. The thecal count is low - 8-9.5 in 10 mm proximally and 8.5-9.5 in 10 mm distally. It is either the same throughout the whole rhabdosome or a little lower distally. The 2TRD of $th2^1$ is about 2.5-2.6 mm (extremes 2.1 and 2.7 mm). The median septum is complete. It appears at the level of $th1^2$'s aperture. The nema is prolonged distally for over 10 mm.

Remarks - *Parakidograptus acuminatus* (Nicholson) is easily recognised by its protracted proximal end (in contrast to *Parakidograptus praematurus* (Davies)), and its orthograptid thecae with prominent wedge-shaped excavations and wide apertures. Comparison with recently described *Par. acuminatus minimus* Li & Ge, *Par. angustitubus* Li & Ge, *Par.*

- 1867 *Diplograptus acuminatus* n. sp. NICHOLSON, p. 109, pl. 7, figs. 16, 17.
- 1908 *Cephalograptus? acuminatus* (Nicholson) - ELLES & WOOD, p. 289, text-fig. 199, pl. 32, figs. 11a-d.
- 1929 *Akidograptus acuminatus* (Nicholson) - DAVIES, p. 9, text-fig. 32, fig. 10.
- 1967 *Akidograptus acuminatus* (Nicholson) - OBU, SOBOLEVSKAYA (& NIKOLAYEV), p. 74, pl. 6, figs. 10-13.
- 1970 *Akidograptus acuminatus* (Nicholson) - CHURKIN & CARTER, p. 34, pl. 3, figs. 16, 17; text-fig. 13 B.
- 1974 *Orthograptus? acuminatus acuminatus* (Nicholson) - HUTT, p. 37, pl. 7, fig. 9; text-fig. 9, fig. 11; text-fig. 10, fig. 4.
- 1981 *Parakidograptus acuminatus* (Nicholson) - LI & GE, p. 229, pl. 1, figs. 8-10.
- 1983 *Parakidograptus acuminatus* (Nicholson) - ŠTORCH, p. 298, pl. 1, figs. 1-8; pl. 2, figs. 1-4; text-fig. 1A, D, E, G, I-L.

helixiensis Li & Ge and *Par. huloensis* Li & Ge is not possible until additional illustrations and translation of Chinese descriptions are available.

Par. acuminatus (Nicholson) is a widespread index fossil which has been recorded from the base of Silurian throughout the world.

Subfamily DIMORPHOGRAPTINAE Elles & Wood, 1908; emend.

Diagnosis – Biserial, proximally uniserial rhabdosomes with metatheca of $th1^2$ absent. Length of the uniserial portion is variable. The median septum of the biserial portion is straight, when developed. The sicula commonly is small. Thecae climacograptid to orthograptid.

Genus RHAPHIDOGAPTUS Bulman, 1936

Type species (by original designation) – *Climacograptus törnquisti* Elles & Wood, 1906; from the Llandovery of Dob's Linn, Scotland.

Diagnosis – After Bulman, 1970.

RHAPHIDOGAPTUS TOERNQUISTI

(Elles & Wood, 1906)

Pl. 5, figs. 2, 4; text-fig. 8E

1906 *Climacograptus Törnquisti*, sp. nov. ELLES & WOOD, p. 190, pl. 26, figs. 6a-f, text-figs. 123a, b.

1970 *Rhaphidograptus toernquisti* (Elles & Wood) - RICKARDS, p. 54, text-fig. 13, figs. 1-3. (See for further synonymy list).

1974 *Rhaphidograptus toernquisti* (Elles & Wood) - HUTT, p. 53, pl. 9, figs. 1, 2; text-fig. 13, figs. 7-9.

1975 *Rhaphidograptus toernquisti* (Elles & Wood) - BJERRESKOV, p. 43, pl. 6, figs. C, D.

1979 *Rhaphidograptus toernquisti* (Elles & Wood) - PAŠKEVIČIUS, p. 150, pl. 8, figs. 1-3a, b; pl. 23, figs. 5a, b and 6.

Lectotype – Designated Přibyl (1948). Specimen no. BU 1155 figured by Elles & Wood (1906, pl. 26, fig. 6f); from the Birkhill Shales of Dob's Linn, Scotland.

Material – 7 more or less complete, flattened, poorly preserved rhabdosomes.

Horizon and locality – *Cyst. vesiculosus* - *C. cyphus* Zone at Terra Murus (TM C), *Dem. triangulatus* Zone at Terra Murus (TM A), *Dem. triangulatus* - *Dem. convolutus* Zones at Genna Quadroxius (GQX).

Description – Rhabdosomes are up to 20 mm long in our collection. The prominent, 1.7+ mm long sicula is almost completely exposed on one side. It is provided with a long and stout virgella. $Th1^1$ grows downwards and then turns upwards at the level of the sicular aperture. $Th2^2$ crosses the sicula below the aperture of $th2^1$. The rhabdosome is 0.55-0.75 mm wide at the level of the first thecal aperture. It widens to about 0.9 mm at the level of the apertures of $th2^2$ - 3^1 . The maximum width of the rhabdosome is about 2 mm in our material. Strongly geniculate, alternating thecae with semicircular apertural excavations number about 10 in the most proximal mm.

Remarks – Our specimens, although badly preserved, show all the most characteristic features of the widely distributed species *Rh. toernquisti*.

Family RETIOLITIDAE Lapworth, 1873;
emend. Mitchell, 1987

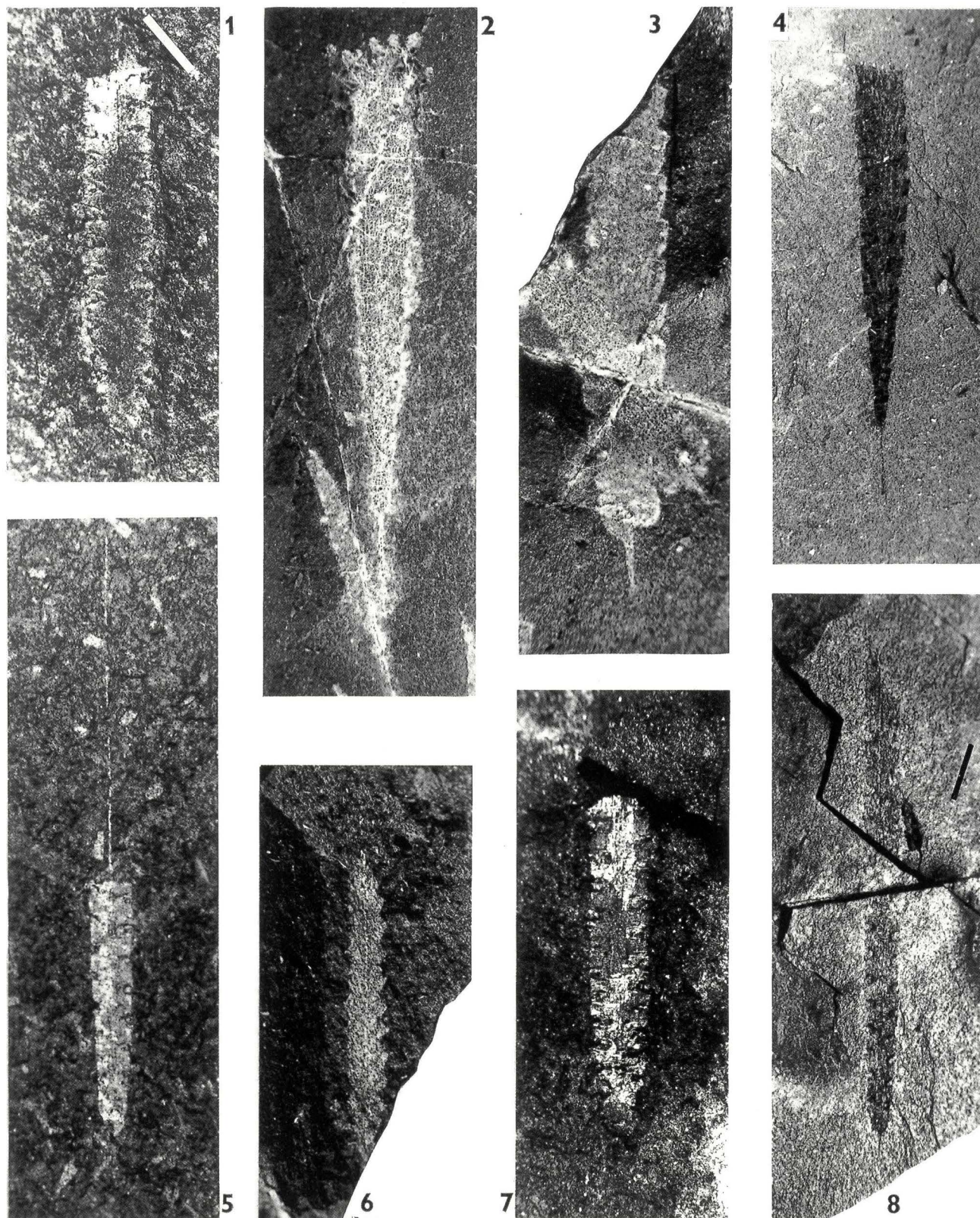
Diagnosis (after Mitchell, 1987) – Biserial rhabdosome with sharply acicular proximal end based on a Pattern I astogeny, among forms with fully sclerotised proximal end, or, commonly, an ancora-based retiolitid astogeny. Primitively with glyptograptid, orthograptid and/or petalograptid thecae but elaborated to glyptograptid, climacograptid, or to a framework of lists.

Remarks – In the present sense the family comprises three subfamilies: Petalograptinae Bulman, Retiolitinae Lapworth, and Plectograptinae Bouček & Münch.

EXPLANATION OF PLATE 5

- Figs. 1, 7 - *Normalograptus medius* (Törnquist), 1) n. 22588, 7) n. 22587/3.
Figs. 2, 4 - *Rhaphidograptus toernquisti* (Elles & Wood), 2) n. 24080, 4) n. 24081a.
Fig. 3 - *Cystograptus vesiculosus* (Nicholson), n. 24083.
Fig. 5 - *Normalograptus trifilis* (Manck), n. 22482, normal view, broken lateral spines.
Fig. 6 - *Petalograptus tenuis* (Barrande), n. 22567.
Fig. 8 - *Normalograptus normalis* (Lapworth), n. 22573b.

The specimens on figs. 1, 5, 7 come from the *acuminatus* Zone of Monte Cortoghiana Becciu (MCB 4), specimens on figs. 2, 3 ? 8 come from the *cyphus* - *vesiculosus* Zone of Terra Murus (TM C), that on fig. 4 from probable *triangulatus* Zone at Genna Quadroxius (GQX), and that on fig. 6 from the *turriculatus* Zone of Genna Muxerru (GMX A). Figs. 1-7, x 5; fig. 8, x 2.7.



Subfamily PETALOGRAPTINAE Bulman, 1955; emend.

Diagnosis – Rhabdosome fully sclerotised. Thecae long, straight or with gentle ventral curvature, commonly with large overlap. Some species have primitive, weakly geniculated, less overlapping, glyptograptid thecae. Th1¹ and th1² often with pronounced upward direction of growth, leaving sicula much exposed. Rhabdosome sub-circular to tabular, exaggeratedly rectangular in cross-section; septum partial or absent. Early astogeny of Pattern I (see Mitchell, 1987). Ancora commonly present. Some species have additional spines on thecal apertures.

Remarks – The subfamily is expanded here to encompass *Glyptograptus* Lapworth (with the early astogeny of Pattern I), *Pseudorthograptus* Legrand, *Petalograptus* Suess, and *Cephalograptus* Hopkinson.

Genus GLYPTOGRAPTUS Lapworth, 1873;
emend. Melchin & Mitchell, 1991

Type species (by original designation) – *Diplograptus tamariscus* Nicholson, 1869; from Duffkinnell Burn, Southern Scotland.

Diagnosis (modified after Melchin & Mitchell, 1991) – Rhabdosome ovoid to sub-circular in cross-section. Thecae alternating, geniculate, typically glyptograptid, with proximally inclined supragenicular walls. Proximal end rather slender, usually tapering. It is based on Pattern I astogeny. Rhabdosome usually aseptate although a partial median septum may be present. Sicula simple, generally short and broad, lacking antivirgellar spines.

GLYPTOGRAPTUS CORTOGHIANENSIS n. sp.
Pl. 2, fig. 1; pl. 4, fig. 4; text-fig. 5B, D

Derivation of name – After the type locality Monte Cortoghiana Becciu.

Holotype – Complete, flattened specimen no. 22586a (pl. 2, fig. 1; text-fig. 5D); from the *acuminatus* Zone of Monte Cortoghiana Becciu. Housed in the University of Modena (Collections of the Palaeontological Institute).

Material – 10 flattened, mostly complete specimens.

Horizon and locality – *Par. acuminatus* Zone at Monte Cortoghiana Becciu (MCB 3 and 4).

Diagnosis – Small rhabdosome widens rapidly from 1 mm to 1.3 mm, maximum width attained at the level of the apertures of the 3rd thecal pair.

Thecae overlap for about one-third of their length. Slightly curved or nearly straight supragenicular walls terminate in prominent excavations which occupy one-quarter of the total width of the rhabdosome. Virgella nearly indiscernible, nema short and slender.

Description – The longest rhabdosome found is 7 mm long. The rhabdosomes are 0.9-1.05 (max. 1.2) mm wide at the level of the 1st thecal pair and then rapidly attain the maximum width of 1.3 (1.1-1.5) mm at about the level of the apertures of the 3rd thecal pair.

The sicula is 1.3-1.4 mm long and slightly curved. It has a 0.2 mm wide aperture (exceptionally 0.4 mm) and its apex reaches above the first thecal aperture. Apparently the virgella is very short.

Th1¹ turns up just below the sicular aperture. The convex ventral walls of the metathecae of th1¹ and 1² give a rather blunt appearance to the proximal end. The succeeding thecae have slightly curved or straight, inclined supragenicular walls. Their genicula are flowing where visible. Thecal apertures are straight, horizontal or slightly everted. Rather deep apertural excavations occupy about one-quarter of the total width of the rhabdosome. Thecal count is 5.5-5.8 in 5 mm, 2TRD of th2¹ is 1.65-1.8 mm. A median septum appears to be present. The nema is short and slender.

Remarks – *Glyptograptus cortoghianensis* sp. n. resembles the contemporary species *Gl. avitus* Davies in its small dimensions and similar thecal spacing. The thecae of *Gl. cortoghianensis* are even more «orthograptid» and more steeply inclined to the axis than those of *Gl. avitus*. In contrast to both *Gl. avitus* and *Gl. nanus* Mu & Ni, the maximum width of the rhabdosome of *Gl. cortoghianensis* is achieved almost immediately. The virgella of our species is very small and never forked. An early astogeny of *Gl. cortoghianensis* is not yet known. On the basis of its weakly geniculate thecae we tentatively assigned the species to *Glyptograptus* Lapworth, characterised by the early astogeny of Pattern I (see Melchin & Mitchell, 1991).

Genus PETALOGRAPTUS Suess, 1851; emend.

Type species (subsequent designation by Lapworth, 1873) – *Prionotus folium* Hisinger, 1837; from the Llandovery of Sweden.

Diagnosis – Broad, tabular rhabdosome with long, tubular (petalograptid) thecae disposed at a high to moderate angle to the rhabdosome axis, and with large overlap. Thecal apertures may be everted. Thecae commonly with concave ventral walls that

may lead to apertural isolation. Distally, thecal inclination commonly increases. The sicula is partially exposed on one side. A four-branched ancora is often developed.

PETALOGRAPTUS TENUIS (Barrande, 1850)

Pl. 5, fig. 6; pl. 8, fig. 2; text-fig. 9B-D

- 1850 *Graptolithus palmeus* var. *tenuis* BARRANDE, p. 61, pl. 3, fig. 2.
 1908 *Diplograptus palmeus* var. *tenuis* Barrande - ELLES & WOOD, p. 276, pl. 32, figs. 3a-d; text-fig. 190.
 1941 *Petalolithus tenuis* (Barrande) - BOUČEK & PŘIBYL, p. 7, pl. 2, fig. 3; text-fig. 2, figs. 8-11.
 1971 *Petalolithus* (*Pet.*) *tenuis* (Barrande) - SCHAUER, p. 47, pl. 14, figs. 4-7; pl. 15, figs. 8-10; pl. 43, figs. 5a, b.
 1975 *Petalograptus tenuis* (Barrande) - BJERRESKOV, p. 34, text-fig. 12A.
 1979 *Petalograptus tenuis* (Barrande) - PAŠKEVIČIUS, p. 133, pl. 21, figs. 8-10, text-figs. 3-7.

Holotype - By monotypy. The specimen no. L 27569 figured by Barrande (1850, pl. 3, fig. 2); from the *turriculatus* Zone of the Litohlavý Formation at Litohlavý near Beroun, Bohemia. Housed in the National Museum, Prague.

Material - 8 more or less complete, flattened rhabdosomes, mostly tectonically deformed.

Horizon and locality - *S. turriculatus* Zone at Genna Muxerru (GMX A and F).

Description - The small rhabdosome attains a maximum length of 11 mm. The maximum width is 1.5-2.4 mm, depending on tectonic compression, and is reached by about the 5th thecal pair. The initial width is 1 mm. The sicula, rarely preserved in our specimens, is 1.3 mm long.

Straight, tube-like thecae overlap for one-half of their length throughout the rhabdosome. They are inclined at about 30° to the rhabdosome axis. The angle of inclination varies with tectonic compression. Thecae number 12.5-14 in 10 mm. The partial median septum is present. The nema is broken just beyond the distal end of the rhabdosome in our specimens.

Remarks - The specimens of *Pet. tenuis* (Barrande) from Genna Muxerru compare well with those from the type locality in Bohemia although the Sardinian specimens tend to have more closely spaced thecae (12.5-14 in 10 mm as oppose to 12-13 in topotypic material). *Pet. wilsoni* Hutt, from the *crispus* Zone of Great Britain, was distinguished from *Pet. tenuis* by its higher thecal count (13-14 in 10 mm), its more tapered proximal end, and by the common presence of a nematularium. All these differences, however, lie within the total variability of the topotypic population of *Pet. tenuis*. *Pet. wilsoni*

may only be separated by its slightly higher thecal count in 10 mm, and longer virgella.

PETALOGRAPTUS sp. A

Text-fig. 9E

Material - One complete, flattened and deformed rhabdosome.

Horizon and locality - ?*Dem. pectinatus* Zone at Genna Quadroxius (GQX).

Description - The rhabdosome is over 20 mm long. It widens from an initial width of 2 mm (at the level of the apertures of the first thecal pair) to a maximum width of 3 mm, which is attained at the 6-7th thecal pair. The sicula is not visible. The thecae are simple tubes, seemingly with partly isolated metathecae, and with straight apertures perpendicular to their longitudinal axes. The ventral walls of the first thecal pair are concave. The proximal thecae are inclined at an angle of 45° to the rhabdosome axis. Up to 3.4 mm long distal thecae are inclined at an angle of 35-40° to the rhabdosome axis. Thecae number 8-8.5 in 10 mm distally.

Remarks - The rhabdosome lies parallel to the cleavage. General dimensions and shape are so deformed that specific determination of the specimen is impossible.

Subfamily RETIOLITINAE Lapworth, 1873;
emend. Lenz & Melchin, 1987

Diagnosis (modified after Lenz & Melchin, 1987) - Rhabdosome with periderm reduced to meshwork and formed by well developed reticula supported on a distinct clathria. Sicula unsclerotised or partially sclerotised (prosicula and, rarely, metasicula). Ancora stage well developed. Clathrial «seams» (see Lenz & Melchin, 1987) face in, reticular «seams» face out; surface fine structures of longitudinal striations composed of peridermal fibrils.

Genus RETIOLITES Barrande, 1850

Type species (subsequent designation by Lapworth, 1873) - *Gladiolites Geinitzianus*, Barrande, 1850; from the Motol Formation, Wenlock, of Bohemia.

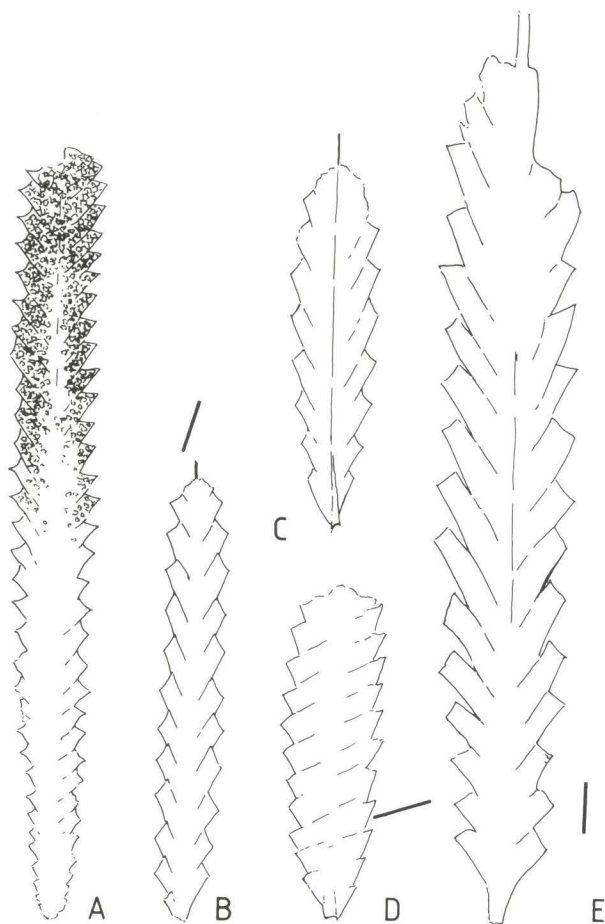
Diagnosis - After Bulman, 1970.

RETIOLITES GEINITZIANUS ANGUSTIDENS

Elles & Wood, 1908

Pl. 9, fig. 6; text-fig. 9A

- 1908 *Retiolites* (*Gladiograptus*) *Geinitzianus* Barrande var. *angustidens* ELLES & WOOD, p. 338, pl. 34, fig. 9a-c.



Text-fig. 9 - A - *Retiolites geinitzianus angustidens* Elles & Wood; n. 24036. B-D - *Petalograptus tenuis* (Barrande); B) n. 22567, C) n. 22534, D) n. 22530. E - *Petalograptus* sp. A; n. 24074.

Specimen on fig. A from the *griestoniensis* Zone of Genna Muxerru (GMX P); specimens on figs. B-D from the *turriculatus* Zone of Genna Muxerru (GMX A - fig. B; GMX F - figs. C, D); specimen on fig. E from Genna Quadroxius (GQX), probably from the *convolutus* Zone. Figs. B-E: x 5; fig. A: x 2.5.

- 1943 *Retiolites (Retiolites) geinitzianus angustidens* Elles & Wood, - BOUČEK & MÜNCH, p. 34, pl. 2, figs. 1-4, text-figs. 11a-e, 12b-e.
- 1966 *Retiolites angustidens* Elles & Wood - OBUT & SOBOLEVSKAYA, p. 16; pl. 3, figs. 14-16; text-fig. 8.
- 1971 *Retiolites (Ret.) geinitzianus angustidens* Elles & Wood - SCHAUER, p. 83, pl. 39, fig. 3; pl. 40, fig. 2.
- 1975 *Retiolites geinitzianus angustidens* Elles & Wood - BJERRESKOV, p. 38, pl. 5D, E.
- 1979 *Retiolites angustidens* Elles & Wood - PAŠKEVIČIUS, p. 142, pl. 6, figs. 5, 6; pl. 22, figs. 8, 9.
- 1982 *Retiolites geinitzianus angustidens* Elles & Wood - LENZ, p. 33, fig. 15C, H.
- 1988 *Retiolites angustidens* Elles & Wood - OBUT *et al.*, p. 44, pl. 3, figs. 3, 4. (See for further reference list).

Lectotype - Designated Bouček & Münch (1943). The specimen figured by Elles & Wood (1908, pl. 34, fig. 9a); from the Silurian of Falbogue Bay, Scotland.

Material - 6 almost complete and about 10 incomplete flattened rhabdosomes.

Horizon and locality - *Mcl. griestoniensis* Zone at Genna Muxerru (GMX P).

Description - The rhabdosome is commonly 20-30 mm long. It increases in width from about 1.5 mm at the level of the first thecal pair up to a maximum of 3.4-3.8 mm which is attained about 15 mm away from the ancora. The maximum width can reach 4.6 mm in specimens oriented perpendicular to the cleavage. The proximal end is poorly preserved in our specimens. The thecae are simple, parallel-sided tubes which overlap throughout their length. They are inclined at an angle of about 45° to the rhabdosome axis. The angle of inclination attains 55° in tectonically deformed specimens. The clathria is well developed. The virgula is present throughout the rhabdosome. Thecae number about 15 in the initial 10 mm of the rhabdosome, and 8.5-10 in 10 mm distally. The reticulum is present but poorly preserved in these specimens.

Remarks - Our specimens correspond with the subspecies *R. geinitzianus angustidens* Elles & Wood in terms of shape and size of the rhabdosome as well as in age. *Ret. geinitzianus geinitzianus* Barrande has a much longer and wider rhabdosome and, though hardly recognisable in the present material, a coarser reticulum. [D. Loydell (pers. comm.) believes that the material illustrated herein may be *Stomatograptus longus* Obut, 1949].

Family MONOGRAPTIDAE Lapworth, 1873

Diagnosis - See Mitchell, 1987 for Monograptinae.

Genus ATAVOGRAPTUS Rickards, 1974

Type species (by original designation) - *Monograptus atavus* Jones, 1909; from the Llandovery of the Rheidol Gorge, Mid Wales.

Diagnosis - After Rickards, 1974.

ATAVOGRAPTUS cf. GRACILIS Hutt, 1975 Text-fig. 10C

Material - Several proximal fragments, one of which possesses a sicula.

Horizon and locality - Possible *Cyst. vesiculosus* - *C. cyphus* Zone at Genna Quadroxius (GQX).

Description – The almost straight, extremely slender rhabdosome has a 3.0-3.4 mm long and 0.1 mm wide sicula which reaches to just below the first thecal aperture. The first metatheca originates 1.1 mm above the sicular aperture. Thecae are slender tubes with distinct genicula and narrow apertures. They are inclined at a very low angle to the axis of the rhabdosome. Th1 (metatheca) is 2.1 mm long. Thecal overlap appears to be about one-third. The 2TRD of th2 is 2 mm. The dorso-ventral width of the rhabdosome is 0.25-0.3 mm at the level of th3.

Remarks – These extremely slender fragments with atavograptid thecae closely resemble *A. gracilis* Hutt, 1975, the proximal end of which however, remains unknown.

Genus CORONOGRAPTUS Obut & Sobolevskaya, 1968; emend. Rickards, 1976

Type species (by original designation) – *Monograptus gregarius* Lapworth, 1876; from the Birkhill Shales of Dob's Linn, Scotland.

Diagnosis – After Rickards, 1976.

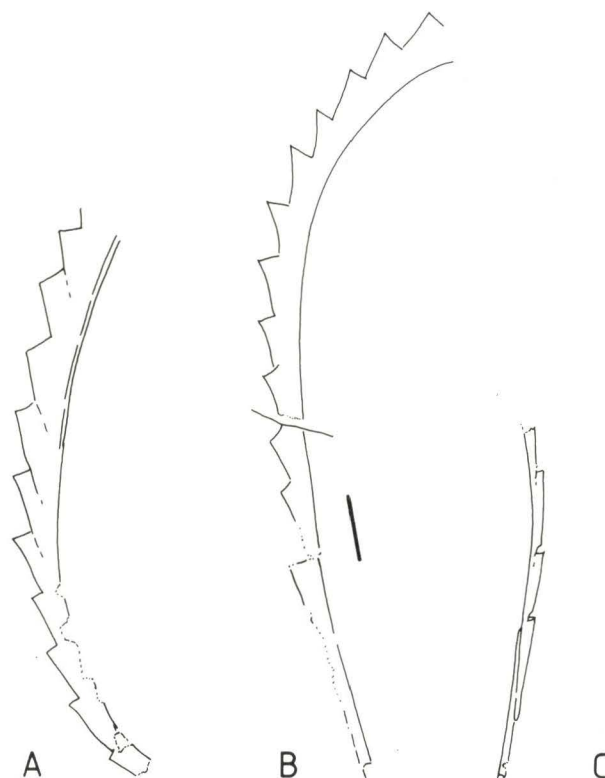
CORONOGRAPTUS cf. CYPHUS (Lapworth, 1876)
Text-fig. 10A, B

Material – 4 flattened, subproximal fragments and one distal part of the rhabdosome.

Horizon and locality – *Cyst. vesiculosus* - *C. cyphus* Zone at Terra Murus (TM C).

Description – The rhabdosome is arcuate, with tubular thecae on its convex side. The proximal end is slender with a 4+ mm long and partly isolated sicula. The first metatheca originates more than 2 mm from the sicular aperture. thecae are long and almost straight tubes, proximally with slightly everted ventral apertural margins. They number 9.5-10 in 10 mm proximally and 6 in 10 mm distally. Thecal inclination is about 20° proximally and less than 10° distally. The dorso-ventral width of the rhabdosome is 0.75 mm at the aperture of th7. Our fragments are up to 1.3 mm in width. The most complete one, which represents the distal part of the rhabdosome, is over 80 mm long.

Remarks – Sardinian rhabdosomes differs from the topotypic material in possessing a more protracted proximal end and, possibly, a longer sicula. They could come from a slightly older horizon based on the co-occurrence of *Cyst. vesiculosus* and *Atavograptus* sp. (aff. *atavus*).



Text-fig. 10 - A, B - *Coronograptus* cf. *cyphus* (Lapworth); A) n. 24100/1, B) n. 24082a. C - *Atavograptus* cf. *gracilis* Hutt; n. 24094b. Specimens on figs. A, B from the *vesiculosus* - *cyphus* Zone of Terra Murus (TM C); specimen on fig. C from Genna Quadroxiu (GQX), probably the *vesiculosus* - *cyphus* Zone. All figs. x 5.

Genus PRISTIOGRAPTUS Jaekel, 1889

Type species (by original designation) – *Pristiograptus frequens* Jaekel, 1889; from the Silurian of Germany.

Diagnosis – After Bulman, 1970.

PRISTIOGRAPTUS cf. BJERRINGUS (Bjerreskov, 1975)
Pl. 9, fig. 4; text-fig. 11F

Material – Two almost complete and three fragmentary flattened rhabdosomes.

Horizon and locality – *S. turriculatus* Zone at Genna Muxerru (GMX F).

Description – The rhabdosome is straight, attaining a length of over 60 mm. The longest distal fragment measures 58 mm. The dorso-ventral width increases from an initial 0.4 mm (0.8 mm in a tectonically broadened specimen) to nearly 2 mm, 20 mm from the proximal end. The maximum width of

3 mm is attained in flattened distal fragments. The sicula is not preserved. The thecae are simple tubes which are inclined at 35-45° to the rhabdosome axis. The distal thecae are 3-3.5 mm long and 0.6-0.7 mm wide, and overlap for two-thirds to three-quarters of their length. Thecae number 14 in the initial 10 mm and 9-10.5 in 10 mm distally.

Remarks – Our specimens closely resemble those of *P. bjerringus* (Bjerreskov) except for their much higher proximal thecal count (11 in 10 mm in *P. bjerringus*) and steeper thecal inclination which, however is caused by flattening. *Pristiograptus nudus* Lapworth has a narrower, more gradually widening rhabdosome and less thecal overlap.

PRISTIOGRAPTUS INITIALIS KIRSTE, 1919
Pl. 9, fig. 1; pl. 10, fig. 6; text-fig. 11D-E

- 1919 *Monogr. (Pristiogr.) initialis* EISEL - KIRSTE, p. 187, pl. 3, fig. 24.
1939 *Monograptus dubius* var. *initialis* KIRSTE - MÜNCH, p. 14, fig. 4.
1940a *Pristiograptus denemarkae* n. sp. PŘIBYL, p. 9, pl. 2, figs. 9, 10.
1940a *Pristiograptus pergratus* n. sp. PŘIBYL, p. 8, pl. 2, figs. 11, 12.
1944 *Pristiograptus initialis* (Eisel MS), KIRSTE - PŘIBYL, p. 9, pl. 2, figs. 1-4.
1971 *Monograptus (Pristiogr.) dubius initialis* EISEL 1899 - SCHAUER, p. 63, pl. 21, figs. 10, 11; pl. 23, figs. 3, 4.

Neotype – *Pristiograptus initialis*, the MS species of Eisel, 1899, was described and figured by KIRSTE (1919, pl. 3, fig. 24). The type specimen, however, is lost. Therefore a neotype was selected from the topotypic specimens described and figured by Schauer (1971). The neotype is the specimen no. 111/Ro I - 82/10 figured by Schauer (1971) pl. 21, fig. 10; from the Llandovery of Raitzhain (Ronneburg), Thuringia. Housed in the Geological Institute of Bergakademie Freiburg.

Material – 7 complete, flattened, slightly tectonically deformed specimens.

Horizon and locality – *Mcl. griestoniensis* Zone at Genna Muxerru (GMX P).

Description – The minute rhabdosome is slightly ventrally curved at about the level of the 3rd-4th theca, and is straight distally. The length of the specimens studied varies between 7-12.5 mm. The width of the rhabdosome is 0.7 mm to 0.9 mm at the level of the aperture of th1 and then increases rapidly over the 3-4 proximal thecae to 0.9-1.1 mm.

The sicula is over 1.5 mm long and 0.3 mm wide at the apertural margin (when flattened). The first theca originates at the level of the sicular aperture.

The distance between th1's aperture and the sicular aperture is 1.1-1.3 mm. Thecae are simple tubes inclined at an angle of 30-40° to the rhabdosome axis. Commonly the free ventral wall is inclined at a slightly lower angle than the interthecal septa. Thecae overlap for less than one-half of their length. The straight thecal apertures face dorso-ventrally. Thecae number 10.4-12 in 10 mm. The 2TRD of th2 is 1.3-1.4 mm.

Remarks – This is an early member of the pristiograptid group comprising *Pr. initialis* KIRSTE, *Pr. praedubius* (Bouček), *Pr. pseudodubius* (Bouček), *Pr. interjectus* Obut Morozova, and *Pr. parvus* Ulst. *Pr. initialis* is distinguished by its smaller rhabdosome, higher thecal count (10.5-12) in 10 mm, and ventral curvature of the rhabdosome at the level of the 3rd-4th theca. It has been recorded, outside of Sardinia, from the upper Llandovery (*crispus* to *crenulata* Zones) of Germany (KIRSTE, 1919; Schauer, 1971) and Bohemia (Přibyl, 1944; Bouček, 1953).

PRISTIOGRAPTUS VARIABILIS (Perner, 1897)
Pl. 6, fig. 3; pl. 7, fig. 3; text-fig. 11A-C

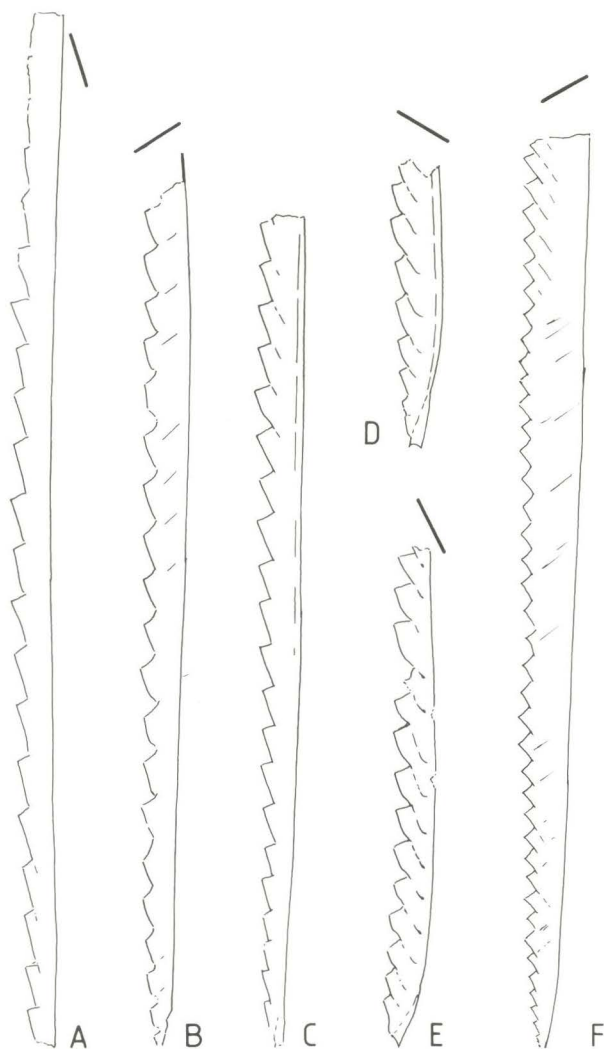
- 1897 *Monograptus jaculum* var. *variabilis* mihi PERNER, p. 21, pl. 13, figs. 10, 11, 15.
? 1911 *Monograptus variabilis* Perner - ELLES & WOOD, p. 374, pl. 37, figs. 5a, b; text-fig. 245a-c.
1940a *Pristiograptus variabilis* (Perner) - PŘIBYL, p. 5, pl. 1, figs. 1-3.
1971 *Monograptus (Pristiogr.) nudus variabilis* Perner - SCHAUER, p. 62, pl. 21, fig. 8; pl. 22, figs. 10, 11.
1982 *Pristiograptus* cf. *variabilis* (Perner) - LENZ, p. 61, figs. 5 K, N, O.

Lectotype – Designated Přibyl (1948). The specimen no. L 27452 figured by Perner (1897, pl. 13, fig. 11); from the *linnaei* Zone at Želkovice, Bohemia. Housed in the National Museum, Prague.

Material – 4 flattened rhabdosomes and several fragments.

Horizon and locality – *S. turriculatus* Zone at Genna Muxerru (GMX A and F).

Description – The straight and slender rhabdosome, though incomplete, attains 21 mm in length. The rhabdosome is 0.45 mm wide at the proximal end which possesses a small sicula. The thecae are simple tubes of pristiograptid type, inclined at 20-30° to the rhabdosome axis. They are 0.35 mm wide, about 1.2 mm long, and overlap for less than one-half of their length. The thecae number up to 14 in the initial 10 mm. The thecal count decreases to 9-12 in 10 mm distally. The maximum dorsoventral width of the rhabdosome is 1.2 mm.



Text-fig. 11 - A-C - *Pristiograptus variabilis* (Perner); A) n. 24046, B) n. 22538, C) n. 22566. D, E - *Pristiograptus initialis* Kirste; D) n. 22547, E) n. 22548. F - *Pristiograptus* cf. *bjerringus* (Bjerreskov); n. 22528. Specimens on figs. A-C, F from the *turriculatus* Zone of Genna Muxerru (GMX A - fig. C; GMX F - figs. A, B, F); specimens on figs. D, E from the *griestoniensis* Zone of Genna Muxerru (GMX F). Figs. A-E: x 5; fig. F: x 2.5

Remarks - The specimens from Sardinia correspond to *Pr. variabilis* (Perner) in their dorso-ventral width and thecal spacing and overlap. The type specimen of *Pr. variabilis*, however, has a lower thecal count proximally (12 thecae in 10 mm). Nevertheless, the average initial thecal count reaches 13 in 10 mm in topotypic specimens of *Pr. variabilis* from Želkovice. The lectotype lies at the margin of the species' variability in this parameter. *Pr. regularis* (Törnquist) differs from *Pr. variabilis* in having a much more robust rhabdosome and greater thecal

overlap at a corresponding distance from the proximal end.

Genus *MONOGRAPTUS* Geinitz, 1852;
emend. Bulman, 1970

Type species (subsequent designation by Bassler, 1915) - *Lomatoceras priodon* Bronn, 1835; from the Silurian of Germany.

Diagnosis - After Bulman, 1970.

Remarks - The genus is widely used as something of a «waste-basket» for most monograptid species. Periodically monograptids are pulled out of the «basket», grouped, and defined and/or redefined as new, probably phyletic genera or subgenera (*Coronograptus*, *Lagarograptus*, *Pribylograptus*, *Spirograptus*, *Stimulograptus*, *Streptograptus*, a.o.).

MONOGRAPTUS cf. *ARCUATUS* Bouček, 1931
Text-fig. 12R

Material - One long but incomplete rhabdosome and two poorly preserved proximal parts, all flattened on one slab.

Horizon and locality - ? *M. crispus* Zone at Genna Muxerru (GMX F).

Description - The 60+ mm long dorsally curved rhabdosome possesses a rather long and slender proximal part, probably resembling that of *M. planus* (Barrande). Neither proximal end nor details of the proximal thecae are preserved in Sardinian material. Mesial thecae are triangular, with a low angle of inclination and insignificant thecal overlap. Ventral thecal walls are inclined at an angle of about 20-35° to the rhabdosome axis. The apertural region of the theca seems to be hooked and to face laterally. The dorso-ventral width is a few tenths of a mm proximally, about 1 mm mesially, and up to 1.3 mm distally. The 2TRD is 2.1 mm mesially and up to 3 mm in the slightly tectonically broadened distal part. The mesial thecae number about 10 in 10 mm, distal thecae number only 6.5 in 10 mm.

Remarks - Our specimens resemble the topotypic material of *M. arcuatus* Bouček from the *crispus* and *griestoniensis* Zones of Bohemia. It has the same dorsal curvature of the rhabdosome and elongate thecae with small, hooked, and twisted apertures. The dorso-ventral width of the Sardinian rhabdosomes is greater both mesially and distally. The distal thecae are longer and the thecal count is lower. *M. planus* (Barrande), a probably closely related species, has a broader rhabdosome with highly triangular mesial and distal thecae. The thecal

apertures are probably of rather similar shape. *M. planus* has a rapidly broadening rhabdosome in its mesial part. Its dorso-ventral width is constant distally, or may decrease slightly.

MONOGRAPTUS cf. CONTORTUS Perner, 1897
Pl. 10, fig. 2; text-fig. 13A

Material – 4 incomplete flattened rhabdosomes, partly pyritized.

Horizon and locality – *Mcl. griestoniensis* Zone at Genna Muxerru (GMX P).

Description – The rhabdosome is several cm long and is coiled into a slightly irregular, probably almost plane spiral. The initial 5-6 thecae are elongated, with little, if any overlap. Their height is up to 0.6 mm, and the 2TRD is 2.6-3.0 mm. The first whorl has triangular thecae with 2TRD's about 1.8 mm. The dorso-ventral width reaches 0.7 mm here. The maximum width of the rhabdosome is 1.5 mm but most of the distal part (the spiral has more than two whorls) is preserved in dorsal or ventral view and the true width and the thecal details are obscure. 2TRD is about 1.7 mm distally.

Remarks – The specimens from Genna Muxerru have more elongated and more widely spaced proximal thecae than the topotypic rhabdosomes of *M. contortus* Perner. More detailed comparison is made impossible because of the insufficient Sardinian material. The similarity to *M. spiralis* (Geinitz) is superficial. The latter has a much larger and more robust rhabdosome with a different proximal end and thecal style. *M. proteus* (Barrande) has a trochispiral rhabdosome with rapidly increasing height of the triangular thecae. Further differences can be observed in thecal style and size.

MONOGRAPTUS LOBIFERUS (McCoy, 1850)
Pl. 7, fig. 6; text-fig. 12B, J

1850 *Graptolites lobiferus* McCoy, p. 270.

1913 *Monograptus lobiferus* (M'Coy) - ELLES & WOOD, p. 448, pl. 45, figs. 1a-f, text-figs. 308a-e.

1971 *Monograptus* (*Monogr.*) *lobiferus* (M'Coy) - SCHAUER, p. 58, pl. 36, figs. 6, 7.

1975 *Monograptus lobiferus* (Mc Coy) - HUTT, p. 94, pl. 18, figs. 1, 3; pl. 19, fig. 6; text-fig. 24, figs 4a, b.

1975 *Monograptus lobiferus lobiferus* (M'Coy) - BJERRESKOV, p. 66, pl. 10D, text-fig. 20C.

1988b *Monograptus lobiferus* (Mc Coy) - ŠTORCH, p. 37, pl. 12, figs. 1, 2; text-fig. 4 E, M.

1988 *Monograptus* (*Monograptus*) *lobiferus lobiferus* (Mc Coy) - OBUT *et al.*, p. 55, pl. 5, fig. 3. (See for further reference list).

Holotype – The specimen no. SM A21182 figured by Mc Coy (1855, pl. 1 B, fig. 3); from the Birkhill Shales of Moffat, Scotland. Housed in the Sedgwick Museum, Cambridge.

Material – 3 flattened distal fragments.

Horizon and locality – Probable *Dem. convolutus* Zone at Genna Quadroxius (GQX).

Description – The rhabdosome is straight except for the proximal end. It is up to 2.4 mm wide in our distal fragments. Thecae are hooked and lobate, with no thecal overlap. They face dorso-proximally. Thecal count is 7-8 in 10 mm in our distal fragments. It is less than in topotypic British material but nearly equal to the material from Bornholm described by Bjerreskov (1975).

MONOGRAPTUS cf. MARRI Perner, 1897
Pl. 6, figs. 1, 2, 5; text-fig. 12I

Material – 10 flattened distal fragments and two deformed specimens with proximal ends.

Horizon and locality – *S. turriculatus* Zone at Genna Muxerru (GMX A and F).

Description – The rhabdosome is gently dorsally curved at the most proximal end and is straight mesially and distally. The longest distal part, though far from being complete, measures 30 mm in length. The proximal part is poorly preserved in our specimens. It closely resembles that of *M. priodon* (Bronn). The dorso-ventral width is 1.1 mm at the level of th10, and attains 1.7 mm about 25 mm away from the proximal end. A maximum width of 2 mm has been observed. Thecae are strongly hooked,

EXPLANATION OF PLATE 6

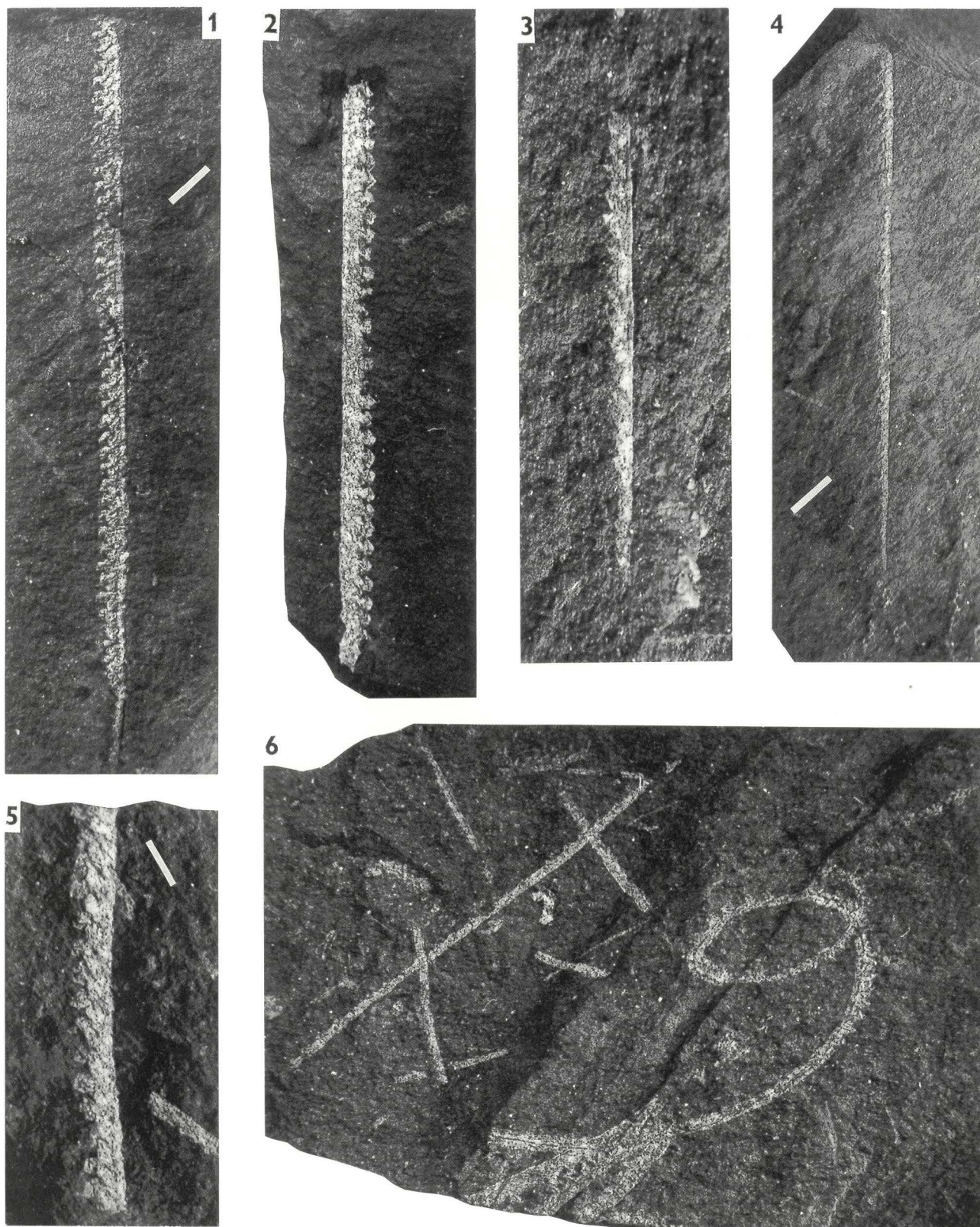
Figs. 1, 2, 5 - *Monograptus* cf. *marri* Perner, 1) n. 22563, 2) n. 22571/1, 5) n. 22568.

Fig. 3 - *Pristiograptus variabilis* (Perner), n. 22566.

Figs. 4, 6 - *Streptograptus* cf. *storchii* Loydell, 4) n. 22565, 6) n. 22570, specimen marked by white arrow.

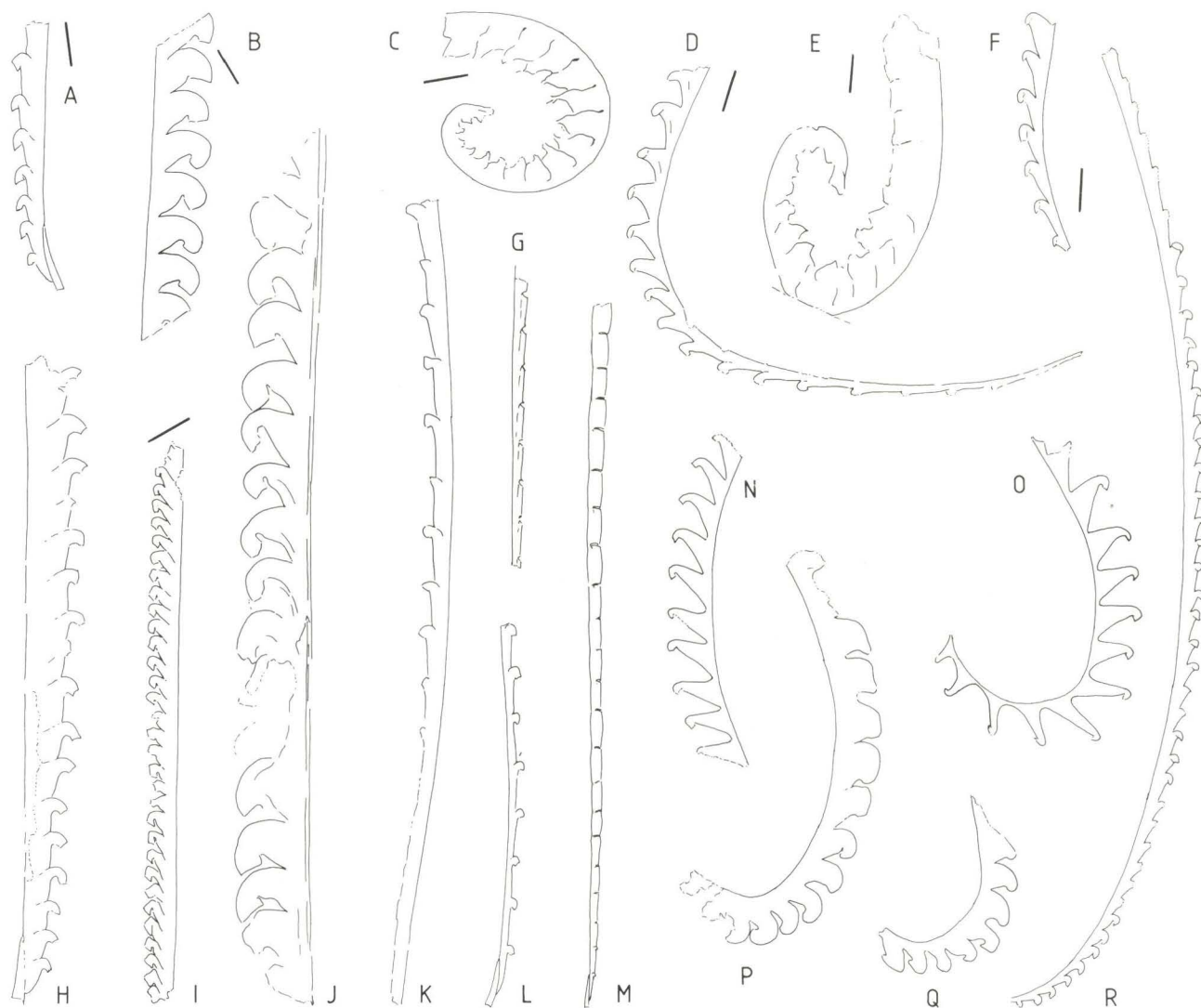
Fig. 6 - *Monograptus proteus* (Barrande), n. 22569.

All specimens from the upper *turriculatus* Zone of Genna Muxerru (GMX A). Figs. 1, 2, 4, x 3; figs. 3, 5, x 5; fig. 6, x 4.

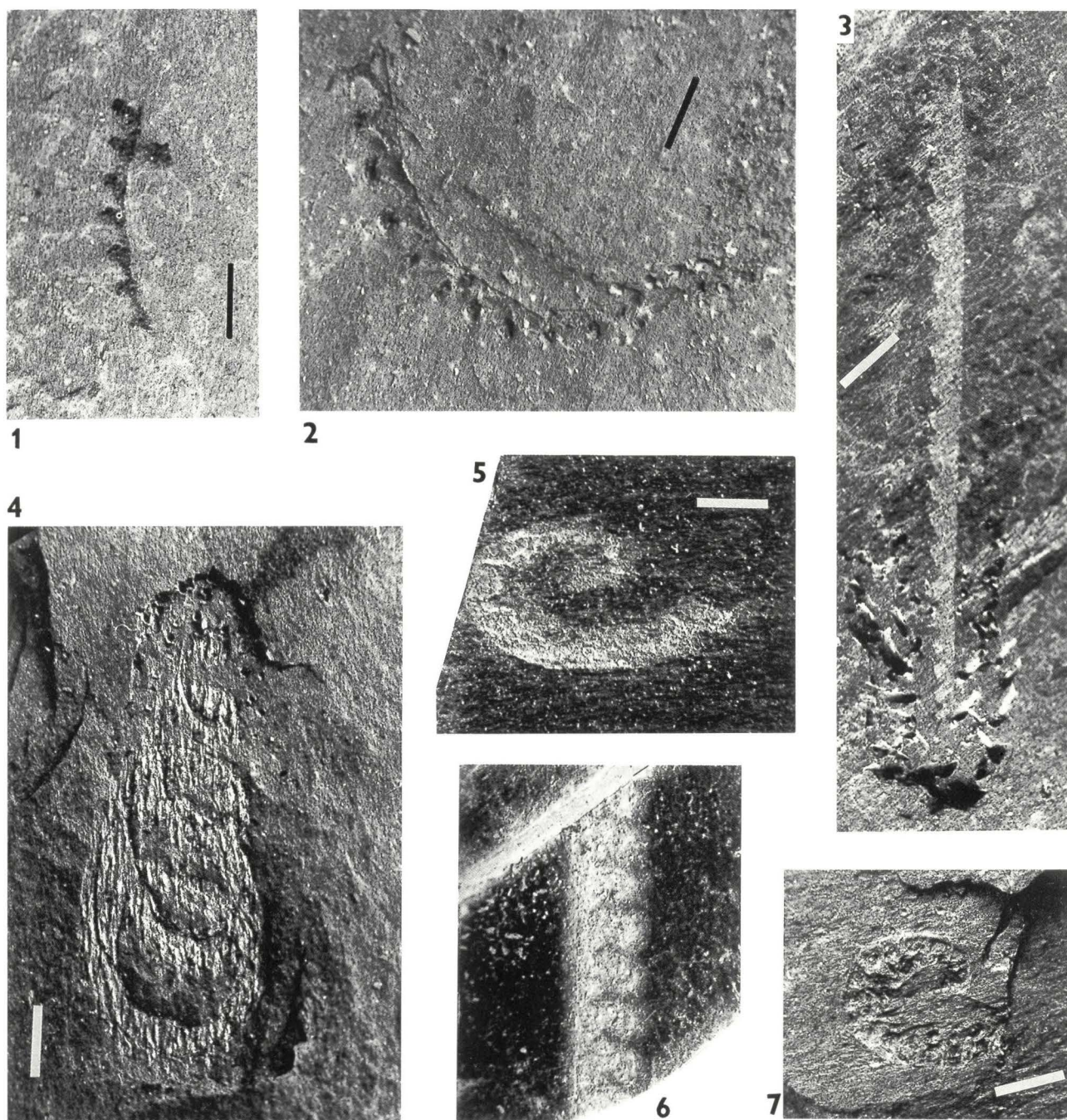


with a rather long recurved part of the metatheca and proximally to slightly dorsally-directed aperture. Distally the hooked part of the metatheca occupies about two-fifths of the total width of the rhabdosome. Thecae number 9.5-12.5 in 10 mm distally.

Remarks - The strongly hooked and closely packed distal thecae with long recurved part of the metathecae, closely resemble those of the topotypic specimens of *M. marri* Perner from Bohemia. Nevertheless, our specimens are left in open nomenclature until well preserved proximal ends are available.



Text-fig. 12 - A, H - *Monograptus priodon* (Bronn); A) n. 24053, H) n. 22553. B, J - *Monograptus lobiferus* (Mc Coy); B) n. 24075, J) n. 24091a. C, E - *Monograptus veles* (Richter); C) n. 22541, E) n. 22539. D, F - *Monograptus planus* (Barrande); D) n. 24063b, F) n. 22533. G, M - *Monoclimacis griestoniensis* (Nicol); G) n. 22479, M) n. 22543a. I - *Monograptus* cf. *marri* Perner; n. 22571/1. K, L - *Monograptus* cf. *speciosus* Tullberg; K) n. 22550, L) n. 24067/2. N, O - *Monograptus pragensis pragensis* (Příbyl); N) n. 22546, O) n. 22553. P, Q - *Campograptus* cf. *millepeda* (Mc Coy); P) n. 24078a, Q) n. 24092. R - *Monograptus* cf. *arcuatus* Bouček; n. 22542. Specimens on figs. A, G, H, K-O from the *griestoniensis* Zone of Genna Muxerru (GMX P); specimens on figs. C, E, R from Genna Muxerru (GMX F), probably from the *crispus* Zone?; specimens on figs. D, F, I from the *turriculatus* Zone of Genna Muxerru (GMX A - fig. I; GMX F - figs. D, F); specimens on figs. B, J, P, Q from the *convolutus* Zone of Genna Quadroxius (GQX). Figs. A-H, J-P: x 5; figs. I, R: x 2.5.



EXPLANATION OF PLATE 7

- Figs. 1, 2 - *Monograptus planus* (Barrande, 1) n. 22533, 2) n. 24063b.
 Fig. 3 - *Pristiograptus variabilis* (Perner), n. 22538.
 Fig. 4 - *Spirograptus turriculatus* (Barrande), n. 22535a.
 Figs. 5, 7 - *Monograptus veles* (Richter, 5) n. 22539, 7) n. 22541.
 Fig. 6 - *Monograptus lobiferus* (Mc Coy), n. 24075.

The specimens on figs. 1-4 come from the *turriculatus* Zone (*sensu lato*) of Genna Muxerru (GMX F), specimens on figs. 5, 7 come from the probable *crispus* Zone of the same locality, specimen on fig. 6 comes from the *convolutus* Zone of Genna Quadroxius (GQX). All figs. x 5.

MONOGRAPTUS PLANUS (Barrande, 1850)

Pl. 7, figs. 1, 2; text-fig. 12D, F

- 1850 *Graptolithus proteus* var. *plana* BARRANDE, p. 58, pl. 4, fig. 15.
 1913 *Monograptus planus* (Barrande) - ELLES & WOOD, p. 484, pl. 48, figs. 6a-c, text-fig. 340.
 1923 *Monograptus planus* (Barrande) - GORTANI, p. 18, pl. 1, figs. 35, 36; text-fig. 10.
 1945 *Spirograptus planus* (Barrande) - PŘIBYL, p. 33, pl. 4, figs. 1, 8; pl. 8, figs. 6-8; pl. 11, figs. 5, 6.
 1967 *Oktavites planus* (Barrande) - OBUT, SOBOLEVSKAYA (& NIKOLAYEV), p. 120, pl. 16, figs. 12, 13.
 1971 *Monograptus* (*Spirogr.*) *planus planus* (Barrande) - SCHAUER, p. 73, pl. 27, figs. 6-9; pl. 33, figs. 5-7.
 ? 1975 *Monograptus planus* (Barrande) - HUTT, p. 99, text-fig. 22, figs. 11, 12.
 1977 *Oktavites planus* (Barrande) - OBUT & SENNIKOV, p. 127, pl. 3, figs. 5-7.
 1988 *Oktavites planus* (Barrande) - OBUT & MOROZOVA, p. 92, pl. 10, fig. 5. (See for further reference list).

Holotype – By monotypy. The specimen no. L 27596 figured by Barrande (1850, pl. 4, fig. 15); from the *linnaei* Zone of Želkovice Formation, Želkovice, Bohemia. Housed in the National Museum, Prague.

Material – 7 flattened, partly pyritized, tectonically deformed fragmentary rhabdosomes.

Horizon and locality – *S. turriculatus* Zone at Genna Muxerru (GMX F).

Description – The rhabdosome is up to several cm long, dorsally curved except for a somewhat straighter slender proximal part. Several proximal thecae are axially elongated, with very gently inclined ventral walls and low apertural hooks. The initial width of about 0.2 mm increases slowly to 0.4 mm in this straighter part of the rhabdosome. The 2TRD is 2.8-3.0 mm here. The mesial part exhibits the maximum curvature, and bears less elongated, triangular thecae with hooked apertures. Torsion of the apertures is not seen due to the poor preservation of the specimens. The dorso-ventral width rapidly increases to more than 1 mm. A maximum width of 2.9 mm has been observed in one tectonically broadened specimen. The 2TRD decreases to about 2.1 mm and the distal thecae number 10 in 10 mm.

Remarks – The badly preserved material from Genna Muxerru agrees well with *M. planus* (Barrande). It has similar dimensions, the characteristic, long proximal end, and rapidly widening mesial part with triangular thecae. The rhabdosomes are dorsally curved throughout, though less so proximally.

MONOGRAPTUS PRAGENSIS PRAGENSIS (Příbyl, 1943)

Pl. 9, figs. 2, 8; text-fig. 12N, O

- 1943 *Demirastrites pragensis pragensis* nov. spec. PŘIBYL, p. 10, text-figs. 1, 3.

- 1954 *Demirastrites pragensis pragensis* Příbyl - WILSON, p. 77, figs. 30, 31.

- 1975 *Monograptus* cf. *pragensis pragensis* (Příbyl) - HUTT, p. 101, text-fig. 17, fig. 7.

Holotype – Original designation. Specimen no. L 29476 figured by Příbyl (1943, fig. 1); from the *griestoniensis* Zone of Prague-Pankrác, Bohemia. Housed in the National Museum, Prague.

Material – One incomplete specimen, one distal part, and one proximal fragment. All are flattened.

Horizon and locality – *Mcl. griestoniensis* Zone at Genna Muxerru (GMX P).

Description – The hook-shaped rhabdosome attains a length of over 10 mm. The sicula is not preserved in our specimens. The most proximal thecae are elongated, do not overlap, and have small apertural hooks with proximally facing apertures. The 2TRD is 2.5 mm. The ventral thecal walls are inclined at a few degrees to the common canal. The common canal is less than 0.1 mm wide at this level. The median thecae, at the most curved part of the rhabdosome, become isolated, with highly triangulate slender metathecae. The thecal height, or dorso-ventral width of the rhabdosome, reaches 1.2 mm here. Distal thecae are broader, highly triangular, with no overlap, small apertural hooks, and proximo-dorsally facing apertures. Apertural hooks take up about one-quarter of the total thecal height. The straight ventral walls of the metathecae are inclined at about 45° to the rhabdosome axis. Thecal height attains 1.1-1.3 mm and 2TRD is 2 mm in the distal part of the rhabdosome.

Remarks – The specimens agree well with the type material of Příbyl (1943) in both size and in the characteristic shape of the thecae and rhabdosome. Comparison of the proximal end is hampered by the fragmentary nature of our proximal fragment and the poor preservation of the proximal portions of the type specimens from Bohemia.

MONOGRAPTUS PRIODON (Bronn, 1835)

Pl. 9, figs. 3-5; text-fig. 12A, H

- 1835 *Lomatoceras priodon* BRONN, p. 55, pl. 1, fig. 13.
 1850 *Graptolithus priodon* Bronn - BARRANDE, p. 38, pl. 1, figs. 3, 4.
 1913 *Monograptus priodon* Bronn - ELLES & WOOD, p. 418, pl. 42, fig. 2a-e; text-fig. 282a-d.
 1923 *Monograptus priodon* (Bronn) - GORTANI, p. 6, pl. 1, figs. 9, 10.
 1968 *Monograptus priodon* (Bronn) - RICKARDS & SMYTH, p. 131, pl. 4, fig. 13a, b.
 1971 *Monograptus* (*Monogr.*) *priodon priodon* (Bronn) - SCHAUER, p. 56, pl. 35, figs. 6-8; pl. 36, figs. 8-11; pl. 37, figs. 1, 2.
 1975 *Monograptus priodon* (Bronn) - BJERRESKOV, p. 70, pl. 10B, tab. 7.

- 1976 *Monograptus priodon* (Bronn) - SENNIKOV, p. 169, pl. 9, figs. 7-10.
 1981 *Monograptus priodon* (Bronn) - BJERRESKOV, p. 44, pl. 6, fig. 3.
 1982 *Monograptus priodon* (Bronn) - LENZ, p. 97, fig. 28A.
 1988 *Monograptus priodon* (Bronn) - OBUT *et al.*, p. 51, pl. 4, fig. 3. (See for further synonymy list).

Holotype - By monotypy. Figured by Bronn (1835, pl. 1, fig. 13); from an unknown horizon and unknown locality.

Material - 14 more or less fragmentary flattened rhabdosomes, including several proximal parts.

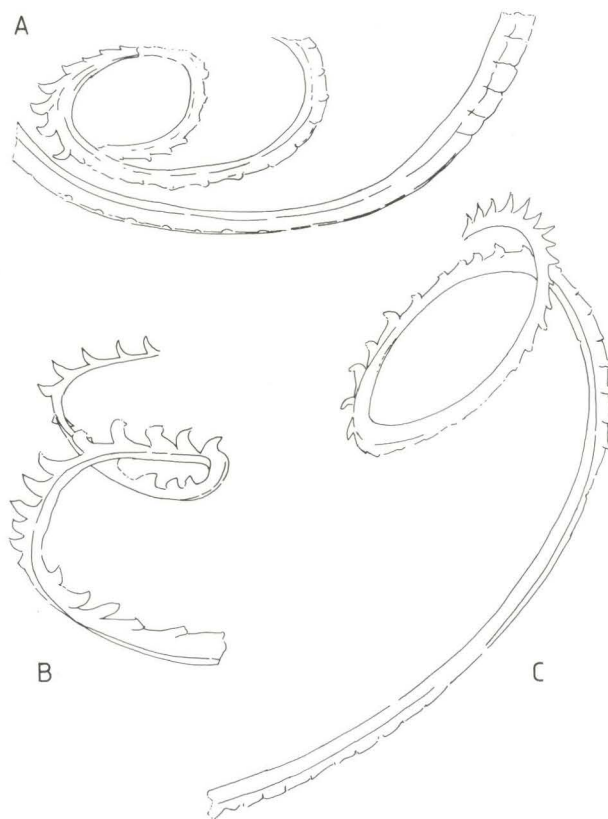
Horizon and locality - *Mcl. griestoniensis* Zone at Genna Muxerru (GMX P).

Description - The rhabdosome is long and straight, occasionally with a gently dorsally curved proximal end. The longest distal fragment measured 10 cm in length. The width of the rhabdosome is about 0.7 mm at the level of th1, and then increases to about 1.3 mm at the level of th10. The maximum width of the flattened distal fragments is 2.3 mm. The sicula is 1.3 mm long and reaches the level of the dorsal wall of th2. The sicular aperture is 0.25-0.3 mm wide. The thecae are hooked, with steeply inclined interthecal septa. They probably overlap for about one-third of their length. The thecal apertures, although badly preserved, appear to face proximo-ventrally to proximally. The hooked parts of the metathecae occupy about two-fifths of the total width proximally, and one-third to one-quarter distally. The thecae number 10.5-13.5 in the initial 10 mm of the rhabdosome, the 2TRD of th2 is 1.2-1.5 mm. Distal thecae number 9-10.5 (exceptionally 8) in 10 mm.

Remarks - The Sardinian specimens are not different from the material described earlier by many authors (Elles & Wood, 1913; Lenz, 1974; Bjerreskov, 1975; a.o.). *M. priodon* differs from *M. marri* Perner in its shorter recurved part of the metathecal hook, by its greater distal width, and its higher distal thecal count. Metathecal hooks occupy a smaller part of the total width of the rhabdosome of *M. priodon* than those of *M. marri*.

MONOGRAPTUS PROTEUS (Barrande, 1850)
 Pl. 6, fig. 6; text-fig. 13B, C

- 1850 *Graptolithus Proteus* BARRANDE, p. 58, pl. 4, figs. 12-14.
 1897 *Monograptus proteus* Bart. - PERNER, p. 14, pl. 12, k figs. 21-23.
 1913 *Monograptus proteus* Barrande - ELLES & WOOD, p. 477, pl. 48, figs. 8a-c; text-figs. 332a-c.
 1923 *Monograptus proteus* (Barrande) - GORTANI, p. 17, pl. 1, figs. 37-40; text-fig. 8, 9.



Text-fig. 13 - A - *Monograptus cf. contortus* Perner; n. 24043a. B, C - *Monograptus proteus* (Barrande); B) n. 22569, C) n. 22570.

Specimen on fig. A from the *griestoniensis* Zone of Genna Muxerru (GMX P); specimens on figs. B, C from the *turriculatus* Zone of Genna Muxerru (GMX A). All figs. x 5.

- 1945 *Spirograptus proteus* (Barrande) - PŘIBYL, p. 11, pl. 3, figs. 3-8; pl. 5, fig. 7; pl. 9, figs. 1-3; text-figs. 2a-f.
 1971 *Monograptus (Spirogr.) proteus proteus* (Barrande) - SCHAUER, p. 75, pl. 30, fig. 9; pl. 31, figs. 1-3; pl. 34, figs. 1, 2.
 1977 *Oktavites proteus* (Barrande) - OBUT & SENNIKOV, p. 128, pl. 4, fig. 1.
 1988 *Oktavites proteus* (Barrande) - OBUT & MOROZOVA, p. 93, pl. 11, fig. 1. (See for further reference list).

Lectotype - Designated Přibyl (1945). The specimen no. L 27583 figured by Barrande (1850, pl. 4, fig. 12); from the *turriculatus* Zone of the Litohlavý Formation, Litohlavý, Bohemia. Housed in the National Museum, Prague.

Material - Two incomplete flattened rhabdosomes and several fragments.

Horizon and locality - *S. turriculatus* Zone at Genna Muxerru (GMX A).

Description - The rhabdosome is coiled into a several cm long, slightly irregular trochoidal spire

with a nearly straight and slender proximal end. One or two whorls are developed in our material whilst the two or three are common in the topotypic Bohemian specimens. Proximal thecae are elongated, not overlapping, with small, hooked, triangular metathecae. The 2TRD is 1.5 mm at the level of about th5. The thecal height is 0.8 mm at this level. Distally the thecae become highly triangular and steeply inclined to the rhabdosome axis. The dorso-ventral width of the rhabdosome rapidly increases to 1.2 mm. The 2TRD slightly decreases distally.

Remarks – As a result of their characteristically shaped rhabdosomes and thecae the Sardinian specimens can be assigned with confidence to *M. proteus* (Barrande).

MONOGRAPTUS cf. SPECIOSUS Tullberg, 1883
Pl. 10, fig. 3; text-fig. 12K, L

Material – 6 mostly fragmentary rhabdosomes, some in partial relief; distal parts and one proximal end.

Horizon and locality – *Mcl. griestoniensis* Zone at Genna Muxerru (GMX P).

Description – The rhabdosome is straight or slightly ventrally curved. The longest fragment measures 40 mm. The width increases very gradually from 0.5 mm proximally (at the level of th1's aperture) to 1 mm distally. The sicula is 0.8 mm long and reaches to about the level of the first thecal aperture. All the thecae are terminated by small hooks with probably proximally facing apertures. The hooks occupy about one-half of the dorso-ventral width proximally and about one-third in the distal part of the rhabdosome. Both the ventral thecal walls and the interthecal septa of the distal thecae are inclined at an angle of about 10° to the common canal. Proximal thecae number 9.5 in 10 mm. The 2TRD of th2 is 2.3 mm. Distal thecae number 7.5-8 in 10 mm.

Remarks – The fragmentary rhabdosomes resemble small monograptids of the polyphyletic «genus»

Mediograptus and also some diversograptids. Our fragments however attain a greater dorso-ventral width and the thecae are simply hooked. The proximal end is monograptid (s.s.) as well. Our specimens differ from *M. speciosus* Tullberg in their almost straight rhabdosome with thecal hooks occupying a greater part of the total width. Distal thecae are less closely spaced and the interthecal septa seem to be less inclined than those of *M. speciosus*.

MONOGRAPTUS VELES (Richter, 1871)
Pl. 7, figs. 5, 7; text-fig. 12C, E

- 1871 *Nautilus veles* n. sp. RICHTER, p. 243, text-fig. on p. 243.
1883 *Monograptus discus* n. sp. TÖRNQUIST, p. 24.
1899 *Monograptus veles* Richt. - EISEL, p. 616.
1913 *Monograptus discus* Törnquist - ELLES & WOOD, p. 439, pl. 44, figs. 5a-d; text-fig. 302a-c.
1944 *Orthograptus* (?) *münchi* n. sp. BOUČEK, p. 3, pl. 1, figs. 5-7.
1944 *Orthograptus* (?) *pygmaeus* n. sp. BOUČEK, p. 4, pl. 1, figs. 1-4.
1952 *Monograptus veles* Richter - MÜNCH, p. 106, pl. 30, figs. 10a-c.
1965 *Monograptus veles* (Richter) - OBUT, SOBOLEVSKAYA (& BONDAREV), p. 52, pl. 7, figs. 2-4.
1970 *Monograptus discus* Törnquist - RICKARDS, p. 76, pl. 6, fig. 8.
1971 *Monograptus* (*Monogr.*) *veles* (Reinh. Richter) - SCHAUER, p. 59, pl. 35, figs. 1-3; pl. 36, figs. 16-18.
1975 *Monograptus discus* Törnquist - HUTT, p. 89, text-fig. 22, figs. 1, 3-5. (See for further reference list).
1975 *Monograptus veles* (Richter) - BJERRESKOV, p. 71, pl. 11D.
1988 *Cochlograptus veles* (Richter) - OBUT & MOROZOVA, p. 67, pl. 6, figs. 5, 6. (see for further reference list).

Holotype – By monotypy. The specimen figured by Richter (1871, fig. on p. 243); from the Silurian of Thüringia.

Material – 18 flattened, badly preserved specimens, one of them in low relief. All are tectonically deformed.

Horizon and locality – Probable *M. crispus* Zone at Genna Muxerru (GMX F).

Description – Some important features were preserved in the tectonically deformed specimens which made possible determination to specific level.

The rhabdosome is ventrally coiled into small plane spiral, tightly enrolled for 250-400°. The rhab-

EXPLANATION OF PLATE 8

- Fig. 1 - *Spirograptus turriculatus* (Barrande), n. 22525a.
Fig. 2 - *Petalograptus tenuis* (Barrande), n. 22534.
Figs. 3, 6 - *Rastrites carnicus* Seelmeier, 3) n. 22589, 6) n. 22591.
Fig. 4 - *Pristiograptus* cf. *bjerringus* (Bjerreskov), n. 22532, oblique view.
Fig. 5 - *Rastrites* cf. *schaueri* Štorch & Loydell, n. 22594a.

All specimens from the *turriculatus* zone (*sensu lato*) of Genna Muxerru (GMX F). Figs. 1, 4, x 3; figs. 2, 3, 5, x 5; fig. 6, x 5.2.



dosome attained length of about 20 mm. The maximum external diameter of the spiral reached about 8 mm in our material. The initial width of the rhabdosome is not clear, the maximum width reaches 1.5-1.9 mm. The sicula is ventrally coiled, having a strongly concave aperture with a small ventral process. Hooked thecae of *priodon* type possess rarely detectable lateral apertural spines.

Remarks – *Monograptus veles* (Richter) is easily distinguished from all other monograptids and the present material agrees well with earlier descriptions of the species. *M. veles* is a widespread species in the European upper Llandovery (*crispus* to *crenulata* and/or lower *spiralis* Zones). It has also been reported from Siberia (Obut, Sobolevskaya & Bondarev, 1965; Obut, Sobolevskaya & Nikolayev, 1967) and arctic Canada (Melchin, 1989).

Genus MONOCLIMACIS Frech, 1897

Type species (by original designation) – *Graptolithus vomerinus* Nicholson, 1872, emend. Lapworth; from the Coniston Flags (Silurian) of Northern England.

Diagnosis – After Bulman, 1970.

MONOCLIMACIS GRIESTONIENSIS (Nicol, 1850)
Pl. 10, figs. 1, 5; text-fig. 12G, M

- 1850 *Graptolites griestoniensis* NICOL, p. 63, figs. 2a-b.
1910 *Monograptus griestoniensis* (Nicol) - ELLES & WOOD, p. 413, pl. 41, fig. 5a-d; text-fig. 279a-f.
1940b *Monoclimacis griestoniensis* (Nicol) - PŘIBYL, p. 8, pl. 3, figs. 1-3.
1966 *Monoclimacis griestoniensis* (Nicol) - OBUK & SOBOLEVSKAYA, p. 39, pl. 7, fig. 6; text-fig. 29.
1970 *Monoclimacis griestoniensis* (Nicol) - TOGHILL & STRACHAN, p. 514, pl. 103, figs. 1-5; text-fig. 1a-h
1975 *Monograptus griestoniensis* (Nicol) - BJERRESKOV, p. 59, pl. 8H-J; text-fig. 18B, tab. 6.

Lectotype – Subsequent designation Přibyl (1948). The specimen no. GSM 11800, figured by Elles & Wood (1910, pl. 41, fig. 5a); from the Llandovery, Grieston Quarry, South Scotland. Housed in the British Geological Survey, Keyworth.

Material – 12 more or less complete rhabdosomes and other fragments, all flattened and/or preserved in very low relief.

Horizon and locality – *Mcl. griestoniensis* Zone at Genna Muxerru (GMX P).

Description – The straight rhabdosome may attain a length of over 40 mm. The longest incomplete specimen is 32 mm long. The dorso-ventral width gradually increases from about 0.2 mm at the first

thecal aperture, to 0.9 mm in the most distal parts.

The sicula is 1.1 mm long and the apex reaches to just below the aperture of th1. The distance between the 0.2 mm wide sicular aperture and the first thecal aperture is 1.5-1.7 mm. The thecae are slender, with ventral walls parallel to the common canal. They overlap for about one-third of their length in more distal fragments. Slight prothecal folds can be detected in some specimens. The apertural regions of the thecae bear small hooks or hoods, rarely and not well preserved in our material. The proximal thecae number 10-10.5 in 10 mm. The 2TRD of th2 is 2.1 mm. Distal thecae number 9 in 10 mm.

Remarks – The Sardinian specimens compare well with those figured and described by Elles & Wood (1910) and Bjerreskov (1975) except for a slightly lower thecal count in 10 mm. The preservation of the apertural structure is not good enough to ascertain as to whether *Mcl. griestoniensis* (Nicol) actually belongs to *Monoclimacis* or to *Monograptus* s.l.

Genus CAMPOGRAPTUS Obut, 1949; emend.

Type species (by original designation) – *Monograptus convolutus* var. *communis* Lapworth, 1876; from the Llandovery of Scotland.

Diagnosis – Rhabdosome dorsally curved proximally, becoming more gently curved distally. Hooked triangular thecae with no overlap have broad prothecal bases and simply hooked metathecae. Thecal hooks involve both the dorsal and ventral walls, and are terminated by nearly rounded apertures, commonly with paired, short lateral spines. Up to 5 axially elongated thecae are developed most proximally.

CAMPOGRAPTUS cf. MILLEPEDA (Mc Coy, 1850)
Text-fig. 12P, Q

Material – 4 small, flattened and slightly deformed rhabdosomes.

Horizon and locality – ? *Dem. convolutus* Zone at Genna Quadroxius (GQX).

Description – The rhabdosome is strongly dorsally curved in the proximal part. Our specimens are up to 10 mm long. The sicula and first theca are indiscernible in our material. The closely spaced thecae are on the convex side of the rhabdosome and are broadly triangular, with no overlap, and have hooked metathecae. Apertures face proximally. Thecal height (dorso-ventral width of the rhabdosome) is up to 1.1-1.3 mm in our specimens. The

2TRD is 1.3-1.7 mm at the level of the 4th to 8th theca.

Remarks – Our specimens have tentatively been assigned to *Campograptus millepeda* (Mc Coy) on account of their triangular, hooked, closely spaced thecae, and 1.3 mm wide rhabdosome.

Genus *STREPTOGRAPTUS* Yin, 1937, emend. Loydell, 1990

Type species (designated by Loydell, 1990) – *Graptolithus plumosus* Baily, 1871; from the Llandoverly of Tievesvilly, County Down, Northern Ireland.

Diagnosis (after Loydell, 1990) – Rhabdosome ventrally, dorsally, or dorso-ventrally curved, rarely straight. Metathecae retroverted, terminating in an upturned lip causing the ventral part of the thecal aperture to face proximally or proximo-ventrally. Laterally the aperture is slit-like. Prothecal bases usually expanded into prothecal folds. Thecal overlap insignificant. Sricula small.

STREPTOGRAPTUS LOYDELLI n. sp.

Pl. 9, fig. 7; pl. 10, figs. 4, 5; text-fig. 14A, B, D

Holotype – Complete, flattened specimen no. 22479 (pl. 10, fig. 5; text-fig. 14, fig. B); from the *griestoniensis* Zone of Genna Muxerru. Housed in the University of Modena (Collections of the Palaeontological Institute).

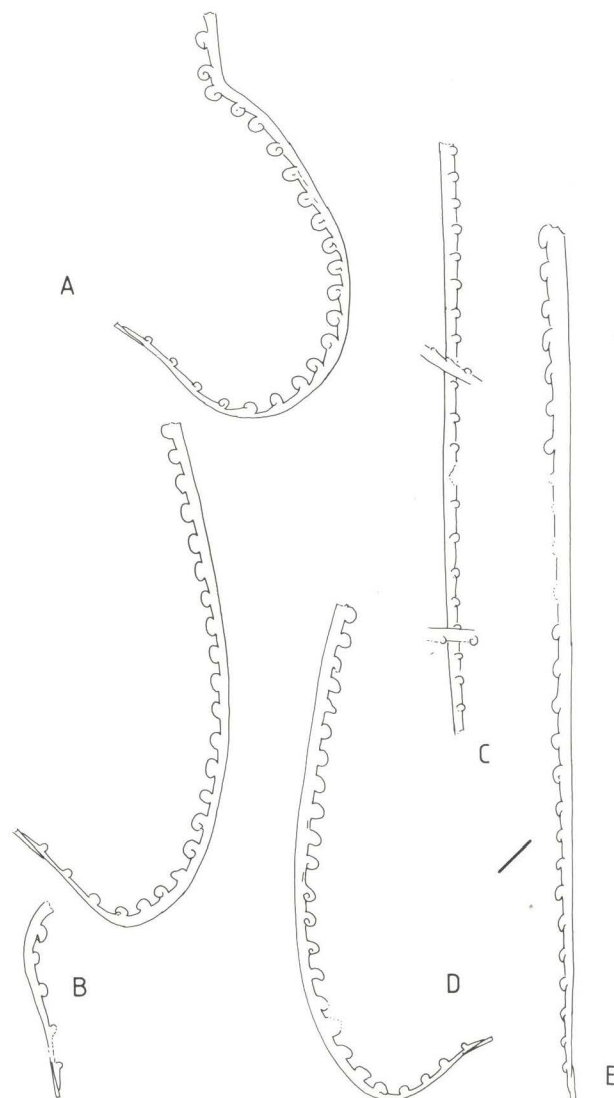
Material – Over 100 flattened specimens, about 40 of them complete, a small number preserved in very low relief.

Horizon and locality – *Mcl. griestoniensis* Zone at Genna Muxerru (GMX P). Common species.

Diagnosis – Small, fish-hook shaped rhabdosome widens rapidly from 0.3 to 0.6-0.7 mm. The maximum width is attained with th6-th8, just at the level of the strongest ventral curvature of the rhabdosome. The proximal end is gently dorsally flexed, the sicula apex reaches the level of the dorsal wall of th1. Enrolled, streptograptid thecae number 13-15 in 10 mm distally. The 2TRD of th2 is 1.7 mm.

Description – The small, fish-hook like rhabdosome attained a length of over 25 mm (commonly about 15 mm). The proximal part is straight over the first 4 thecae, or a little dorsally flexed, thereafter pronounced ventral curvature follows. The distal part is slightly ventrally curved or almost straight.

The sicula is 0.9 mm long and reaches to the level of the dorsal metathecal wall of th1. The sicula aperture is 0.2-0.25 mm wide. Thecae are enrolled, of streptograptid type, the first one originating just



Text-fig. 14 - A, B, D - *Streptograptus loydeli* n. sp.; A) n. 22553, B) n. 22479 = holotype, D) n. 22479 (the same slab). C, E - *Streptograptus cf. storchi* Loydell; C) n. 22570, E) n. 22565.

Specimens on figs. A, B, D from the *griestoniensis* Zone of Genna Muxerru (GMX P); specimens on figs. C, E from the *turriculatus* Zone of Genna Muxerru (GMX A). All figs. x 5.

above the sicula aperture. Neither lateral apertural spines nor prothecal folds have been observed. The ventral wall of the narrow protheca is inclined at an angle of 0-10° to the rhabdosome axis. There is no thecal overlap.

The rhabdosome is 0.3-0.35 mm wide over the first 3 thecae and then widens rapidly to 0.6-0.7 mm in the strongly ventrally curved median part of the rhabdosome (at the level of th6-8). Distally the dorso-ventral width of the rhabdosome does not in-

crease further. The most proximal thecae are less closely spaced than those in the distal part of the rhabdosome. The 2TRD of th2 is 1.7 mm, distally the 2TRD is 1.4-1.5 mm. Distal thecae number 13-15 in 10 mm.

Remarks – *Streptograptus loydelli* n. sp. is separated from its possible ancestor *Streptograptus exiguus* (Lapworth) by its more robust rhabdosome. In *Str. loydelli* the dorso-ventral width is 0.6-0.7 mm whilst it never exceeds 0.5 mm in *Str. exiguus*. The 2TRD is 1.4 mm in the most curved median part of the rhabdosome of *Str. loydelli* whilst it is 1.1-1.2 mm at the same level of the rhabdosome of *Str. exiguus*. The thecae are less prominent and more closely spaced in *Str. exiguus*. Our specimens are well comparable to those described and figured by Howe (1982MS) as *Streptograptus exiguus* sp. A.

STREPTOGRAPTUS cf. STORCHI Loydell, 1991

Pl. 6, figs. 4, 6; text-fig. 14C, E

Material – 5 flattened rhabdosomes, proximal and mesial parts.

Horizon and locality – *S. turriculatus* Zone at Genna Muxerru (GMX A).

Description – The rhabdosome is straight and more than 30 mm long when complete. Nearly indiscernible dorsal curvature of the most proximal end has been observed in two of our proximal fragments. The initial width is 0.2-0.3 mm at the level of the first metatheca, and attains about 1 mm at the most distal end of the 29 mm long specimen. The sicula is small but not easily measured in our material. Retroverted streptograptid metathecæ take up one-quarter to one-third of the dorso-ventral width of the rhabdosome. Prothecal folds, documented by the undulation of the dorsal wall of the rhabdosome, are distinguishable in some specimens. The free ventral thecal wall is parallel to the rhabdosome axis. The inward inclination of the free wall towards the thecal aperture is not well developed in our mostly proximal fragments. The 2TRD is 1.8 mm at the level of the 2nd or 3rd theca. It increases to 2.1

mm about 20 mm away from the sicular aperture, where the thecae number 9.5-10 in 10 mm.

Remarks – Our specimens are comparable to the recently described and widely distributed *Str. storchi* Loydell which also occurs with the corresponding graptolite association of the same zone. *Str. storchi* has been misidentified as *Str. runcinatus* (Lapworth) by many previous authors (Perner, 1897; Bouček & Přibyl, 1942; Schauer, 1971; Ni, 1987). *Paradiversograptus runcinatus* (Lapworth), however, has simply hooked monograptid thecae and the rhabdosome has distinct curvature. We prefer to leave our specimens in open nomenclature until further material with better preserved thecal details is available.

Genus SPIROGRAPTUS Gürich, 1908; emend. Loydell, Štorch & Melchin (in press)

Type species – Original designation. *Graptolithus turriculatus* Barrande, 1850; from the upper Llandovery (Litohlavý Formation) of Bohemia.

Diagnosis – (after Loydell, Štorch & Melchin, in press).

SPIROGRAPTUS TURRICULATUS (Barrande, 1850)

Pl. 7, fig. 4; pl. 8, fig. 1; text-fig. 15A, B

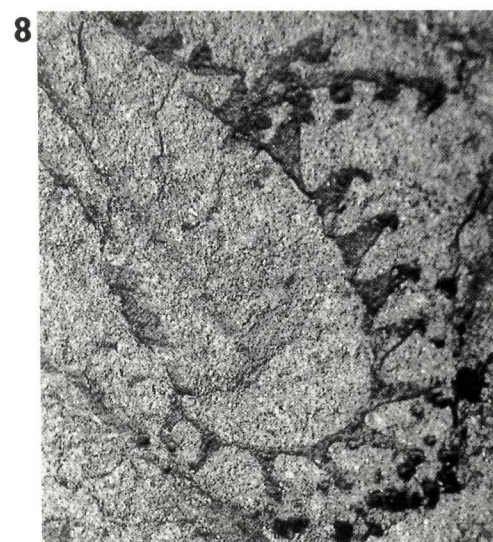
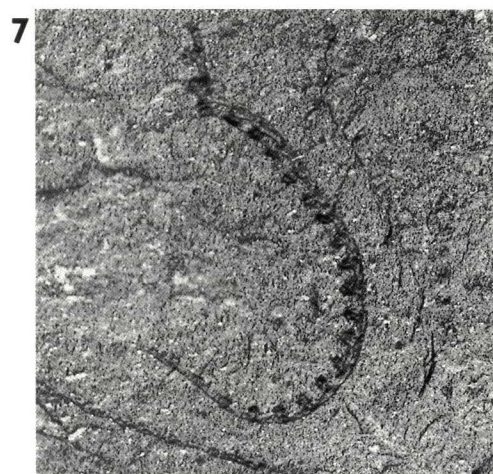
- 1850 *Graptolithus turriculatus* BARRANDE, p. 56, pl. 4, figs. 7-11.
 1913 *Monograptus turriculatus* (Barrande) - ELLES & WOOD, p. 438, pl. 46, figs. 4a-e; text-fig. 301a-c.
 1945 *Spirograptus turriculatus* (Barrande) - PŘIBYL, p. 26, pl. 10, figs. 1, 2.
 1971 *Monograptus* (*Spirogr.*) *turriculatus turriculatus* (Barrande) - SCHAUER, p. 74, pl. 30, figs. 1-5; pl. 31, figs. 11-13; pl. 45, figs. 1-3.
 1975 *Monograptus turriculatus* (Barrande) - BJERRESKOV, p. 70, pl. 10 H.
 1975 *Monograptus turriculatus* (Barrande) - HUTT, p. 111, text-fig. 22, figs. 9, 10. (See for further reference list).
 1982 *Monograptus turriculatus* (Barrande) - LENZ, p. 118, figs. 9N, 32D, E, G; 33A-C.
 1986 *Monograptus turriculatus* (Barrande) - MELCHIN & LENZ, p. 579, fig. 1a-i.

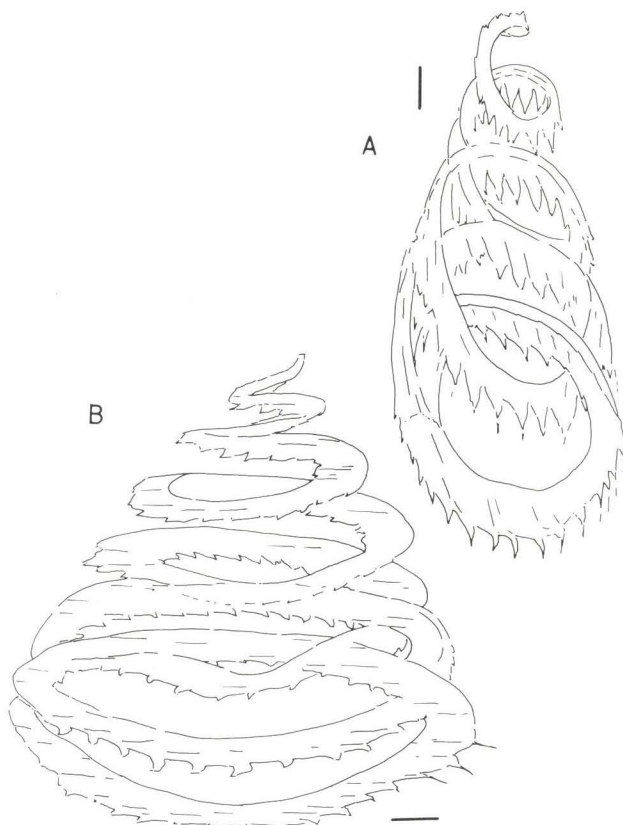
Lectotype – Designated Přibyl (1944). The specimen no. L 27597 figured by Barrande (1850, pl.

EXPLANATION OF PLATE 9

- Fig. 1 - *Pristiograptus initialis* KIRSTE, n. 22547.
 Figs. 2, 8 - *Monograptus pragensis pragensis* (Přibyl), 2) n. 22546, 8) n. 22553.
 Figs. 3-5 - *Monograptus priodon* (Bronn), 3) n. 22553, 4) n. 22545, 5) n. 24068.
 Fig. 6 - *Retiolites geinitzianus angustidens* ELLES & WOOD, n. 24036.
 Fig. 7 - *Streptograptus loydelli* n. sp. n. 22553.

All specimens from the *griestoniensis* Zone of Genna Muxerru (GMX P). Figs. 1-4, 7, x 5; fig. 5, 6, x 3; fig. 8, x 8.





Text-fig. 15 - A, B - *Spirograptus turriculatus* (Barrande); A) n. 22535a, B) n. 22525a; from the *turriculatus* Zone of Genna Muxerru (GMX F). Both figs. x 5.

4, fig. 10); from the Litohlavy Formation at Litohlavy, Bohemia. Housed in the National Museum, Prague.

Material - 8 flattened, almost complete rhabdosomes and several fragments. All deformed by cleavage.

Horizon and locality - *S. turriculatus* Zone at Genna Muxerru (GMX A, GMX F).

Description - The rhabdosome is coiled into a tight, trochoidal spire consisting of eight or more whorls in the most mature rhabdosomes. The 3rd whorl commonly attains 5-6.8 mm in diameter. The diameter of the 5th whorl is about 10 mm. The total height of the spiral is nearly 20 mm in some specimens. Variation of all dimensions is much influenced by cleavage as well as by the original orientation of the trochispiral rhabdosome at the seabottom.

The sicula is not preserved in our material. The dorso-ventral width of the rhabdosome is 0.4-0.5 mm at the level of initial thecae, and reaches 1.0-1.5 mm distally. Thecae are highly triangular with

asymmetrical, slightly hooked apertures possessing apertural spines which are more than 1 mm long. The true thecal shape is indiscernible in our material. It has been described by Melchin & Lenz (1986) from isolated material from arctic Canada. The 2TRD is about 1.7 mm in distal thecae.

Remarks - The only similar species is *Spirograptus minor* Bouček which differs from *S. turriculatus* in its smaller rhabdosome with less whorls, smaller diameter of corresponding whorls, and lower dorso-ventral width of the rhabdosome.

Genus DEMIRASTRITES Eisel, 1911; emend.

Type species (subsequent designation by Přibyl & Münch, 1942) - *Rastrites triangulatus* Harkness, 1851; from the Llandovery of Scotland.

Diagnosis - Rhabdosome dorsally curved or coiled, commonly hook-shaped proximally. The first theca is axially elongated, the few following proximal thecae more or less rastritid, later thecae narrowly triangular. Thecae are isolated, hooked, with apertures expanded laterally, often into a pair of horns.

DEMIRASTRITES TRIANGULATUS TRIANGULATUS (Harkness, 1851)

Text-fig. 15A, B

- 1851 *Rastrites triangulatus* HARKNESS, p. 59, pl. 1, figs. 3a, b (non c, d).
- 1942 *Demirastrites triangulatus triangulatus* (Harkness) - PŘIBYL MÜNCH, p. 3, pl. 1, figs. 1-5; text-figs. 1a, b; 2a, b; 3a, b.
- 1958 *Monograptus separatus triangulatus* (Harkness) - SUDBURY, p. 503, pl. 20, figs. 52-63.
- 1970 *Monograptus triangulatus triangulatus* (Harkness) - RICKARDS, p. 80, text-fig. 18, fig. 1. (See for further reference list).
- 1971 *Monograptus (Demirastrites) triangulatus* (Harkness) - SCHAUER, p. 78, pl. 26, figs. 9-11; pl. 27, fig. 3.
- 1975 *Monograptus triangulatus triangulatus* (Harkness) - BJERRESKOV, pl. 11, fig. E; text-fig. 23A.
- 1988 *Demirastrites triangulatus triangulatus* (Harkness) - OBUK & MOROZOVA, p. 71, pl. 7, fig. 1. (See for further reference list).

Lectotype - Designated by Přibyl & Münch (1942). The specimen no. GSM 6941 figured by Harkness (1851, pl. 1, fig. 3a, ?b); from Frenchland Burn, Dumfriesshire, Scotland; housed in the British Geological Survey, Keyworth.

Material - Several flattened and slightly compressed fragments.

Horizon and locality - *Dem. triangulatus* Zone at Terra Murus (TM A) and, probably, Genna Quadroxius (GQX).

Description - The rhabdosome is dorsally curved, hook-shaped proximally and gently curved distally. Isolated thecae are developed on the convex side of

the rhabdosome. The shape of the thecae is modified by cleavage in our material. Thecae are highly triangular, hooked, and have proximally facing apertures. Thecal height (dorso-ventral width of the rhabdosome) is 1.8 mm mesially and 2 mm distally in the less deformed fragments from Terra Murus. The 2TRD is 2.1 mm mesially. Thecae number about 8 in 10 mm distally.

Remarks – At Genna Quadroxius the dimensions are very variable due to cleavage but the general shape and characteristic features make possible the determination of the specimens from Terra Murus.

Genus *RASTRITES* Barrande, 1850; emend.

Type species (subsequent designation by Hopkinson, 1869) – *Rastrites peregrinus* Barrande, 1850; from the Llandovery (Želkovice Formation) of Bohemia.

Diagnosis (after Štorch & Loydell, 1992) – Rhabdosome with thread-like prothecae and straight, completely isolated tubular (rastritid) metathecae, inclined at a high, commonly over 90°, angle to the rhabdosome axis. The apertures are hooked and laterally expanded in many species.



Text-fig. 16 – A, B – *Demirastrites triangulatus triangulatus* (Harkness); A) n. 24093/3, B) n. 24093/1. C, D – *Rastrites* cf. *approximatus* Perner; C) n. 24077b, D) n. 24091a. E, F – *Rastrites carnicus* Seelmeier; E) n. 22591, F) n. 22589. G, H – *Rastrites* cf. *schaueri* Štorch & Loydell; G) n. 22594, H) n. 22593.

Specimens on figs. A, B from the *triangulatus* Zone of Terra Murus (TM A); specimens on figs. C, D from Genna Quadroxius (GQX), probably *convolutus* Zone; specimens on figs. E-H from the *turriculatus* Zone (?) and/or the *linnaei* Zone) of Genna Muxerru (GMX F). All figs. x 5.

RASTRITES cf. APPROXIMATUS Perner, 1897
Text-fig. 16C, D

Material – 5 small, flattened and slightly deformed, incomplete rhabdosomes.

Horizon and locality – *Dem. convolutus* Zone at Genna Quadroxius (CQX).

Description – No proximal ends are preserved in our small (up to 8 mm long), dorsally curved rastritid rhabdosomes. Long, tubular, isolated metathecae are terminated by small, possibly simple hooks with dorsally facing apertures. Thecal height varies between 1.8 and 2.6 mm due to tectonic deformation. The 2TRD is 0.85–1.25 mm in our rhabdosomes. Thecae are almost perpendicular to the common canal.

Remarks – Our fragments are tentatively assigned to *Rastrites approximatus* Perner on the basis of their closely spaced and long metathecae which are almost perpendicular to the rhabdosome axis. The rhabdosomes seem to be more tightly curved in the proximal part than the topotypic *R. approximatus* Perner from Bohemia.

RASTRITES CARNICUS Seelmeier, 1936
Pl. 8, figs. 3, 6; text-fig. 16E, F

- 1907 *Rastrites maximus* Carruthers - TÖRNQUIST, p. 15, pl. 3, fig. 1.
1912 *Rastrites maximus* Carruthers - EISEL, p. 36, pl. 1, figs. 23, 26 (non 24, 25, 27, 28).
1931 *Rastrites maximus* Carr. - HABERFELNER, p. 161, pl. 3, fig. 13b (non a).
1936 *Rastrites carnicus* nov. sp. SEELMEIER, p. 223, fig. 4.
1942 *Rastrites carnicus* Seelmeier - PRIBYL, p. 6, pl. 1, figs. 6, 7; text-fig. 1c.
1955 *Rastrites carnicus* Seel. - MALINOWSKA, p. 56, pl. 11, fig. 1.
1967 *Rastrites carnicus* Seelmeier - SCHAUER, p. 184, pl. 6, figs. 6, 7; text-fig. 1c.
1992 *Rastrites carnicus* Seelmeier - ŠTORCH & LOYDELL, p. 73, figs. 5C, G; 7F.

Holotype – By monotypy. Figured Seelmeier (1936, fig. 4). Specimen no. 1712 from the *S. turriculatus* Zone of Gugel in the Carnic Alps,

Austria. Housed in the Geologisch-Paläontologisches Institut, Universität Graz.

Material – Three incomplete flattened rhabdosomes and several fragments.

Horizon and locality – *S. turriculatus* Zone at Genna Muxerru (GMX F).

Description – The proximal end of the rhabdosome is not present in our Sardinian material. More distally the rhabdosome is almost straight, the longest fragment measuring 20 mm in length. The prothecae are long and thread-like. The completely isolated tubular metathecae have broad triangular bases and are inclined at about 100–130° to the rhabdosome axis. Flattened metathecae show, typically, one or two longitudinal ribs. The metathecae are 8.5–9.6 mm long. Small apertural hooks are almost indiscernible in our material. The thecal distance varies between 2.1 and 3.0 mm in these rhabdosomes.

Remarks – On the basis of the up to 9.6 mm long thecae, comparatively small thecal distance (2.1–3.0 mm), and high angle of metathecal inclination (100–130°), our specimens can be assigned to *R. carnicus*. *Rastrites linnaei* Barrande has shorter thecae with longer thecal interspaces.

RASTRITES cf. SCHAUERI Štorch & Loydell, 1992
Pl. 8, fig. 5; text-fig. 16G, H

Material – Two flattened nearly complete rhabdosomes and three fragments.

Horizon and locality – *S. turriculatus* Zone at Genna Muxerru (GMX F).

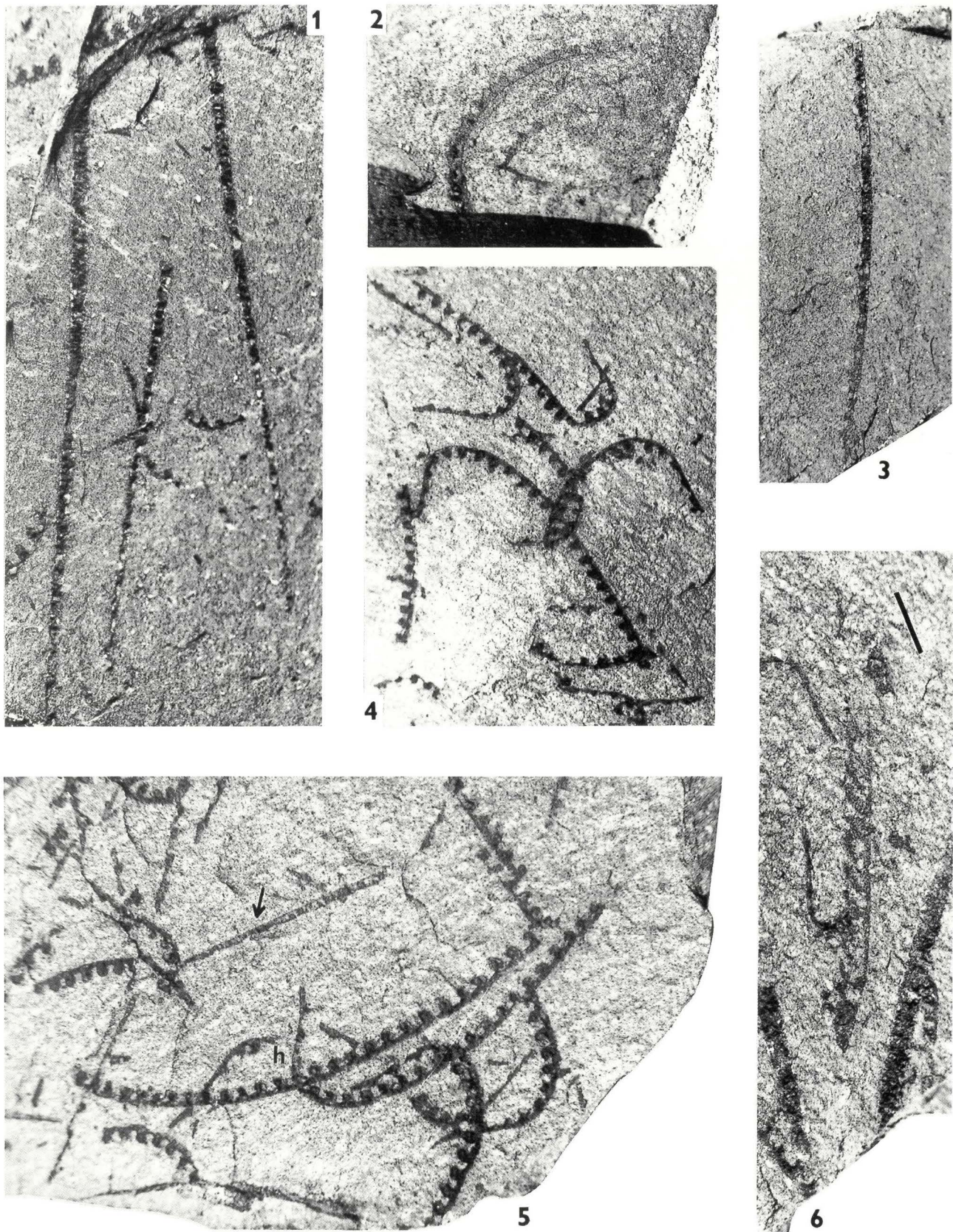
Description – The rhabdosome is dorsally curved in the proximal part and nearly straight distally. The maximum length observed is 16 mm. The sicula is about 1.4 mm long, reaching to just above the second metatheca.

Completely isolated tube-like metathecae have broadened bases and terminate in small but distinctive apertural hooks. Flattened metathecal tubes

EXPLANATION OF PLATE 10

- Figs. 1, 5 – *Monoclimacis griestoniensis* (Nicol), 1) n. 22543, 5) n. 22479, specimen marked by black arrow.
Fig. 2 – *Monograptus* cf. *contortus* Perner, n. 22552a.
Fig. 3 – *Monograptus* cf. *speciosus* Tullberg, n. 22550.
Figs. 4, 5 – *Streptograptus loydelli* n. sp., 4) n. 22479, 5) n. 22479, another place of the same slab, holotype marked by h.
Fig. 6 – *Pristiograptus initialis* Kirste, n. 22546.

All specimens from the *griestoniensis* Zone of Genna Muxerru (GMX P). Figs. 1, 2, 4, 6, x 5; fig. 3, x 3; fig. 5, x 4.



show the typical longitudinal rib. Prothecae are extremely slender, less than 0.1 mm wide when flattened. The first metatheca is 1.5 mm long, th2 is 2.0 mm long, th3 is 2.8 mm long. Distal thecae are 2.4-3.5 mm long and are inclined at an angle of 100-140° to the rhabdosome axis. The distance between th1 and th2 is 0.9 mm, th3-4 distance is 1.6-2.0 mm. Distally the thecal distance reaches 2.0-2.8 mm.

Remarks – The rhabdosome closely resemble those of *R. schaueri* Štorch et Loydell from the type locality Želkovice in Bohemia, except for the longer thecae and a slightly smaller thecal distances. The present material is inadequate to decide whether its greater dimensions are due only to tectonic deformation by cleavage or represent the original differences in biometry. *R. cf. schaueri* has a much smaller rhabdosome than *R. linnaei* Barrande, *R. maximus* Carruthers, *R. distans* Lapworth, and *R. carnicus* Seelmeier. *R. abbreviatus* Lapworth differs in its greater thecal distances, thinner metathecæ, less well developed apertural hooks, and almost straight proximal end of the rhabdosome.

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