New data on Telychian (Upper Llandovery, Silurian) graptolites from Spain

Nové poznatky o graptolitech svrchního llandovery (silur) Španělska (Czech summary)

(*5 text-figs., 7 plates*)

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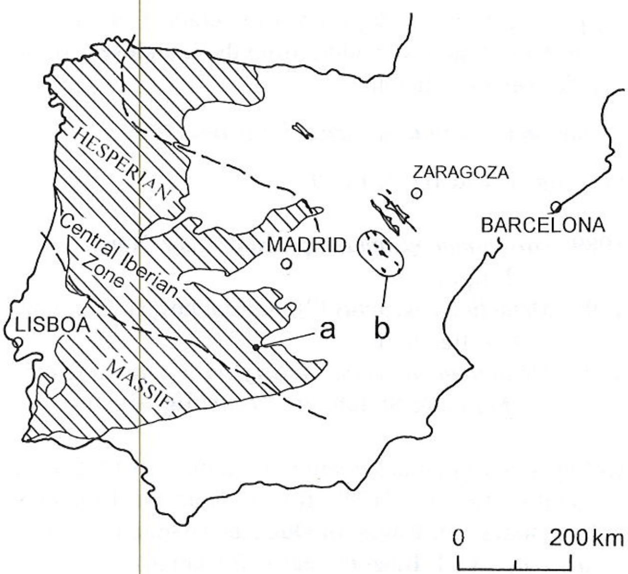
Descriptions and/or comments on twenty Upper Llandovery (Telychian) graptolite taxa are based on new material acquired from the densely sampled Lower Silurian black-shale sequences of the Western Iberian Cordillera and southern part of the Central Iberian Zone in Spain. One new genus (*Euroclimacis*) and five new species (*Euroclimacis iberica*, *Monograptus juancarlosi*, *Stimulograptus*? *splendens*, *Streptograptus pericoi* and *Torquigraptus australis*) are erected.

Key words: Graptolites, taxonomy, Llandovery, Western Iberian Cordillera, Spain,

Introduction

Lower Silurian graptolite black shales are widely distributed in the Variscan basement of the Iberian Peninsula. Graptolites have been listed in many papers (see e.g. Truyols & Julivert 1983, for references) which largely dealt with stratigraphical and geological problems. However, few papers describing and illustrating the graptolites listed in these stratigraphical papers have been published to date (Haberfelner 1931, Suñer Coma 1959, Hernández Sampelayo 1960, Romariz 1962, 1969).

Many of the Silurian black shales of the Iberian Peninsula are often cleaved and graptolite rhabdosomes are affected by moderate to severe tectonic deformation. This deformation has not always been considered by authors describing new taxa from the Spanish Silurian. Cleavage parallel to bedding occasionally has produced gigantic graptolite rhabdosomes. Romariz et al. (1971) discriminated a special Mediterranean graptolite fauna and/or province based on such tectonically broadened graptolites of Wenlock age. Rickards et al. (1990) recognized tectonic origin of several seemingly endemic graptolite species but retained the Mediterranean Subprovince in their graptolite biogeography review.



Text-fig. 1. Sketch map of the Iberian Peninsula showing location of the sampled areas.
a – Corral de Calatrava; b – Western Iberian Cordillera, Central Iberian Zone of Hesperian Massif is bounded by dashed lines.

At some localities, however, the graptolite rhabdosomes are little deformed and are often preserved in low to moderate relief. A particularly rich and well preserved Telychian graptolite fauna was found in the Sierra Menera, Nevera, and Tremedal massifs of the Western Iberian Cordillera. Detailed biostratigraphical sampling carried out by Gutiérrez-Marco & Štorch (1998) yielded rich material comprising 64 graptolite taxa. The latter paper discussed and illustrated elements of these graptolite faunas. Some species were considered new; many others were left in open nomenclature.

This paper aims to bring formal description of or comments on many of these new, little known and often misidentified species. The graptolite material from several sections of the Western Iberian Cordillera has been recently supplemented by other samples collected at Corral de Calatrava (García Palacios et al. 1996a, b) and neighbouring sections in the southern part of the Central Iberian Zone.

Geological and stratigraphical setting

The graptolite material described herein originates from two widely separated Silurian outcrop areas of Spain.

The Corral de Calatrava section is situated *c.* 3.5 km north-east of Corral de Calatrava village (Ciudad Real Province) in the southern part of the Central Iberian Zone of the Hesperian Massif – the largest Variscan block of the Iberian Peninsula. The section was briefly described by García Palacios et al. (1996a, b). Early and Middle Llandovery is represented by pale quartzose sandstones of the Criadero Quartzite in the uppermost part of which a local shaly intercalation with normalograptid rhabdosomes was found by García Palacios et al. (1996a). The quartzite unit is abruptly succeeded by a micaceous, laminated black shale with common early Telychian graptolites. The black shale sequence starts in the *Parapetalolithus hispanicus* Subbiozone representing the uppermost part of the *Rastrites linnaei* Biozone. In neighbouring sections, however, the immediately preceding *Parapetalolithus palmeus* Subbiozone has been tentatively identified at the base of the black shale sequence. The Telychian sequence of the Corral de Calatrava continues with black clayey shales (*Spirograptus turriculatus*, *Monoclimacis griestoniensis*, *Torquigraptus tullbergi* and *Oktavites spiralis* biozones) and the same lithology is maintained until the early Sheinwoodian (early Wenlock). The precise position of the Llandovery–Wenlock boundary has not yet been determined because of the very incomplete cyrtograptid record. *Cyrtograptus centrifugus* is not present and *Cyrtograptus insectus* is represented only by immature, poorly preserved specimens. The rather condensed Telychian sequence measures *c.* 18 m thick.

Several sections in the second outcrop area are situated in the Nevera, Tremedal and Sierra Menera massifs of the Sierra de Albarracín Anticlinorium of the Western Iberian Cordillera. The Western Iberian Cordillera is a part of the European Alpine Belt which runs with a general northwest-southeast orientation to the northeast of the Hesperian Massif. The sections at Checa, Orihuela del Tremedal, and El Pobo de Dueñas (Guadalajara and Teruel provinces) were described in detail by Gutiérrez-Marco & Štorch (1998). In the Western Iberian Cordillera the early and middle Llandovery is represented by pale quartzose sandstones of the upper part of the Los Puertos Quartzite. Three shaly intercalations, with Rhuddanian and Aeronian graptolites, have been found in the uppermost part of the quartzite unit (Gutiérrez-Marco & Štorch 1998). The quartzites are conformably overlain by black shales (*c.* 60 m thick) of the Bádenas Formation. The base of the Bádenas Formation is sharp and somewhat diachronous. The degree of diachroneity was documented by Gutiérrez-Marco & Štorch (1998) on the basis of graptolite occurrences. The earliest Telychian graptolite fauna representing the *Paradiversograptus runcinatus–Monograptus gemmatus* Subbiozone of the *linnaei* Biozone is developed at the base of the Bádenas Formation at Checa (locality A of the latter authors). At Orea – Checa road section (B) and Orihuela del Tremedal road sections (C, D) the Bádenas Formation starts with *hispanicus* Subbiozone. Here, the exposed Telychian sequence of the Bádenas Formation (*Rastrites linnaei*, *Spirograptus turriculatus*, ?*Streptograptus crispus*, *Monoclimacis griestoniensis*, *Torquigraptus tullbergi* and *Oktavites spiralis* biozones) is composed of black shales, with black sandy-micaceous laminites near the base of the Formation and in the upper *turriculatus* Biozone. Graptolites are usually well oriented by currents. The highest beds, exposed in the sections Checa (A) and El Pobo de Dueñas (F), correspond with the lower part of the *spiralis* Biozone.

Gutiérrez-Marco & Štorch (1998) suggested that the Upper Llandovery black shales of the Bádenas Formation of the Western Iberian Cordillera were deposited on an open shelf (*c.* mid-shelf conditions), at a depth not much greater under which the storm-influenced sandstones of the Los Puertos Quartzite were deposited. A similar depositional environment is envisaged for the Telychian black shales and Criadero Quartzite in the southern part of the Central Iberian Zone.

Depository of the graptolite material

Most of the specimens figured herein, including all holotypes, are housed in the Museo Geominero (ITGE), Madrid (numbers prefixed MGM); a small number are housed in the author's collection in the Czech Geological Survey Prague (numbers prefixed PŠ). Recently the specimens figured by Gutiérrez-Marco & Štorch (1998), and prefixed DPM, have joined the present collection housed in the Museo Geominero. DPM prefixes changed to MGM but the original numbers have been retained.

Terminology

In the systematic descriptions below the terminology used is largely that of Loydell (1992, 1993a) and Štorch & Serpagli (1993). Thecal spacing is preferably expressed as a two-thecae repeat distance (an abbreviation 2TRD) as defined by Howe (1983).

Systematic part

Family *Metaclimacograptidae* Koren' & Rickards, 1996

Genus *Metaclimacograptus* Bulman & Rickards, 1968

Type species: *Diplograpsus hughesi* Nicholson, 1869; original designation; from the Llandovery of the Lake District, England.

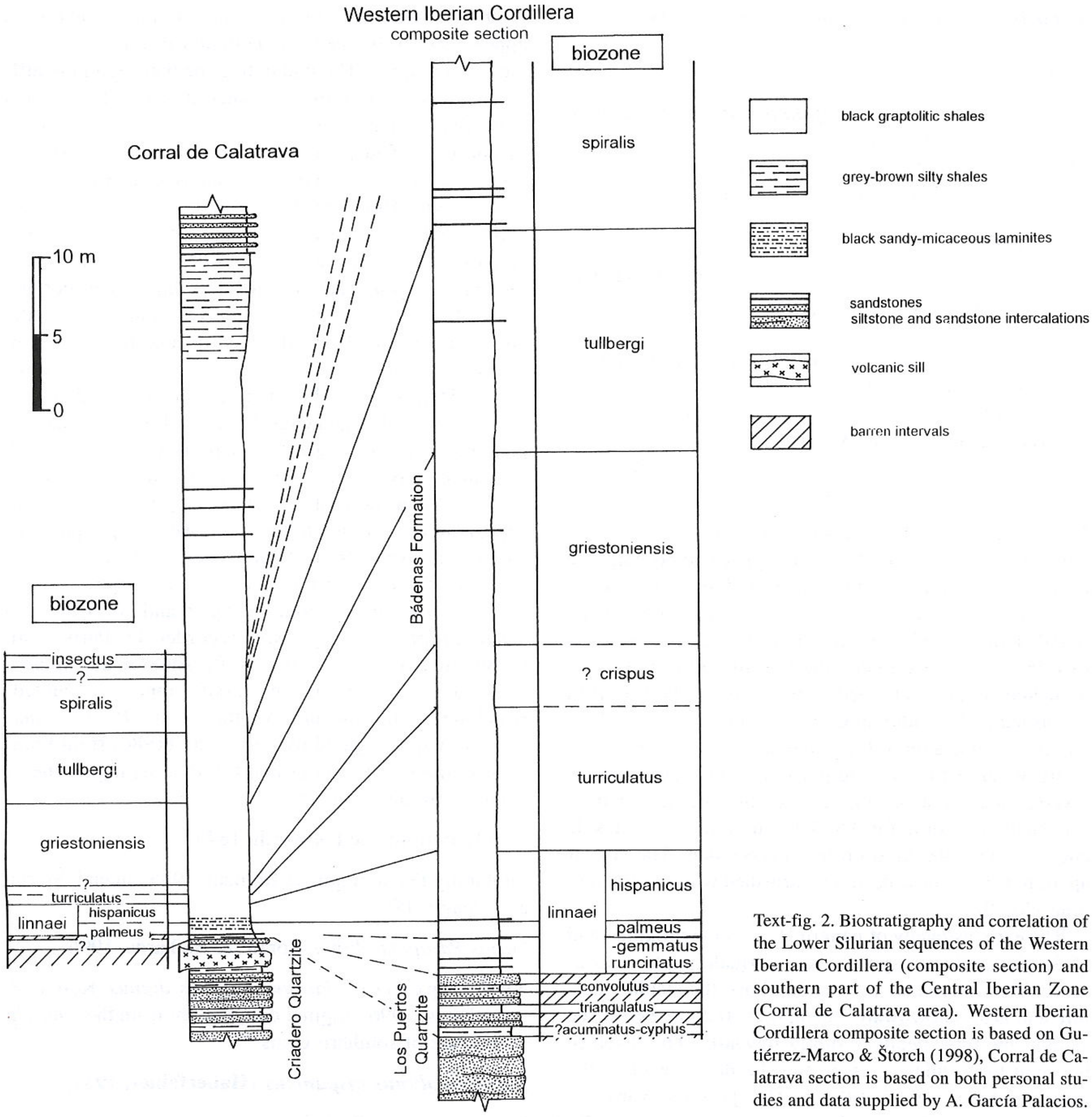
Metaclimacograptus asejradi **Legrand, 1993**

Pl. I, fig. 1; text-fig. 3, fig. 9

1989 *Paraclimacograptus* sp.; Rodríguez Núñez et al., pl. 2, fig. 5.
1993 *Metaclimacograptus* (?) *asejradi* nov. sp.; Legrand, p. 423, fig. 5e, f.
1998 *Metaclimacograptus* cf. *asejradi* Legrand; Gutiérrez-Marco & Štorch, pp. 87–88, fig. 10e, f.

Holotype: Original designation: specimen no 1815 a1 figured by Legrand (1993, fig. 5e) from the Tioukeline Claystones, north-west of Ouallene (Asejrad, Algeria); *turriculatus* s.l. Biozone (early Telychian).

Material: 26 specimens, in moderate or low relief or flattened; several are internal moulds.



Text-fig. 2. Biostratigraphy and correlation of the Lower Silurian sequences of the Western Iberian Cordillera (composite section) and southern part of the Central Iberian Zone (Corral de Calatrava area). Western Iberian Cordillera composite section is based on Gutiérrez-Marco & Štorch (1998), Corral de Calatrava section is based on both personal studies and data supplied by A. García Palacios.

Description: Rhabdosomes are 10–12 mm long, and possess a slender nema. It widens from 0.7–0.85 mm at the level of th1^1–1^2 apertures to a maximum width of 1.3–1.4 mm which is attained at *c.* the level of the 4th–5th thecal pair. The proximal end is asymmetrical, being of normalograptid appearance. The primordial astogeny appears to be of pattern H (sensu Mitchell 1987). A virgella, almost 1 mm long is usually preserved. The thecae are doubly sigmoidally curved. Thecal curvature is considerably stronger in flattened specimens. The supragenicular walls of the thecae are parallel to the rhabdosome axis. The apertural excavations are not provided with hoods. The two thecae repeat distance (2TRD) is 1.5–1.7 mm in the distal part of the rhabdosome so that the thecae number 11.5–14 in 10 mm. The median septum undulates with sub-angular bending.

Remarks: *Metaclimacograptus asejradi* Legrand can be distinguished from most other metaclimacograptids by its robust rhabdosome with regular subangular undulation of the median septum. *Metaclimacograptus scalaris* (Hisinger) which has a stratigraphical range similar to that of *M. asejradi* differs in having stronger geniculation of the thecae and a less undulating septum. The type material of *M. asejradi* figured by Legrand (1993) slightly differs from Spanish specimens in its lesser distal width and higher thecal count (14–16, rarely 12). *M. asejradi* is common in the upper *linnaei* Biozone (*hispanicus* Subzone) and lower *turriculatus* Biozone at Corral de Calatrava and all the localities studied by Gutiérrez-Marco & Štorch (1998).

Metaclimacograptus flamandi **(Legrand, 1993)**

Pl. I, fig. 3; text-fig. 3, figs 7, 8

1980 *"Orthograptus insectiformis"*; Paris, Rickards & Skevington, p. 164, fig. 4a.
?1980 *Pseudoclimacograptus* sp.; Paris, Rickards & Skevington, p. 164, pl. 1, figs 7, 8, 11, 12.
1993 *Normalograptus (?) flamandi* nov.sp.; Legrand, p. 421, fig. 5c–d.
1998 *Paraclimacograptus flamandi* (Legrand); Gutiérrez-Marco & Štorch, fig. 9o.

Holotype: Original designation. The specimen no SX 245a6bis figured by Legrand (1993, fig. 5e) from the Tioukeline Claystones, l'Oued In Tsila (Asejrad, Algeria); ?*griestoniensis* Biozone (Telychian).

Material: 65 specimens, mostly flattened but some preserved in low to medium relief.

Description: The rhabdosome is 15–20 mm long, parallel sided except for the tapered proximal portion. The initial dorso-ventral width is 0.75–0.85 mm at the level of the apertures of $th1^1–1^2$. The maximum width of the rhabdosome is 1.35–1.45 mm (in flattened specimens up to 1.45–1.9 mm) excluding the laterally projecting apertural hoods and is attained at the level of the 6th–10th thecal pair. The undulating median septum is complete. On the obverse side of the rhabdosome it extends proximally as far as the exposed portion of the sicula. On the reverse side it reaches the level of the aperture of $th1^2$. The sicula is visible for 0.8–0.9 mm on the obverse side and is almost obscured on the reverse side. The sicular aperture is 0.2 mm wide and is furnished with a *c.* 0.8 mm long virgella.

The early astogeny of pattern H gives the proximal end of *M. flamandi* an asymmetrical normalograptid appearance. $Th1^1$ originates *c.* 0.4 mm above the sicular aperture and grows downwards, then, 0.15–0.2 mm below the sicular aperture, bends abruptly upwards. The distance between the sicular aperture and the dorsal wall of the aperture of $th1^1$ is 0.95–1.0 mm. $Th1^2$ grows upwards for its entire length. Further thecae are doubly sigmoidally curved, alternating, having short supragenicular ventral walls which are parallel to the rhabdosome axis. Thecal apertures are strongly everted. The dorsal thecal wall is prolonged into a large hood which roofs a small, ventrally facing apertural excavation. These apertural hoods, perpendicular to the rhabdosome axis and then weakly curved towards the proximal end, project for *c.* 0.4 mm away from the regular outline of the rhabdosome. The dorso-ventral width of the rhabdosome attains 2.6 mm including the apertural hoods. The apertural hoods commonly appear spine-like in flattened rhabdosomes. The 2TRD is 1.25–1.3 mm at th2; distally 2TRD reaches 1.6–1.7 mm, (12–13 thecae in 10 mm).

Remarks: The present material corresponds well with the Algerian specimens described and figured by Legrand (1993). As with the Algerian material, a normalograptid appearance to the thecae is common in flattened specimens from Spain. The undulating median septum is difficult to observe in flattened material in which the nema is pressed through and well seen in the axial part of the rhabdosome. Thus, flattened specimens from Corral de Calatrava and Checa may occasionally appear to be *Normalograptus*. However, the undulating septum and alternating doubly sigmoidal thecae are well seen in the specimens preserved in relief and justify placement in *Metaclimacograptus*. The species may have been derived from *M. asejradi* by the progressive elongation of the dorsal supragenicular wall which created the prominent apertural hoods. The rhabdosome also became more robust in *M. flamandi*. The apertural hoods are rather long and may resemble genicular hoods and/or the spines typical of *Paraclimacograptus*. This is why the Spanish specimens have been assigned to *Paraclimacograptus brasiliensis* in the past (e.g. Jaeger 1976). *M. flamandi* appears to be confined to the south-western periphery of Gondwana. Apart from its type area in Algeria, it is a widespread species in the upper *crispus*, *griestoniensis*, and lower *tullbergi* biozones of Spain and Portugal. Also „*Orthograptus insectiformis*" recorded by Paris et al. (1980) from the *griestoniensis* Biozone of the Ménez-Bélair Syncline (Armorican Massif, France) undoubtedly belongs in *M. flamandi*. Another form – *Pseudoclimacograptus* sp. – figured by Paris et al. (1980) from France also looks very similar but differs in its higher thecal count in 10 mm (14–18).

Family Retiolitidae Lapworth, 1873

Subfamily Petalograptinae Bulman, 1955; emend. Štorch & Serpagli, 1993

Genus *Parapetalolithus* Koren' & Rickards, 1996

Type species: *Parapetalolithus dignus* Koren' & Rickards, 1996; original designation; from the *guerichi* Biozone of southern Urals.

Parapetalolithus hispanicus **(Haberfelner, 1931)**

Pl. I, fig. 6; text-fig. 3, fig. 2

1923 *Diplograptus (Petalograptus) altissimus* Elles and Wood; Gortani, p. 5, pl. 1, fig. 6.
1931 *Petalograptus hispanicus* nov. sp.; Haberfelner, pp. 49–50, pl. 1, figs 11a–d.
1932 *Petalograptus conicus* n. sp.; Bouček, pp. 151–154, text-fig. 2a, b.
1941 *Petalograptus hispanicus* (Haberfelner 1931); Bouček & Přibyl, pp. 10–11, pl. 2, fig. 5, text-fig. 2, figs 16–19.
1941 *Petalolithus conicus* (Bouček, 1932); Bouček & Přibyl, p. 11, pl. 2, fig. 4, text-fig. 2, figs 9, 10.
1947 *Diplograptus (Orthograptus) kwantungensis* Sun (sp. nov.); Chang & Sun, pp. 14, 15, pl. 1, fig. 3.
?1962 *P. hispanicus* (Haberfelner); Romariz, p. 238.

1967 *Petalograptus conicus* Bouček, 1932; Koren' pp. 194–195, pl. 1, fig. 13.
1968 *Petalograptus palmeus* (Barr.); Teller & Korejwo, pl. 1, figs 4,5, ?6.
1969 *Petalograptus conicus* Bouček; Müller & Schauer, fig. 9a.
1971 *Petalolithus (Pet.)* sp. aff. *hispanicus* Haberfelner 1931; Schauer, pp. 46–47, pl. 15, fig. 3, ?pl. 12, fig. 9.
1979 *Petalolithus* cf. *conicus* Bouček; Jaeger & Robardet, pl. 2, fig. 8.
non 1981 *Petalograptus ?conicus* Bouček, 1932; Bjerreskov, p. 19, pl. 1, fig. 8.
1982 *Petalolithus altissimus* Elles and Wood, 1908; Lenz, pp. 10–12, figs 2A (non B), 12H (non A–C).
1983 *Petalolithus conicus* Bouček; Li, Song & Fu, pp. 327–328, pl. 79, fig. 35.
non 1984 *Petalolithus hispanicus* (Haberfelner); Chen, p. 44, pl. 4, figs 8, 9.
1989 *Petalolithus* cf. *conicus* Bouček, 1932; Rodriguez Núñez et al., pl. 1, fig. 7.
non 1990 *Petalolithus hispanicus* Haberfelner; Ge, p. 72, pl. 5, fig. 9, pl. VII, figs 11, 24.
non 1990 *Petalolithus conicus* Bouček; Ge, p. 67, pl. 6, figs 10, 25, 29.
1991 *Pe. conicus* (Bouček 1932), Loydell, p. 242, fig. 9b.
1992 *Petalolithus conicus* (Bouček, 1932); Loydell, pp. 39–40, pl. 2, fig. 1, text-fig. 12, figs 8, 18–21.
1992 *Petalolithus hispanicus* (Haberfelner, 1931); Loydell, pp. 44–45, text-fig. 12, figs 1, 2.
1998 *Parapetalolithus hispanicus* (Haberfelner); Gutiérrez-Marco & Štorch, fig. 8r.

Lectotype: subsequent designation by Přibyl, 1948, p. 13; figured Haberfelner 1931, pl. 1, fig. 11a; from the *linnaei* Biozone of Almaden, Sierra Morena, Spain.
Material: More than 50 flattened specimens.

Diagnosis (based on Spanish material): Robust rhabdosome with conspicuously tapering proximal part. The dorso-ventral width increases from 0.95–1.1 mm at the level of the apertures of $th1^1–1^2$ to 1.9–2.5 mm at the 5th thecal pair and thence to the maximum width 2.5–3.4 mm at the 9th–11th thecal pair. 2TRD increases from 1.3–1.45 mm at th2 to a distal maximum of 1.5–1.8 mm. The apertures of the straight, tubular thecae are usually perpendicular to the thecal axis; slight eversion is rarely observed. Thecal inclination is 40–45°.
Remarks: Recent examination of the type material of *P. conicus* (Bouček, 1932) and its comparison with a large collection of the Bohemian and Spanish specimens assigned in *P. hispanicus* (Haberfelner, 1931) indicate that the two species are identical. Specimens from Želkovice in Bohemia – the type locality of *P. conicus* – show a remarkable variability in thecal spacing, maximum dorso-ventral width and the rate of dorso-ventral expansion of the rhabdosome. They are 0.8–1.2 mm wide at the level of the 1st thecal pair, 1.1–1.7 mm at 2nd thecal pair, 1.4–2.2 mm at th5, and 2.3–3.4mm at th10. Distal maximum width of 2.9–4.0 mm is reached at the level of th10–th15. 2TRD increases from 1.0–1.5 mm at th2 to 1.2–1.5 mm at th5, 1.3–1.7 mm at th10, and, thereafter, to a distal maximum of 1.4–1.7 mm. In addition, shorter rhabdosomes, which seemingly had attained their maximum width, are usually narrower than longer, more mature rhabdosomes. The distal thecae of less mature rhabdosomes are often shorter than the corresponding thecae in more mature rhabdosomes. It is possible that several earlier thecae have been further elongated during the continued growth of the rhabdosome. Also the thecal inclination varies slightly. The type specimen of *P. conicus* illustrated by Bouček (1932) has a particularly high angle of inclination of the proximal thecae to the rhabdosome axis which results in a rapid dorso-ventral widening of the rhabdosome and higher thecal count. Some specimens from Almaden (the type locality of *P. hispanicus*) housed in the Instituto de Geologia Economica CSIC have been examined along with the material collected by Garcia-Palacios et al. (1996) in the Corral de Calatrava and by Gutiérrez-Marco & Štorch (1998) in the Western Iberian Cordillera. The Spanish specimens show the same variability as those from Bohemia.

P. altissimus Elles & Wood differs from *P. hispanicus* (Haberfelner) in its broader, less tapered proximal end, and shorter, more inclined thecae with everted apertures. *P. hispanicus* occurs in the eponymous subzone of the upper part of the *linnaei* Biozone of Spain and Bohemia. It is present also in Thuringia, Wales and elsewhere.

***Parapetalolithus meridionalis* (Legrand, 1998)**

Pl. I, figs 2, 4, 5; text-fig. 3, figs 1, 3, 10

1998 *Parapetalolithus* cf. *schaueri* (? sp. n.); Gutiérrez-Marco & Štorch, p. 88, fig. 9p.
1998 *Petalolithus (?) meridionalis* nov. sp.; Legrand, p. 211, fig. 2a–g.

Holotype: Specimen No. SX 115 a_2 figured by Legrand (1998) on fig. 2d; from the *crispus–griestoniensis* boundary beds (Telychian) of Foum Ennemil Section, Western Tassili N´Ajjer, Algerian Sahara.
Material: More than 50 complete rhabdosomes, most preserved flattened but some in relief.

Diagnosis: Robust parapetalolithid rapidly widening from 1.2–1.45 mm at the level of the 1st thecal pair to 3.1–3.4 mm at the 5th pair, 4.3–4.8 mm at the 10th pair, and thence to a maximum of 5.0–5.4 mm attained at *c.* 14th thecal pair. Thecae are simple tubes inclined at 40–45° to the rhabdosome axis. Distal thecae overlap for five-sixths to six-sevenths of their length. 2TRD increases from *c.* 1.5 mm at th5 to *c.* 1.8 mm distally. The nematularium is straight, up to 2.4 mm wide, and is lanceolate in mature rhabdosomes.

Description: This rapidly widening and very robust, 30–40 mm long parapetalolithid possesses a large nematularium. The sicula is almost 2 mm long and its apex reaches at least the level of the aperture of th3. The sicular aperture is 0.3–0.4 mm broad and possesses a simple 1–2 mm long virgella. The thecae are simple tubes inclined at 40–45° to the rhabdosome axis. Distal thecae are often slightly concave to the proximal end. Thecal apertures are also concave, being almost parallel to the rhabdosome axis. Thecal overlap reaches five-sixths to six-sevenths in the distal portion of the rhabdosome, where the thecae are 3.5–3.6 mm long. Dorso-ventral width increases from 1.2–1.45 mm at the level of the apertures of $th1^1–1^2$, to 2.4–2.6 mm at the 3rd thecal pair, 3.1–3.4 mm at the 5th pair, and 4.3–4.8 mm at 10th pair. The maximum dorso-ventral width of 5.0–5.4 mm is attained approximately at the 13th–15th thecal pair. A prominent nematularium is developed in the great majority of rhabdosomes. The nematularium originated early in the astogeny of the rhabdosome and further expanded in the more mature rhabdosomes. It is over 7 mm long and 0.4 mm wide in a specimen with six thecal pairs. In mature rhabdosomes the nematularium up to 2.4 mm wide extends *c.* 30 mm beyond the rounded distal end of the thecate portion of the rhabdosome.

The nematularium appears to have a thickened axis or third list and does not exhibit any axial twisting. It may be t-shaped in cross-section.

Remarks: The present material matches recently described „*Petalolithus*" *meridionalis* Legrand, 1998 from the *crispus–griestoniensis* biozones of Algerian Sahara. The species is reassigned to *Parapelalolithus* with respect to its simple, unancorate virgella. Even considering the occasional flattening and slight tectonic deformation of the Spanish material, *P. meridionalis* (Legrand) is still broader than any other parapetalolithid. The robust proximal portion of *P. meridionalis* (Legrand) is even wider, and more rapidly widening than that of *P. schaueri* (Loydell), although the specimens of the latter species collected in Wales (Loydell 1992) and Germany (Schauer 1971, described as *Petalolithus palmeus posterus*) have not reached the maturity common in Spanish material. Chinese specimens of similar dorsoventral width, assigned to *P. latus* Barrande by Chen (1984), belongs in a new species, resembling *Parapetalolithus palmeus* (Barrande) according to my observation of the type material. In the previous lists of the Telychian graptolite faunas of the Iberian Peninsula, specimens of *P. meridionalis* were referred to *Petalograptus giganteus* Bouček & Přibyl. Recent examination of the highly tectonically deformed type material of *Pet. giganteus*, which originates from the *linnaei* Biozone, suggested that the species should be regarded as a junior synonym of *P. hispanicus* (Haberfelner).

The large nematularium of *P. meridionalis* resembles the three-vaned nematularium of *Cystograptus vesiculosus* Nicholson (Urbanek et al. 1982) rather than twisted, probably spiraliform nematularium of *P. schaueri* (see Schauer 1971, pl. 10, fig. 10). It also originated early within the thecate portion of the rhabdosome and developed during later astogeny.

P. meridionalis (Legrand) is a common and widespread graptolite in the *crispus* and *griestoniensis* biozones (middle Telychian) of the Iberian Peninsula. The specimens of *Parapetalolithus* sp., aff. *schaueri* listed by Gutiérrez & Štorch (1998) from the *turriculatus* Biozone of the Checa section may be *P. schaueri*; they have less robust proximal portions and less overlap to their thecae, than *P. meridionalis*.

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

Genus *Pseudoplegmatograptus* Přibyl, 1948

Type species: *Retiolites perlatus* var. *obesus* Lapworth, 1877; original designation; from Elwand Water, Melrose, Borders, Scotland.

***Pseudoplegmatograptus obesus* (Lapworth, 1877)**

Pl. II, fig. 4

1877 *Retiolites perlatus* var. *obesus* Lapw.; Lapworth 1877, p. 137, pl. 6, fig. 29.

1908 *Retiolites* (*Plegmatograptus*) *obesus* Lapworth; Elles & Wood, p. 342, pl. 34, figs 12a–c, text-fig. 223a–c.

Text-fig. 3. 1, 3, 10 – *Parapetalolithus meridionalis* (Legrand, 1998): 1 – MGM 3469 S (*griestoniensis* Biozone), 3 – MGM 3413 S (*griestoniensis* Biozone): 10 – MGM 3467 S (?*crispus* Biozone) ⇨

2 – *Parapetalolithus hispanicus* (Haberfelner, 1931), MGM 3457 S, (*linnaei* Biozone, *hispanicus* Subzone);

4–6 – *Streptograptus pericoi* sp. n.: 4, 6 – MGM 3480 S, (the same slab, *linnaei* Biozone, *hispanicus* Subzone), 5 – MGM 3481 S (*linnaei* Biozone, *hispanicus* Subzone);

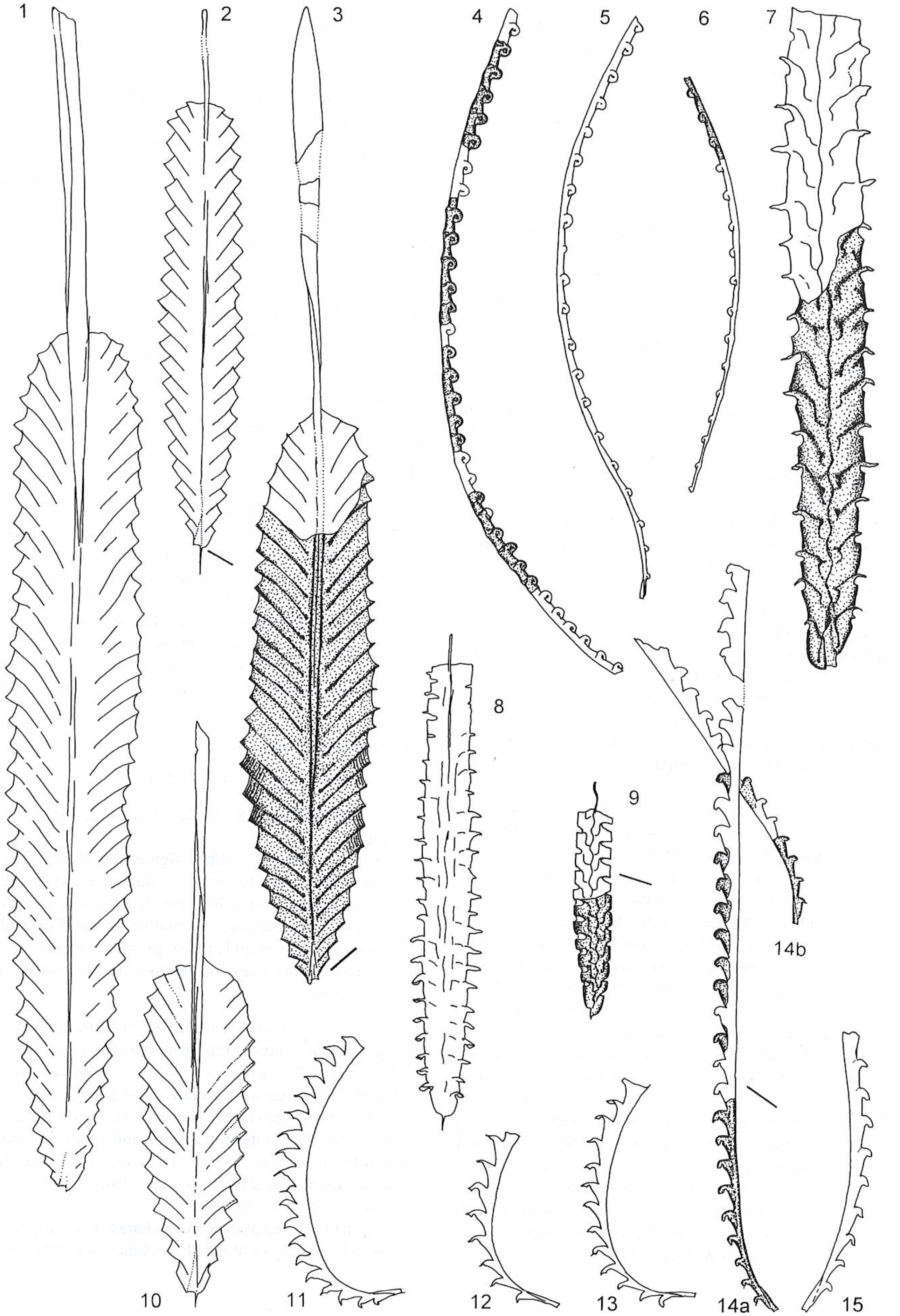
7, 8 – *Metaclimacograptus flamandi* (Legrand, 1993): 7 – MGM 3479 S, (*griestoniensis* Biozone), 8 – MGM 3421 S (lower *tullbergi* Biozone);

9 – *Metaclimacograptus asejradi* Legrand, 1993: MGM 3485 S, (*linnaei* Biozone, *hispanicus* Subzone);

11–13 – *Oktavites*? *falx* (Suess, 1851): 11 – MGM 3579 S, (upper *spiralis* Biozone), 12, 13 – MGM 3474 S, (the same slab, upper *spiralis* Biozone);

14a, b, 15 – *Stimulograptus*? *splendens* sp. n.: 14a, b – MGM 3466 S (holotype, uppermost *tullbergi* Biozone), 15 – MGM 3409 S, (lower *spiralis* Biozone);

1–6, 8, 9, 14a, b – from Checa A locality; 7 – from Estación de Belalcázar, 10–13 from Corral de Calatrava, 15 – from El Pobo de Dueñas; all specimens x5, except of (7) x10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non 1944 *Plegmatograptus obesus obesus* (Lapworth, 1877); Bouček & Münch, pp. 6–9, pl. 1, figs 1, 2, text-figs 1a–g, 2a, b.
1993a *Pseudoplegmatograptus obesus* (Lapworth, 1877); Loydell, pp. 59–61, text-fig. 13, fig. 24. (see for full synonymy).
1998 *Pseudoplegmatograptus* sp. n.; Gutiérrez-Marco & Štorch, p. 89, fig. 7c.

Holotype: By monotypy; figured by Lapworth (1877, pl. 6, fig. 29) and refigured by Elles & Wood (1908, pl. 34, fig. 12b); the specimen no. BU 1363 from the Gala Beds of Elwand Water, Melrose, Borders, Scotland.

Material: 2 complete and 9 incomplete flattened specimens and several fragments.

Description: Large pseudoplegmatograptid with well developed external appendages and membranous tissue appearing to form an external cover to the rhabdosome. The rhabdosome expands rapidly from *c.* 1.9 mm to its maximum width of 6.8–8.0 mm which is attained at about the tenth thecal pair. The rhabdosome is over 40 mm long and 9.0–10.0 mm wide, including the apertural spines and external membrane. The meshwork of lists appears irregular, the subhexagonal meshes being *c.* 0.4 mm in diameter. Septal bars (for explanation see Loydell, Štorch & Bates 1997) are inclined at an angle of 60–65° to the rhabdosome axis. 2TRD is 2.0–2.2 mm. Thecae number 9–10 in 10 mm (rarely up to 10.5). The thecal apertures are provided with paired, proximally curved spines, the distal portions of which ramify into spathes-membranous appendages forming the external cover to thecae apertures (for explanation see Bates & Kirk 1992).

Remarks: The present material differs from *Ps. obesus* Lapworth, as described and illustrated by Elles & Wood (1908) in having a wider rhabdosome with less closely packed thecae. The differences, however, can be explained by the flattening and weak tectonic deformation of Spanish material. Much greater differences can be observed when the present specimens are compared with those described from the *crispus–griestoniensis* biozones of Central Europe (Barrandian area, Thuringia). Those specimens from the upper *turriculatus–tullbergi* biozones of these areas are 4–5 mm wide, including the apertural spines. Similar specimens, although badly preserved, were found in the *crispus* Biozone of the Orihuela del Tremedal section (Gutiérrez-Marco & Štorch 1998). The latter authors, however, followed Bouček & Münch's (1944) conception of *Ps. obesus* and mistakenly assigned these diminutive specimens to Lapworth's (1877) species. The present material from Orihuela del Tremedal is too poor to serve as a reliable basis for comparison with the other, probably valid pseudoplegmatograptid species introduced by Bouček & Münch (1944).

Family Monograptidae Lapworth, 1873

Genus *Euroclimacis* gen. n.

Name: After all-European geographic distribution of the genus and monoclimacid origin of the thecae.

Type species: *Monograptus aduncus* Bouček, 1931, p. 295, fig. 2a–c; from the *murchisoni* Biozone (Sheinwoodian, Wenlock) of Vyskočilka section at Praha-Malá Chuchle, Czech Republic.

Diagnosis: Rhabdosome dorsally curved in the proximal part and ventrally curved or almost straight in the distal part. Thecae of monoclimacid type, with strong geniculum, narrow aperure and, particularly in proximal thecae, pronounced apertural hood formed by elongated dorsal thecal wall. In some species the whole metathecal tubes are further elongated giving the metathecae a hooked appearance.

Remarks: The genus erected herein includes four closely similar species: *Euroclimacis adunca* (Bouček, 1931), *Euroclimacis iberica* sp. n., *Euroclimacis radotinensis* (Bouček, 1931), and *Euroclimacis deflexa* (Bouček, 1931). Assignment of „*Monograptus*" *capillaceus* Tullberg to *Euroclimacis* is uncertain because of its poorly known apertural development. „*Monograptus*" *hemmanni* Přibyl – the species based on several straight distal fragments – has similar apertural hoods but weakly inclined, much overlaping thecae. The representatives of *Euroclimacis* gen. n. range from the late Telychian (*spiralis* Biozone) to the early Sheinwoodian (*murchisoni–firmus* biozones) and have not yet been recorded outside Europe.

***Euroclimacis iberica* sp. n.**

Pl. III, figs 4–7; text-fig. 4, figs 2–4, 8

Name: After Iberian Peninsula in which the species was found.

Holotype: MGM 3470b S figured on pl. III, fig. 7 and text-fig. 4, fig. 4; complete, flattened rhabdosome from the upper *spiralis* Biozone (late Telychian, Llandovery) of the Bádenas Formation in the Corral de Calatrava section (Ciudad Real province, Spain).

Material: More than 50 rhabdosomes, flattened, often complete.

Diagnosis: Doubly curved rhabdosome increases slowly in dorso-ventral width from 0.6 mm at th2 to 0.8–0.85 mm at th20 and thence to a distal maximum of 1.15 mm. Dorsal curvature until th8–12, thereafter followed by ventral curvature. Thecae have gently inclined ventral walls, steep interthecal septa and small apertures covered by prominent hoods comprising 2/5–1/5 of the dorso-ventral width. 2TRD increases from 1.6–1.8 mm at th2 to 2.0–2.1 mm distally.

Description: Rhabdosome is characteristically doubly curved, dorsally until th8–12 and then ventrally. Dorso-ventral width increases from 0.6–0.65 mm at the level of th1 to 0.7–0.8 mm at th10, 0.8–0.85 mm at th20, and thence gradually attains the distal maximum 1.15 mm.

The sicula is 1.2–1.4 mm long and has a 0.25–0.3 mm wide aperture. The sicular apex reaches up to half way up th2. Th1 is 0.8–0.9 mm long. The thecae overlap for *c.* one-quarter of their length in the proximal part of the rhabdosome and even less distally. The interthecal septa appear to be short and steeply inclined. The ventral thecal walls of the proximal thecae are inclined at 10–15° to the rhabdosome axis, being slightly everted at the ventral apertural lip. The ventral wall of distal thecae is almost parallel to the rhabdosome axis. Dorsal walls of the metathecae are prolonged into prominent hoods throughout the rhabdosome and cover small, narrow, almost slit-like apertures. The apertural hoods comprise *c.* two-fifths of the dorso-ventral width of the rhabdosome proximally and *c.* one-fifth of the width distally. The 2TRD is 1.6–1.8 mm at the level of th2 and gradually increases to 2.0–2.1 mm distally.

Remarks: *Euroclimacis iberica* sp. n. is a common species in the upper part of the *spiralis* Biozone in the Corral de Calatrava section. This level probably correlates with the *lapworthi* Biozone of the global reference zonal scheme by Koren' et al. (1996). *E. iberica* belongs in a distinctive group of uppermost Llandovery–lower Wenlock monograptids, of questionable generic status until now, which has been described from Bohemia (Bouček 1931, Přibyl 1940, Štorch 1994) and reported also from Wales (Loydell & Cave 1996) and Estonia (Loydell et al. in press). These are *Euroclimacis adunca* (Bouček), *Euroclimacis deflexa* (Bouček) and *Euroclimacis radotinensis* (Bouček), all of which have hooded to hooked thecae and a dorsally curved proximal part of the rhabdosome. *E. radotinensis* differs from *E. iberica* in having well developed apertural hooks, and an almost straight distal portion of the rhabdosome. *E. adunca* has smaller and distally often missing apertural hoods, a more rapid increase in rhabdosome dorso-ventral width, stronger dorsal curvature of the proximal portion of the rhabdosome and, thereafter, weaker ventral curvature. *E. deflexa* has a narrower rhabdosome, without ventral curvature, and less hooded, widely spaced thecae.

Genus *Monograptus* Geinitz, 1852 *sensu lato*

Type species: Subsequent designation by Bassler 1915; *Lomatoceras priodon* Bronn, 1835; from the Silurian of Germany.

Monograptus curvus **Manck, 1923**

Pl. III, figs 2, 3; text-fig. 4, figs 1, 6, 7

1923 *Monograptus curvus* spec. nov.; Manck, p. 286–287, text-fig. 2, figs 20–25.
1931 *Monograptus curvus* Manck; Hemmann, p. 121, pl. 5, figs 3, 4.
1945 *Spirograptus curvus* (Manck 1923); Přibyl, p. 16–18, pl. 3, figs 1, 2; pl. 4, figs 2–7.
1971 *Monograptus (Spirogr.) proteus proteus* Manck 1923; Schauer, p. 75, pl. 31, figs 4–6.
non 1982 *Monograptus curvus* Manck, 1923; Lenz, pp. 73–74, figs 6A, C; 22C, D.

Lectotype: Subsequent designation by Přibyl 1945, specimen figured by Manck (1923, text-fig. 2, fig. 20) from the *crenulata* Biozone at Oelsnitz (Vogtland, Germany).

Description: The rhabdosome is ventrally coiled except for the proximal part in which the axis is twisted so that the most proximal thecae are situated on the dorsal side. The sicular end has not been encountered in the present material from Corral de Calatrava. The few proximal thecae available in the present material, are low, triangular, *c.* 0.6 mm high, isolated, and provided with small apertural hooks. 2TRD is 2.3 mm. The mesial thecae after the axial twisting of the rhabdosome are triangular, with ventral thecal walls inclined at an angle of 30° to the rhabdosome axis. They overlap for about one-quarter of their length. The apertural hooks gradually change into apertural hoods composed of the dorsal wall of the theca. About 10 mm distalwards from the axial twisting, the rhabdosome attains *c.* 1.3 mm in the dorso-ventral width. 2TRD is 1.7–1.9 mm. The thecal inclination increases to 40°. The most distal thecae appear to be simply triangular, without any apertural hooks or hoods.

Remarks: Our specimens, coming from about the lower third of the *spiralis* Biozone, correspond well with those figured by Manck (1923) and Hemmann (1931) from Germany. Rich material from the Barrandian area was referred to in Přibyl's (1945) redescription of the species. *M. curvus* appears to be restricted to the *tullbergi*/*spiralis* Biozone boundary beds and the lower part of the *spiralis* Biozone. The specimens figured by Lenz (1982) from Northern Canadian Cordillera differ in having a less curved, proximally straightened rhabdosome and less hooked and more overlapping thecae.

Monograptus drepanoformis **Toghill & Strachan, 1970**

Pl. V, figs 1, 2; text-fig. 4, figs 9, 13a, b

1970 *Monograptus drepanoformis* sp. nov.; Toghill & Strachan, p. 517–518, pl. 104, figs 1–4, text-fig. 2 a–f.
1975 *Monograptus drepanoformis* Toghill & Strachan, 1970; Bjerreskov, p. 75, fig. 21 C.
1980 *Monograptus* cf. *drepanoformis* Toghill & Strachan; Paris, Rickards & Skevington, p. 164–165, fig. 4B.
?1984 *Monograptus drepanoformis* Toghill and Strachan; Chen, pp. 73–74, pl. 17, figs 3, 9, 10.
?1990 *Monograptus drepanoformis* Toghill et Strachan; Ge, p. 94, pl. 13, figs 1–7, pl. 14, figs 1, 2.
1998 *Monograptus drepanoformis* Toghill & Strachan; Gutiérrez-Marco & Štorch, fig. 9f.

Holotype: Original designation Toghill & Strachan (1970); specimen BMNH Q3072b figured on pl. 104, fig. 1, text-fig. 2a; from the *griestoniensis* Biozone of Grieston Quarry, Innerleithen, Peebleshire, Scotland.
Material: Thirty flattened specimens.

Description: The short, tightly ventrally curved rhabdosome has a straight or slightly dorsally recurved proximal end. The sicula is 1.0–1.3 mm long with its apex attaining the base of th2. The thecae are triangular, isolated, simply hooked with proximally facing apertures. The first two or three thecae are axially elongated, 0.35–0.4 mm high. 2TRD is 2.1–2.5 mm at th2. The rhabdosome rapidly widens from th3 or th4. The maximum width attained is 0.75–0.9 mm. Distally, 2TRD is *c.* 1.7 mm.
Remarks: Rhabdosomes from the *griestoniensis* Biozone of the Western Iberian Cordillera match well the type material described by Toghill and Strachan (1970), except in having a lesser distal width. Spanish specimens are, however, immature having no more than 8 thecae.

The Chinese specimens assigned to *M. drepanoformis* by Ge (1990) differ in having a longer (1.2–1.5 mm) and more robust sicula which reaches one-half to two-thirds up th2 (personal observation). The distal widening of the rhabdosome is more gradual in Chinese specimens. The similar „*Streptograptus*" *sinicus* (NIGP, 1974) has a very similar rhabdosome morphology, but is more robust proximally and possesses incurved thecae of almost streptograptid appearance.

Monograptus gemmatus Barrande, 1850

Pl. II, figs 1, 2; text-fig. 4, fig. 11

1993a "*Monograptus*" *gemmatus* (Barrande, 1850); Loydell, p. 126–128, pl. 5, figs 13, 16; text-fig. 22, figs 7, 9, 11, 12, 16, 17, 20, 21, 28, 29; text-fig. 23, figs 18, 20. (see for full synonymy).

Holotype: By monotypy, specimen L27590 figured by Barrande (1850) on pl. 4, fig. 5 (refigured Bouček & Přibyl, 1951, pl. 3, fig. 13); from the *linnaei* Biozone, Želkovice Formation, Želkovice, Bohemia.
Material: 12 flattened rhabdosomes, mostly complete.

Description: The rhabdosome is coiled into a loose, probably conical spiral. The sicula has not been found in the present material. The proximal thecae are on convex side of the spiral whilst the distal thecae are either on ventral side of the curvature or perpendicular to the bedding plane. Proximal thecae have thread-like prothecae and loosely hooked isolated metathecae. The proximal width of the rhabdosome is *c.* 0.4 mm and the 2TRD is *c.* 1.8 mm. Distally the thecae become low triangular with metathecal hooks comprising more then one-half of the 0.6 mm wide rhabdosome. Distally, 2TRD attains 2.4 mm.
Remarks: The present material agrees well with the Welsh specimens, described by Loydell (1993) in greater detail. It occurs in the lower part of the *linnaei* Biozone being accompanied by common *Paradiversograptus runcinatus* and other species in the Checa section. Gutiérrez-Marco & Štorch (1998) employed *M. gemmatus* and *P. runcinatus* as index taxa defining the lowermost subzone of the *linnaei* Biozone in Western Iberian Cordillera. This subzone may be correlated with the *gemmatus* and *runcinatus* subzones erected by Loydell (1991) in the lowermost Telychian of the Welsh Basin.

Monograptus juancarlosi sp. n.

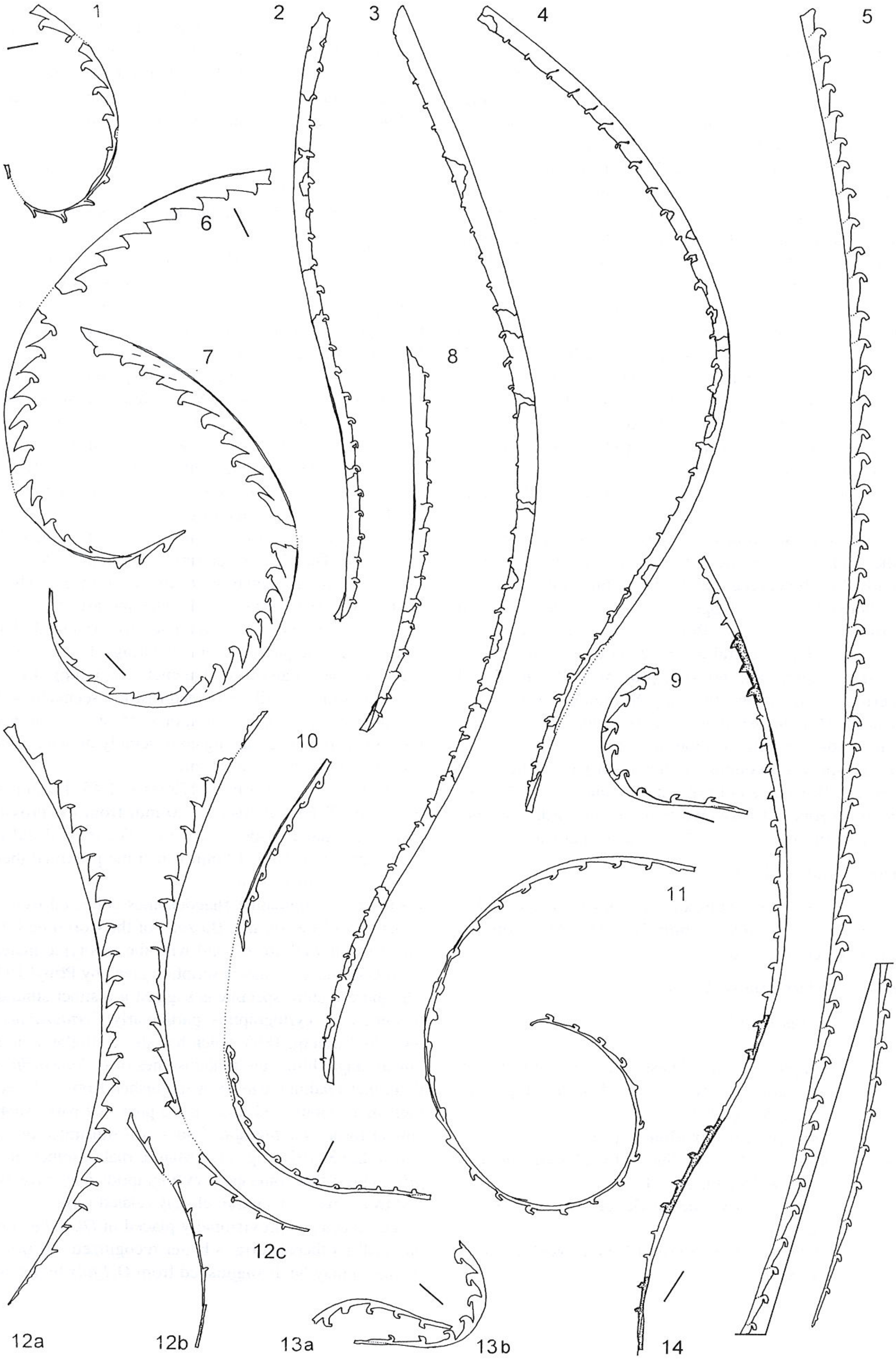
Pl. IV, figs 2, 7; pl. VII, figs 3, 5; text-fig. 4, fig. 5

1998 *Monograptus* sp. n. A, Gutiérrez-Marco & Štorch, p. 89, text-fig. 9.

Name: After Dr. Juan Carlos Gutiérrez-Marco.
Holotype: MGM 3462 S figured on pl. IV, fig. 7 and text-fig. 4, fig. 5, an external mould of 61 mm long incomplete rhabdosome preserved in moderate relief; several other rhabdosomes on the same slab from the lower *tullbergi* Biozone (middle Telychian) of the Bádenas Formation in the Checa section (Guadalajara Province, Western Iberian Cordillera, Spain). Housed in the Museo Geominero (ITGE), Madrid.
Material: More than 50 rhabdosomes in all states of preservation; proximal portions appear to be common but the sicular end is missing.

Diagnosis: Gently dorsally curved rhabdosome very slowly and regularly widens from 0.2–0.25 mm to 0.8 mm. The maximum width of 0.95 mm is attained at least 100 mm away from the proximal end. Thecae hooked throughout the rhabdosome, having simple, proximally directed apertures. Metathecal hooks comprise two-fifths to one-half of the dorso-ventral width proximally and one-third distally. Thecal overlap negligible. 2TRD decreases slowly distalwards from 2.4–2.5 mm to 1.9–2.1 mm.

Text-fig. 4. 1, 6, 7 – *Monograptus curvus* (Manck, 1923): 1 – MGM 3472 S, 6, 7 – MGM 3471 S (the same slab), (*spiralis* Biozone); ⇨
2–4, 8 – *Euroclimacis iberica* sp. n.: 2 – MGM 3475 S, 3 – MGM 3473 S, 4 – MGM 3470b S (holotype), 8 – MGM 3476 S, (upper *spiralis* Biozone);
5 – *Monograptus juancarlosi* sp. n.: 5 – MGM 3462 S, (holotype, lower *tullbergi* Biozone);
9, 13a, b – *Monograptus drepanoformis* Toghill & Strachan, 1970: 9 – MGM 3426 S, 13a, b – MGM 3427 S (*griestoniensis* Biozone);
10 – *Streptograptus linearis* Chen, 1984: MGM 3438 S (*linnaei* Biozone, *hispanicus* Subzone);
11 – *Monograptus gemmatus* (Barrande, 1850), 1 – MGM 3444 S, (*linnaei* Biozone, *runcinatus–gemmatus* Subzone);
12a–c – *Torquigraptus arcuatus* (Bouček, 1931): MGM 3465 S, (lowermost *griestoniensis* Biozone);
14 – *Stimulograptus becki* (Barrande, 1850), MGM 3434 S, (*linnaei* Biozone, *hispanicus* Subzone);
1–4, 6–8, 12a–c – from Corral de Calatrava, 5, 9–11, 13a, b, 14 – from Checa A; all specimens x5.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Description: The rhabdosome is gently dorsally curved throughout. The longest, but still incomplete specimen measured 172 mm. Fragmentary rhabdosomes exceeding 100 mm long are common in the present material but the sicular end has not been detected. The most proximal fragments are 0.25–0.3 mm wide, having axially elongated, hooked thecae. There the prothecae are almost parallel-sided, terminating in small metathecal hooks which comprise two-fifths to one-half of the dorsoventral width of the rhabdosome. 2TRD is 2.1–2.5 mm. Within the following *c.* 60 mm of its length the rhabdosome slowly widens from 0.4 mm to 0.8 mm. 2TRD decreases from 2.4–2.5 mm to 1.9–2.1 mm, The most distal fragments attain 0.95 mm in width, having a 2TRD of 2 mm or less. The thecae are simply hooked and almost or entirely isolated throughout. The ventral prothecal walls are inclined at an angle of less than 10° in the proximal part of the rhabdosome, at 10–15° mesially, and at 25–30° in the most distal part. Prothecal bases take up *c.* one-third to one-half of the rhabdosomal width. Metathecal hooks are terminated by simple, proximally directed apertures.

Remarks: *M. juancarlosi* may be distinguished from other Telychian monograptids by its slowly widening, gently dorsally curved rhabdosome which possesses simply hooked, non-overlapping thecae. It differs also from *Torquigraptus arcuatus* (Bouček) in its very slow rate of increase in dorso-ventral width, lesser dorsal curvature of the rhabdosome, and hooked, proximally facing thecal apertures without any twisting. Stimulograptid assignment of *M. juancarlosi* may be excluded due to its having simple apertures without any spines (pl. VII, figs 3, 5). The species is common in the upper part of the *griestoniensis* Biozone and lower and middle parts of the *tullbergi* Biozone at Checa (Western Iberian Cordillera) and, rarely, in the same level at Corral de Calatrava.

Genus *Oktavites* Levina, 1928

Type species: Subsequently designated by Obut (1964); *Graptolithus spiralis* Geinitz, 1842; from the Llandovery of Germany.

***Oktavites? falx* (Suess, 1851)**

Text-fig. 3, figs 11–13

1851 *Graptolithus falx*; Suess, p. 35, pl. 9, fig. 10a, b.
1945 *Spirograptus falx* (Suess, 1851); Přibyl, pp. 31–32, pl. 5, figs 1–6.
1952 *Spirograptus falx* Münch, p. 117.
non 1982 *Monograptus falx* (Suess, 1851); Lenz, pp. 80–81, figs 7N,P,Q; 24G–I.
?1990 *Oktavites falx* (Suess); Ge, pp. 152–153, pl. 64, figs 3, 6, 9.
1993 *Oktavites? falx* (Suess, 1851); Loydell & Cave, fig. 8k–n.

Lectotype: Designated Přibyl (1945). Specimen L31091 figured by Suess (1851) on pl. 9, fig. 10a; from the *spiralis* Biozone of Litohlavy Formation, Praha-Malá Chuchle, Bohemia. The specimens figured by Suess (1851) are small fragments without proximal ends. Thus the present conception of *O. falx* is practically based on the better preserved specimens figured by Přibyl (1945).

Material: 35 flattened, mostly complete rhabdosomes.

Description: The rhabdosome is falcate in the proximal part. This rhabdosomal form is developed in both the type specimen of *O. falx* figured by Suess (1851) and the topotypic rhabdosomes figured by Přibyl (1945). More mature rhabdosomes found at Corral de Calatrava are coiled, however, in open, helical spiral resembling the spiral procladia of some cyrtograptids. The rhabdosomes also show gradual axial twisting beginning at the *c.* 10th–15th theca. The rhabdosome widens from 0.55–0.6 mm at th1 to 0.8–0.9 mm at th5 and 1.0–1.1 mm at th10. Thereafter the true dorso-ventral width is obscured by the axial twisting of the rhabdosome.

The apex of the 1.0–1.2 mm long sicula reaches the top of th1. The sicular aperture is 0.2 mm wide. Proximal thecae are triangular, with narrow prothecae. The 3rd protheca is 0.15 mm broad. The metathecae posses a small apertural hooks with a laterally expanded, dorsal rostrum. The apparent lateral twisting of the apertures may have been caused by diagenetic flattening. In some specimens the laterally extended rostrum seems to be terminated in a pair of lateral spines. Mesial thecae become higher-triangular, having considerably broader prothecae (0.4 mm at the level of th8).

2TRD2 is 1.35–1.5 mm, 2TRD5 is 1.45–1.7 mm; the maximum 2TRD, attained *c.* 20 mm from the proximal end of the rhabdosome, is 2.1 mm. The most distal thecae number 9.5–10 in 10 mm whilst the proximal thecae number *c.* 12 in 10 mm.

Remarks: Immature rhabdosomes collected from the upper part of the *spiralis* Biozone of the Corral de Calatrava section well correspond with the topotypic material from Bohemia (see also description given by Přibyl 1945). The more mature specimens suggest a distinct similarity to some early cyrtograptids, particularly *Cyrtograptus lapworthi* Tullberg, 1883 which has also a similar stratigraphical range. Immature rhabdosomes of *C. lapworthi*, without metacladium, can be distinguished from *O.? falx* by their more robust and less curved proximal part. Another similar form – *Cyrtograptus*? sp. – was illustrated by Loydell & Cave (1996, fig. 11i). Mature rhabdosomes of *O.? falx* suggest that some early cyrtograptids may have evolved from this, or a similar, closely related form.

The species is provisionally placed in *Oktavites* Levina untill its thecal form is better recognized. *O. spiralis* (Geinitz) may be distinguished from *O.? falx* by its more coiled, rapidly widening rhabdosome with greater dorso-ventral width (*c.* 3 mm), highly triangular thecae, and prominent rostral spines. *Monograptus* aff. *falx* discussed by Zalasiewicz (1994) differs from *O.*? *falx* in having simply hooked rather then rostrate thecae and broader prothecal bases. Tectonically widened specimen figured on text-fig. 3, fig. 11 comes from the same beds as those figured on figs 12 and 13. It resembles *Monograptus vesiculosus* Perner in its broader, densely packed thecae. The latter species may be distinguished from *O.*? *falx* by its robust, less protracted proximal end, narrower prothecae and, unlike the illustrations given by Perner (1897), the sicula reaching dorsall wall of the th2. Dorsal curvature of *M. vesiculosus* is less accentuated proximally.

Genus *Paradiversograptus* Sennikov, 1976

Type species: *Rastrites capillaris* Carruthers, 1867; original designation; from the Birkhill Shales of Moffat, Dumfries & Galloway, Scotland.

***Paradiversograptus runcinatus* (Lapworth, 1876)**

Pl. IV, fig. 4

1993a *Paradiversograptus runcinatus* (Lapworth, 1876a); Loydell, p. 149, 152–153, text-fig. 26, figs 1–9, 15 (see for full synonymy).
1998 *Paradiversograptus runcinatus* (Lapworth); Gutiérrez-Marco & Štorch, fig. 8a.

Lectotype: Subsequent designation by Bouček & Přibyl 1942, specimen BU 1639 figured by Lapworth (1876a) on pl. 20, fig. 4c (refigured by Elles & Wood, 1913, pl. 45, fig. 2e); from the Upper Birkhill Shales of Glenkiln Burn, Kirkmichael, Strathclyde, Scotland.
Material: More than 30 flattened specimens, Many rhabdosomes are complete with well preserved sicular ends. No trace of bipolar growth was observed.

Description: The proximal end of the rhabdosome, comprising th1–4, is gently dorsally curved. Thereafter the rhabdosome becomes gently ventrally curved. The maximum length of the rhabdosome exceeds 60 mm in the present material. The sicula is *c.* 1.2 mm long and attains up the level of the dorsal wall of the first metatheca. The first thecae are 0.35–0.4 mm high. The dorso-ventral width of the rhabdosome is 0.45 mm at th10. The maximum width of 0.7 mm is attained in the distal part of the mature rhabdosomes. The 2TRD is 1.8–2.2 mm at th2, and 1.9 mm at th10. Most distally, 2TRD is *c.* 2.1 mm. The prothecae are parallel sided whilst the metathecae form simple hooks with, proximally faced, elongated apertural portions. The hooks comprise *c.* one-third of the dorso-ventral width of the rhabdosome. The thecae do not overlap.
Remarks: Apart from its shorter sicula the present material agrees well with the specimens described by Loydell (1993a). Bipolar specimens, rare in Loydell's (1993a) material have not yet been recorded from Spain.

Genus *Stimulograptus* Přibyl & Štorch, 1983

Type species: *Graptolithus halli* Barrande, 1850; original designation; from the Llandovery *linnaei* Biozone, Želkovice, Bohemia.

***Stimulograptus becki* (Barrande, 1850)**

Pl. II, fig. 5; text-fig. 4, fig. 14

1850 *Graptolithus becki* Barr.; Barrande, pp. 50–51, pl. 3, figs 14–16, non 17, 18.
1993a *Stimulograptus becki* (Barrande, 1850); Loydell, pp. 72–74, pl. 3, fig. 2, text-fig. 15, figs 1, 2, 9–13 (see for full synonymy list).
1998 *Stimulograptus becki* (Barrande); Gutiérrez-Marco & Štorch, fig. 8e.

Lectotype: Subsequent designation by Přibyl 1948, specimen L 27585 figured by Barrande (1850) on pl. 3, fig. 15; from the *linnaei* Biozone of Želkovice, Bohemia.
Material: 16 specimens preserved in relief and over 50 flattened, often fragmentary rhabdosomes.

Description: The rhabdosome is gently dorsally curved to th5–7 and thereafter is gently dorsally curved. The dorso-ventral width of the rhabdosome increases very slowly from *c.* 0.4 mm at th1 to 0.6 mm at th10. A maximum width of *c.* 1.0 mm is attained several centimetres from the proximal end. Both the sicula and thecae correspond well in shape and size with those of the type and topotypic specimens from Bohemia as well as with Loydell's (1993) descriptions of the Welsh material. The apertural spines were rarely detected in Spanish specimens. 2TRD is 2.0 mm at th2 and thereafter varies between 1.8 and 2.1 mm.
Remarks: In Spain, *S. becki* is a common species in the upper part of the *linnaei* Biozone (*palmeus* and *hispanicus* subzones) and lower *turriculatus* Biozone in both the Western Iberian Cordillera sections (Gutiérrez-Marco & Štorch 1998) and in Corral de Calatrava and neighbouring localities.

***Stimulograptus*? *splendens* sp. n.**

Pl. IV, figs 3,6; text-fig. 3, figs 14a, b, 15

1998 *Monograptus* sp. n. B, Gutiérrez-Marco & Štorch, p. 89, text-fig. 9.

Name: Latin „splendens" meaning splendid.
Holotype: MGM 3466 S figured on pl. IV, fig. 6 and text-fig. 3, fig. 14a; rhabdosome preserved in moderate relief; several other rhabdosomes on the same slab; from the uppermost *tullbergi* Biozone (middle-late Telychian, Llandovery) of the Bádenas Formation in the Checa section (Guadalajara Province, Western Iberian Cordillera, Spain).

Material: More than 100 specimens, mostly flattened, some in low relief. Many proximal portions available.

Diagnosis: Rhabdosome straight, except for dorsally curved proximal part. Curved portion comprises 6–10 proximal thecae. The dorso-ventral width (DVW) increases slowly from 0.7–0.8 mm to a maximum of *c.* 1.6 mm. The sicula is 1.7–1.9 mm long and reaches almost half way up th2. Thecae are uniform, simply hooked, without significant overlap. Apertural hooks comprise two-fifths of the DVW. 2TRD increases from 1.7–1.9 mm at th2 to 2.1–2.4 mm in the most distal thecae.

Description: The rhabdosome is straight except for the dorsally curved proximal portion. This arcuate dorsal curvature comprises 6–10 proximal thecae. The dorso-ventral width increases slowly from 0.7–0.8 mm at the level of th1 to 0.9–1.0 mm at the level of th10. A width of 1.6 mm is attained *c.* 40 mm from the proximal end; distal fragments are even wider.

The sicula is 1.7–1.9 mm long and reaches one-third to one-half up th2. Its aperture is slightly expanded in some specimens, and is provided with a tiny virgella. The thecae are simply hooked throughout, without any significant overlap. The apertural hooks comprise two-fifths of the rhabdosome width. In some specimens, the apertural hook appears to be formed by the dorsal and lateral walls only so that it resembles a hood rather than a hook. Th1 is 1.0–1.1 mm long and 0.7–0.8 mm high. 2TRD is 1.7–1.9 mm at th2, 1.95–2.1 mm at th10, and slowly increases to 2.1–2.4 mm in the most distal fragments.

Remarks: *S.? splendens* sp. n. may be easily distinguished from *M. priodon* (Bronn, 1835) and *M. parapriodon* Bouček, 1931 by its dorsally curved, slowly widening rhabdosome and non-overlapping thecae. It appears to be related to *M. rickardsi minor* Hutt, 1975 from which it differs in its prominent dorsal curvature, longer sicula and lesser difference between proximal and distal thecal spacing. The short apertural processes, resembling those described in *M. rickardsi rickardsi* and *M. rickardsi minor* may, however, attach to the dorsal wall of the metathecal hook. Loydell (1993a) synonymized *M. rickardsi minor* with *M. priodon*. Paris *et al.* (1980) assigned similar species from the *crispus* and *griestoniensis* biozones of the Armorican Massif to *?Monograptus rickardsi minor* and *Monograptus* sp. A respectively. The thecal overlap of these taxa is not clearly visible. *Monograptus novaki* Bouček differs from *S.? splendens* in its arcuate, regularly dorsally curved and more rapidly widening rhabdosome. Isolated proximal portions of the two species, however, show almost identical dorsal curvature and thecal characters and may be easily mistaken. No spines have been so far recorded on thecal apercures of *M. novaki*. *Stimulograptus clintonensis* (Hall) – another similar species – may be distinguished from *S.? splendens* by its high-triangular thecae and straight rhabdosome without proximal dorsal curvature. In according to Loydell & Cave (1993) *S. clintonensis* is common in shallower, shelf settings similar to those proposed by Gutiérrez-Marco & Štorch (1998) for *Monograptus* sp. n. B, i.e. for *S.? splendens*.

M. splendens sp. n. appears to be widespread and common species of the upper *tullbergi* and lower *spiralis* biozones of the Iberian Peninsula. It is abundant in El Pobo and Checa sections (Western Iberian Cordillera), in Corral de Calatrava (southern part of the Central Iberian Zone) and has also been recorded from the southern Pyrenees.

Genus *Streptograptus* Yin, 1937

Type species: Designated by Loydell & Chen, 1991; *Graptolithus plumosus* Baily, 1871; from the Llandovery of Tieveshilly, County Down, Northern Ireland. Yin (1937) designated *Monograptus nodifer* Törnquist, 1881 *sensu* Elles & Wood 1913 as the type species of *Streptograptus*. Elles & Wood's (1913) specimens, however, belong in *S. plumosus* (Baily).

***Streptograptus linearis* Chen, 1984**

Pl. II, fig. 3; text-fig. 4, fig. 10

1984 *Streptograptus anguinus linearis* subsp. n.; Chen, p. 72, pl. 16, figs 6, 9–11, 14, 15; pl. 17, fig. 1.
1998 *Streptograptus* cf. *johnsonae* Loydell (? sp. n.); Gutiérrez-Marco & Štorch, p. 89, text-fig. 8b.

Holotype: Specimen NIGP 59858 figured by Chen (1984) on pl. 16, fig. 11; from the „*exiguus* Biozone" (uppermost part of *guerichi* Biozone), Nanjiang, Sichuan, China.

Material: Three complete flattened rhabdosomes and several fragments.

Diagnosis: Rhabdosome slender, ventrally curved, fish-hook shaped. Streptograptid metathecae comprise *c.* one-half of the rhabdosome width. Rhabdosome width expands from 0.3–0.35 mm at th1 to 0.6–0.65 mm distally.

Description: The slender, ventrally curved rhabdosome resembles an open fish-hook in its shape. Its dorso-ventral width increases from 0.3–0.35 mm at th1, to 0.45–0.5 mm at th10, and to a distal maximum of 0.65 mm. The sicula is *c.* 0.8 mm long and its apex reaches to the level of the top of th1. Prothecae are parallel-sided; typical streptograptid metathecae comprise *c.* one-half of the rhabdosome width. The apertures are broadened longitudinally. 2TRD is 1.5–1.8 mm in the proximal part of the rhabdosome, distally it increases to 1.8–1.9 mm.

Remarks: The rhabdosomes described herein agree well with the type specimens of *Streptograptus linearis* figured by Chen (1984). They have the same rhabdosomal and thecal shape, dorso-ventral widths and 2TRDs. *S. linearis* differs from the otherwise similar *S. johnsonae* Loydell in its wider rhabdosome, less pronounced ventral curvature and less closely spaced thecae. *S. peti-*

lus Hutt – another similar species described from English Lake District (Hutt 1975) – is still more gracile (maximum width 0.3 mm) and has also more closely spaced thecae. *S. linearis* has been found in the lower part of the *hispanicus* Subzone of the *linnaei* Biozone in the Checa Section whilst the two other taxa discussed herein came from the younger *utilis* Subzone. Loydell (1993b) identified *S. linearis* also in Linnarsson's collection which originates from Klubbudden in Sweden.

***Streptograptus pericoi* sp. n.**

Pl. II, fig. 6; text-fig. 3, figs 4–6

Name: After Dr. Pedro („Perico") Herranz Araújo.

1998 *"Paradiversograptus"* aff. *runcinatus* (Lapworth); Gutiérrez-Marco & Štorch, p. 90, fig. 10a, b, d.

Holotype: MGM 3480 S figured on pl. II, fig. 6 and text-fig. 3, fig. 4; ventrally curved distal part of the rhabdosome preserved in moderate relief, proximal portion on the same slab; from the upper part of the *linnaei* Biozone (*hispanicus* Subzone, early Telychian) of the Bádenas Formation at Checa section (Western Iberian Cordillera, Guadalajara Province, Spain).

Material: 6 more-or-less complete specimens preserved in low to moderate relief, and several fragments.

Diagnosis: Rhabdosome robust, gently doubly curved. Dorsally curved proximal end is 0.25 mm wide; ventrally curved distal part slowly widens to 0.9 mm. Prothecae narrow towards prominent, coiled metathecae of almost semicircular profile which comprise *c.* two-fifths of dorso-ventral width of the rhabdosome proximally and *c.* one-half of the width in the distal part. Distal metathecae occupy one-half of the thecal length. Axially extended apertures face the dorsal wall of the rhabdosome. 2TRD is 1.7–2.0 mm proximally and 1.6–1.9 mm distally.

Description: Streptograptid with gently ventrally curved rhabdosome, the most proximal portion of which may be weakly dorsally recurved. The rhabdosome widens slowly from the initial width 0.25 mm (height of th1) to a maximum width of 0.8–0.9 mm. Thecae provided with node-like prothecal folds; prothecae narrow towards the metathecal portion. Prominent metathecae of medium, almost semicircular profile have extended apertures which face the dorsal wall of the rhabdosome. The metathecae comprise *c.* two-fifths of the proximal dorso-ventral width of the rhabdosome and *c.* one-half of the width in the distal part of the rhabdosome. Distal metathecae occupy one-half of the thecal length. The thecal aperture is extended and faces the dorsal wall of the rhabdosome. The sicula is *c.* 1 mm long and reaches the top of th1. 2TRD is 1.7–2.0 mm in the proximal part of the rhabdosome and thereafter decreases slightly to 1.6–1.9 mm.

Remarks: *Streptograptus pericoi* sp. n. may be distinguished from most other early Telychian streptograptids by its distally more robust, gently but regularly ventrally curved rhabdosome with prominent medium profile metathecae. *Streptograptus pseudoruncinatus* (Bjerreskov, 1975), one of the few species having streptograptid thecae and the rhabdosome of similar shape and dimensions, differs from *S. pericoi* in having lower profile, more closely spaced thecae (2TRD – 1.2–1.6 mm after Loydell 1993a). Proximal portions of *S. filiformis* Chen may be easily misidentified with those of *S. pericoi* which occur in the same horizon in the Checa section. Proximal portion of *S. pericoi*, however, is a more rapidly widening and more ventrally curved. Distal portion of *S. pericoi* may be distinquished from otherwise similar *S. plumosus* by its considerably distally narrowing prothecae and broader metathecae of semicircular profile. *Monograptus pseudobecki* Bouček & Přibyl, 1942 is also similar but has a more rapidly broadening rhabdosome and possesses narrower, rather hooked than streptograptid metathecae. *Paradiversograptus runcinatus* (Lapworth) differs in having hooked thecae.

S. pericoi was found only in the Checa section. It is uncommon in a thin bed in the upper part of the *linnaei* Biozone (*hispanicus* Subzone).

Genus *Torquigraptus* Loydell, 1993

Type species: *Graptolithus Pròteus* var. *plana* Barrande, 1850; original designation; from the upper Llandovery (*linnaei* Biozone) of Želkovice, Bohemia.

***Torquigraptus arcuatus* (Bouček, 1931)**

Pl. IV, fig. 5; pl. V, figs 3–5; text-fig. 4, fig. 12a–c; text-fig. 5, figs 3a–c, 11

1931 *Monograptus arcuatus* sp. n.; Bouček, p. 7, text-fig. 7a, b.

1939 *Monograptus arcuatus* Bouček; Münch, p. 20, text-fig. 26.

1945 *Spirograptus arcuatus* (Bouček, 1931); Přibyl, p. 35, pl. 8, figs 4, 5.

1993 *"Monograptus" arcuatus* Bouček, 1931; Loydell & Cave, fig. 5o, p.

1998 *Torquigraptus* cf. *arcuatus* (Bouček); Gutiérrez-Marco & Štorch, p. 90, fig. 9k.

Lectotype: Subsequent designation by Přibyl 1945; specimen L31368 figured by Bouček (1931) on text-fig. 7a; from the upper *crispus*–lower *griestoniensis* Biozone of Radotín, Bohemia.

Material: Over 40 more-or-less complete rhabdosomes, including several proximal portions. The specimens from Corral de Calatrava are flattened; those from Orihuela del Tremedal are preserved in moderate relief.

Diagnosis: Rhabdosome with regular dorsal curvature. Several proximal thecae axially elongated (2TRD 2 is 2.5–3.0 mm, 2TRD 5 is 2.3–2.8 mm), 0.25 mm high and simply hooked. Distalwards the apertural parts of the

The sicula is 1.1 mm long, having a *c.* 0.1–0.15 mm wide aperture, its apex reaching about two-thirds up th1. The earliest three to five thecae have axially elongated low-angle prothecae and tiny, probably hooked metathecae. The prothecal bases are 0.1 mm wide in the first few thecae, the thecal height of which attains 0.2 mm. The following thecae become less axially elongated having more prominent, isolated torquigraptid metathecae with hooked and twisted apertures. Thecal overlap is negligible. The width of the rhabdosome increases to 0.6 mm at the level of *c.* th6. The maximum width of 0.9 mm (in low relief) is attained at th8–th10. 2TRD decreases from 2.4 mm at th3, to 2.1 mm at th6. Distally, 2TRD is *c.* 1.8 mm. The prothecal base comprises one-third of the rhabdosome width at the level of th10 (0.3 mm of 0.9 mm high theca); more distally the prothecal bases comprise two-fifths of the rhabdosome width.

Mesial and distal thecae are oriented perpendicular to the plane of the rhabdosome spiral so that the true shape of the metathecae and the dorso-ventral width of the rhabdosome are usually obscured by the „scalariform view".

Remarks: Proximal fragments of *T. australis* may be difficult to distinguish from *T. tullbergi*. The thecae of the two species seem to be almost identical in form and size. The former species, however, more rapidly increases in dorso-ventral width and has broader prothecal bases which comprise one-third to two-fifths of the DVW from *c.* th10. The distal appearance of the thecae developes later in *T. tullbergi*. Beginning at the second half of the first whorl the thecae are perpendicular to the spiral plane in *T. australis*. The circular outline of the regular spiraliform rhabdosome distinguishes *T. australis* from all other torquigraptids except *T. spiraloides* which, however, was probably of helical form. *T. spiraloides* also differs from *T. australis* in having more isolated and higher metathecae and a more rapid proximal increase in dorso-ventral width. *Oktavites contortus* (Perner) may be easily distinguished from *T. australis* by its slender, axially elongated proximal portion which widens rapidly within th6–th9 (as shown by the specimen figured by Perner 1897 and Přibyl 1945, pl. 9, fig. 11, and many other rhabdosomes collected by the author). *T. proteus* has a helically spiralled rhabdosome with a more elongated, slender proximal portion and a considerably wider distal portion with high-triangular thecae.

The species is common in the *griestoniensis* Biozone of both the Central Iberian Zone and Western Iberian Cordillera. It is also common in the same biozone of the Barrandian area in Bohemia (Štorch 1994, *Monograptus* cf. *contortus*). Other records are from Sardinia (Štorch & Serpagli 1993, *Monograptus* cf. *contortus*) and Wales (Zalasiewicz 1994, *Torquigraptus tullbergi* cf. *spiraloides*). The overall stratigraphical range of *T. australis* is probably upper *crispus* Biozone to ?lowermost *crenulata* and/or *tullbergi* Biozone.

***Torquigraptus flagellaris* (Törnquist, 1892)**

Text-fig. 5, figs 2, 5, 6

1892 *Monograptus flagellaris*; Törnquist, pp. 42–43, pl. 3, figs 31–33.
?1913 *Monograptus flagellaris* Törnquist; Elles & Wood, p. 457, pl. 46, fig. 3, text-fig. 315.
?1931 *Monograptus flagellaris* (Toernquist); Haberfelner, pp. 137–138, pl. 2, fig. 8a–d.
1945 *Spirograptus flagellaris* (Törnquist 1892); Přibyl, pp. 14–15.
1998 *Torquigraptus flagellaris* (Törnquist); Gutiérrez-Marco & Štorch, fig. 9f.

Lectotype: Subsequent designation by Přibyl 1945; the specimen figured by Törnquist (1892) on pl. 3, fig. 31; from Nittsjo, Sweden.

Material: 45 flattened specimens, including several complete rhabdosomes with siculae.

Description: The rhabdosome is coiled into a high helical spiral, with a short, dorsally curved proximal portion. At the level of th4–th7 the rhabdosome axis twists abruptly so that the remainder of the rhabdosome appears to be ventrally coiled. A maximum of one-and-a-half whorls were recorded in the present material. The sicula is 0.9–1.0 mm long and its apex attains the level of the dorsal wall of the first metatheca. Thecae are triangular in shape throughout the whole rhabdosome, being isolated proximally and overlapping a little distally. The ventral wall of the distal thecae is inclined at 35–40° to the rhabdosome axis. The small, laterally twisted metathecal hooks, of torquigraptid appearance, terminate in laterally facing apertures. Thecal height is 0.6 mm at th1–2; the maximum rhabdosome dorso-ventral width – 1.25 mm – is attained between th8 and th10. 2TRD at th2 is 2.1 mm; distally the 2TRD increases slightly to 2.2 mm.

Remarks: The Spanish material, common in the uppermost *tullbergi* and lower *spiralis* biozones, is very similar to the type material figured by Törnquist (1892). Bouček (1953) listed *T. flagellaris* from the *griestoniensis* Biozone of Bohemia. All specimens from his collection, however, originate from the *crenulata* (i.e. *tullbergi*/*spiralis* Biozone boundary beds.

***Torquigraptus tullbergi* (Bouček, 1931)**

Pl. III, fig. 1; pl. IV, fig. 1, pl. VI, figs 2, 4–6; pl. VII, figs 1, 2, 4, 6; text-fig. 5, figs 7–10

1931 *Monograptus tullbergi* Bouček, p. 8, text-fig. 9f, g.
1931 *Monograptus communis* var. *rostratus* (Elles und Wood); Haberfelner, pp. 43–44, text-fig. 2a, b.
1931 *Monograptus intermedius* (Carruthers); partim Haberfelner, pl. 1, fig. 26c, non 26a, b, d, text-fig. 3a, b.
1945 *Spirograptus tullbergi tullbergi* (Bouček 1931); Přibyl, p. 17, pl. 6, figs 1–6.
1970 *Monograptus spiralis* (Geinitz) sensu Elles and Wood; Toghill and Strachan, p. 518, pl. 104, figs 5–7, ?8, 9, pl. 105, fig. 14.

1971 *Monograptus (Spirogr.) tullbergi tullbergi* Bouček, 1931; Schauer, pp. 75–76, pl. 29, figs 17–18; pl. 34, figs 3–4.
1975 *Monograptus tullbergi* Bouček, 1931; Bjerreskov, p. 66, fig. 19C.
1994 *Torquigraptus tullbergi tullbergi* (Bouček, 1931); Zalasiewicz, p. 385, text-fig. 8 E, F.
1998 *Torquigraptus tullbergi* (Bouček); Gutiérrez-Marco & Štorch, fig. 9c.
1998 *Torquigraptus* cf. *tullbergi* (Bouček) – ? sp. n.; Gutiérrez-Marco & Štorch, p. 90, fig. 9d.

Lectotype: designated Přibyl (1945); the specimen No L30524 figured by Bouček (1931, fig. 9f) from the Litohlavy Formation (mid-late Telychian) at Barrande's locality "Colony Lapworth" near Zdice, Bohemia. Housed in the National Museum, Prague.
Material: More than one hundred rhabdosomes, some with the sicular end, some late mature, preserved both flattened and in moderate relief.

Description: The rhabdosome is coiled into a loose, low-conical spiral. Late mature rhabdosomes, composed of almost two whorls (*c.* 540–720°) may attained more than 100 mm in length. The second whorl, in which the rhabdosome axis is twisted, opens rapidly so that the distal end of the rhabdosome becomes almost straight, with only slight ventral curvature.

The sicula is 1.0–1.2 mm long and reaches up to 2/3 up th1. The proximal thecae are axially elongated, very low-triangular in shape, being 0.1 mm in diameter at the level of the early protheca. Their metathecae are small, probably simply hooked. A small prothecal fold has been observed. The mesial and distal thecae are triangular, typically torquigraptid. Metathecae are isolated, of almost rastritiform appearance, but slightly ventrally coiled. The laterally twisted apertural part of the metatheca faces the reverse side of the rhabdosome. The apertures appear to be slightly expanded transversely.

Th1 is *c.* 1.2 mm long and 0.15–0.2 mm high. The dorso-ventral width of the rhabdosome further increases from 0.2–0.25 mm (th2) and 0.5–0.8 mm (th5) to 0.9–1.1 mm at th10. Then the dorso-ventral width of the rhabdosome increases more gradually, measurement being complicated by the twisted rhabdosome. The distal width of the longest rhabdosomes is 2.1 mm. The early parts of the proximal prothecae are 0.1–0.15 wide; the early parts of the most distal prothecae are up to 0.9 mm wide. 2TRD is 2.2–2.4 mm at th2, 1.9–2.3 mm at th5 and 1.75–2.05 mm at th10. Distally, 2TRD reaches 2.1–2.45 mm.
Remarks: During the astogeny of *T. tullbergi*, the metathecal part of the theca increases in the proportion of the theca which it represents. The most proximal thecae have long, slowly expanding prothecae and very small, hooked metathecae. Distally, the prothecal portion is gradually suppressed in favour of the progressively developing metatheca. This astogenic development, however, can be more or less delayed in different specimens. This may explain the apparent polymorphism in the proximal shape and elongation of rhabdosomes observed as bedding-plane assemblages (thanatocenoses). Even more pronounced differences emerge when assemblages from different bedding planes are compared. Some specimens of *T. tullbergi* have almost arcuate proximal portions with many elongated prothecae and a gradual increase of the dorso-ventral width; other specimens are almost fish-hook shaped proximally, having more rapid development of the metathecae. The type specimen figured by Bouček (1931) is one of those specimens with a less elongated proximal part and a more rapid increase in the dorso-ventral width of the rhabdosome.

The large variability observed in both Iberian and Bohemian populations, may embrace even specimens having a gracile, very elongated proximal portion of the rhabdosome. These were separated by Gutiérrez-Marco & Štorch (1998) from the coeval *T. tullbergi* and left in open nomenclature (*T.* cf. *tullbergi* – ? sp. n.) until further, more complete material was available. Other specimens resembling *T.* cf. *tullbergi* (? sp. n.) have been figured by Schauer (1971, pl. 29, fig. 17) and Zalasiewicz (1994, text-fig. 8F). In the light of new biometric data, we refer all of these specimens to *Torquigraptus tullbergi* (Bouček, 1931).

Torquigraptus tullbergi resembles *T. spiraloides* (Přibyl) in its spiraliform rhabdosome and laterally twisted torquigraptid thecae. It differs from the latter species in having a gracile, elongated proximal portion to the rhabdosome and a less tightly enrolled spiral which resembles some cyrtograptid procladia. The sicula is longer and the proximal metathecae smaller in *T. tullbergi*.

T. tullbergi is a common component of mid-late Telychian graptolite faunas in many parts of the world and has, thus, considerable value in biostratigraphical correlation. In Spain (Gutiérrez-Marco & Štorch 1998) and Bohemia (Štorch 1994) it gives the name to the *tullbergi* Biozone corresponding in age to the *crenulata* Biozone elsewhere. *T. tullbergi* appears together with late populations of *Monoclimacis griestoniensis* Nicol, s.s. (as documented by Gutierréz-Marco & Štorch 1998) and disappears in the lower part of the *spiralis* Biozone. Similar specimens from the lower part of the *griestoniensis* Biozone, formerly assigned to this species, belong in *T. australis* sp. n. Schauer (1971) reported *T. tullbergi* also from the *turriculatus* and *crispus* biozones but all specimens figured in his paper come from Ronneburg I section, in which the *crenulata* and *spiralis* biozones were sampled.

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Nové poznatky o graptolitech svrchního llandovery (silur) Španělska

Rozsáhlé výchozy černých graptolitových břidlic, postupně dokumentované z mnoha provincií Španělska i Portugalska, činí z Pyrenejského poloostrova klíčovou oblast pro poznání biostratigrafie a graptolitových faun spodního siluru peri-Gondwanské Evropy. Předložená práce shrnuje nové poznatky o graptolitové fauně svrchního llandovery (telych) západní části Centrální iberské kordillery (masivy Sierra Menera, Nevera a Tremedal) a jižní části centrální zóny iberského masivu. Práce navazuje na výsledky stratigrafického a paleoekologického výzkumu obou oblastí (Gutiérrez-Marco – Štorch 1998, García Palacios et al. 1996a, b). Detailním vzorkováním několika profilů svrchním llandovery bylo uvedenými autory zjištěno přes 60 druhů graptolitů, z nichž řada byla citována v otevřené nomenklatuře, event. jako „? n. sp.“. Většina těchto nových, nebo nedostatečně známých taxonů je systematicky zpracována v této práci (*Euroclimacis* n. gen., *Euroclimacis iberica* n. sp., *Monograptus juancarlosi* n. sp., *Stimulograptus? splendens* n. sp., *Streptograptus pericoi* n. sp. a *Torquigraptus australis* n. sp. a popisy či komentáře k dalším 15 druhům).

Svrchnollandoverská graptolitová fauna Pyrenejského poloostrova je nejbližší fauně armorického masivu ve Francii. Kromě mnoha druhů s téměř celosvětovým rozšířením je také mnoho druhů společných s Českým masivem (torquigrapti, petalograpti), zatímco některé diskutované taxony (metaclimacograpti, *P. meridionalis*) byly dosud známy jen ze severní Afriky (z Alžírska, Libye, Tuniska).

Explanation of plates

Plate I

1 – *Metaclimacograptus asejradi* Legrand, 1993, MGM 3485 S, (*linnaei* Biozone, *hispanicus* Subzone).
2, 4, 5 – *Parapetalolithus meridionalis* (Legrand, 1998), 2 – MGM 3467 S (?*crispus* Biozone), 4 – MGM 3413 S (*griestoniensis* Biozone), 5 – MGM 3478 S (*griestoniensis* Biozone).
3 – *Metaclimacograptus flamandi* (Legrand, 1993), MGM 3479 S, (*griestoniensis* Biozone).
6 – *Parapetalolithus hispanicus* (Haberfelner, 1931), MGM 3457 S, (*linnaei* Biozone, *hispanicus* Subzone).
1, 4–6 from Checa A locality, 2 from Corral de Calatrava section and 3 from Estación de Belalcázar (Corral de Calatrava area); 1, 3 x10; 2, 4–6 x5.

Plate II

1, 2 – *Monograptus gemmatus* (Barrande, 1850), 1 – MGM 3444 S, 2 – MGM 3458 S, (*linnaei* Biozone, *runcinatus–gemmatus* Subzone).
3 – *Streptograptus linearis* Chen, 1984, MGM 3438 S (*linnaei* Biozone, *hispanicus* Subzone).
4 – *Pseudoplegmatograptus obesus* (Lapworth, 1877), MGM 3428 S, (*linnaei* Biozone, *hispanicus* Subzone).
5 – *Stimulograptus becki* (Barrande, 1850), MGM 3434 S, (*linnaei* Biozone, *hispanicus* Subzone).
6 – *Streptograptus pericoi* sp. n., MGM 3480 S, (holotype, *linnaei* Biozone, *hispanicus* Subzone).
All specimens from Checa A locality; x5.

Plate III

1 – *Torquigraptus tullbergi* (Bouček, 1931), PŠ 696, (*tullbergi* Biozone).
2, 3 – *Monograptus curvus* Manck, 1923, MGM 3471 S (the same slab, lower *spiralis* Biozone).
4–7 – *Euroclimacis iberica* sp. n., 4 – MGM 3473 S, 5 – MGM 3477 S, 6 – MGM 3475 S, 7 – MGM 3470b S (holotype), (upper *spiralis* Biozone).
1 – from El Pobo de Dueñas locality (F), 2–7 from Corral de Calatrava section; 1–4, 6, 7 x5; 5 x10.

Plate IV

1 – *Torquigraptus tullbergi* (Bouček, 1931), MGM 3411 S, (*tullbergi* Biozone).
2, 7 – *Monograptus juancarlosi* sp. n., MGM 3462 S (the same slab, holotype figured on fig. 7), (lower *tullbergi* Biozone).
3, 6 – *Stimulograptus*? *splendens* sp. n., 3 – MGM 3409 S, (lower *spiralis* Biozone), 6 – MGM 3466 S (holotype, uppermost *tullbergi* Biozone).
4 – *Paradiversograptus runcinatus* (Lapworth, 1876), MGM 3455 S (*linnaei* Biozone, *runcinatus–gemmatus* Subzone).
5 – *Torquigraptus arcuatus* (Bouček, 1931), MGM 3416 S, (upper ?*crispus* Biozone).
1, 3 – from El Pobo de Dueñas locality (F), 2, 4, 6, 7 – from Checa A locality, 4 – from Orihuela del Tremedal, section C; 1, 3, 5, 6 x5; 2, 4, 7 x3.

Plate V

1, 2 – *Monograptus drepanoformis* Toghill & Strachan, 1970, 1 – MGM 3427 S, 2 – DPM 3426 S (*griestoniensis* Biozone).
3–5 – *Torquigraptus arcuatus* (Bouček, 1931), 3 – MGM 3580 S, 4 – MGM 3464 S, 5 – MGM 3465 S, (?lowermost *griestoniensis* Biozone).
1, 2 – from Checa A locality, 3–5 – from Corral de Calatrava section; 1, 3–5 x5; 2 x10.

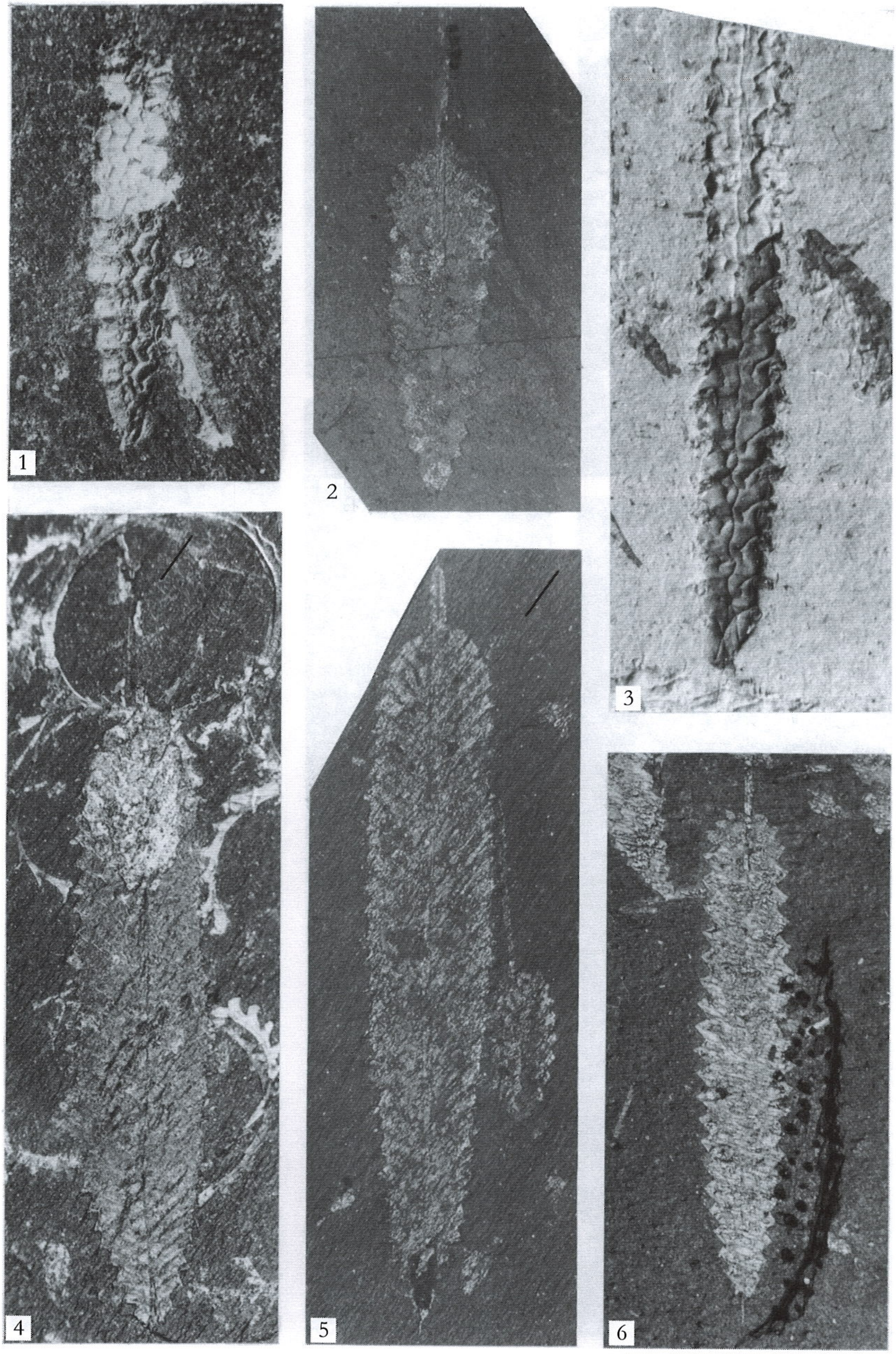
Plate VI

1, 3 – *Torquigraptus australis* sp. n., 1 – MGM 3412 S (holotype), 3 – MGM 3420 S, (*griestoniensis* Biozone).
2, 4–6 – *Torquigraptus tullbergi* (Bouček, 1931), 2 – MGM 3419a S, 4, 6 – MGM 3463 S (the same slab), 5 – MGM 3408 S, (*tullbergi* Biozone).
All specimens from Checa A locality, x5.

Plate VII

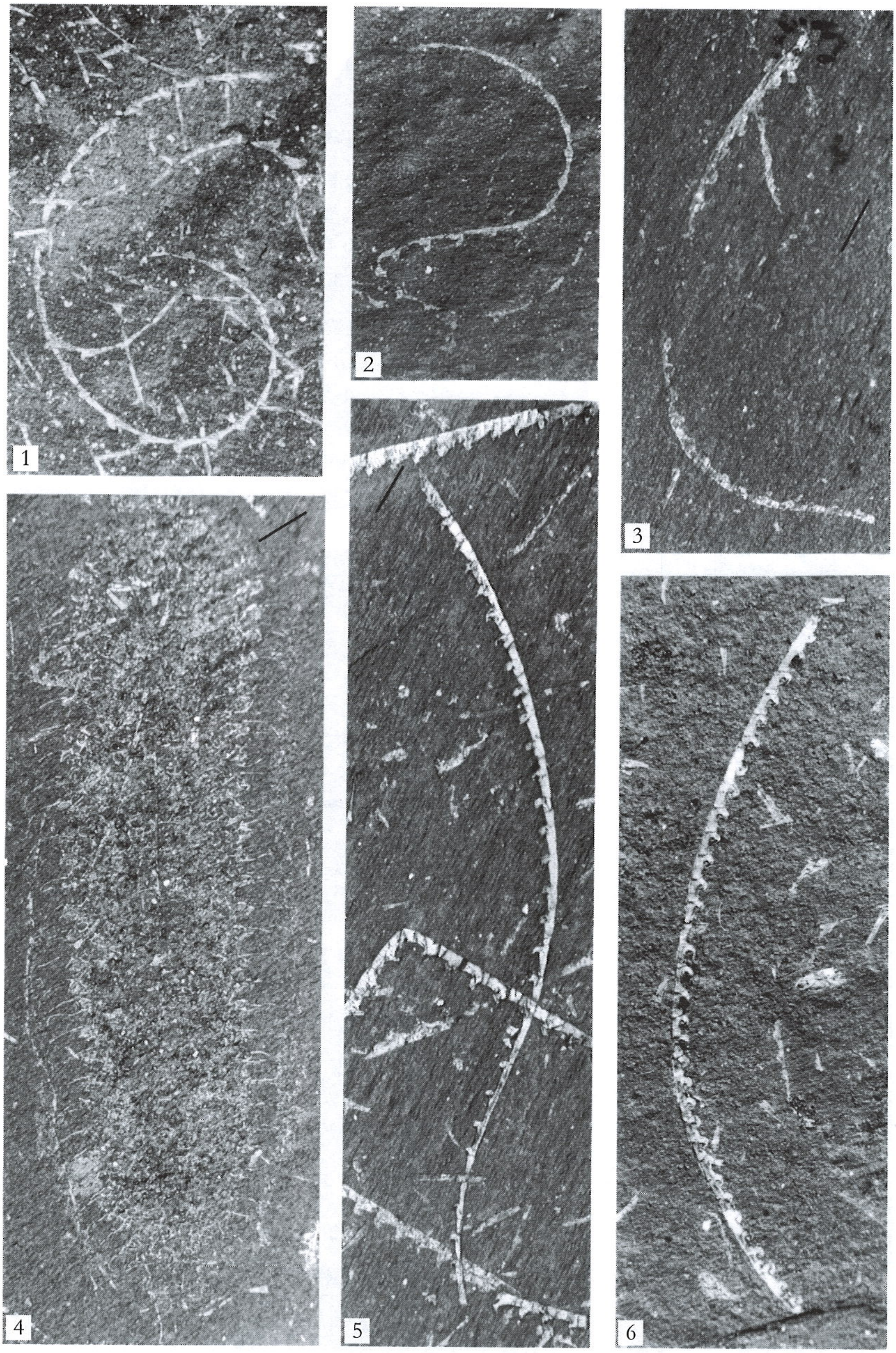
1, 2, 4, 6 – *Torquigraptus tullbergi* (Bouček, 1931), 1 – PŠ 900, (the sicula and th1), 2 – PŠ 901 (ca 10th theca, obverse view), 4 – PŠ 905 (9–11th thecae, reverse view), 6 – PŠ 904 (7th theca, obverse view), (*tullbergi* Biozone).
3, 5 – *Monograptus juancarlosi* sp. n., 3 – PŠ 902 (mesial thecae), 5 – PŠ 903 (late mesial theca), (lower *tullbergi* Biozone).
All specimens from Checa A locality, SEM photos, 1, 5 x90; 2 x45; 3 x70; 4 x37; 6 x100. White scale bar = 0.1 mm.

P. Štorch: New data on Telychian (Upper Llandovery, Silurian) graptolites from Spain (Pl. I)

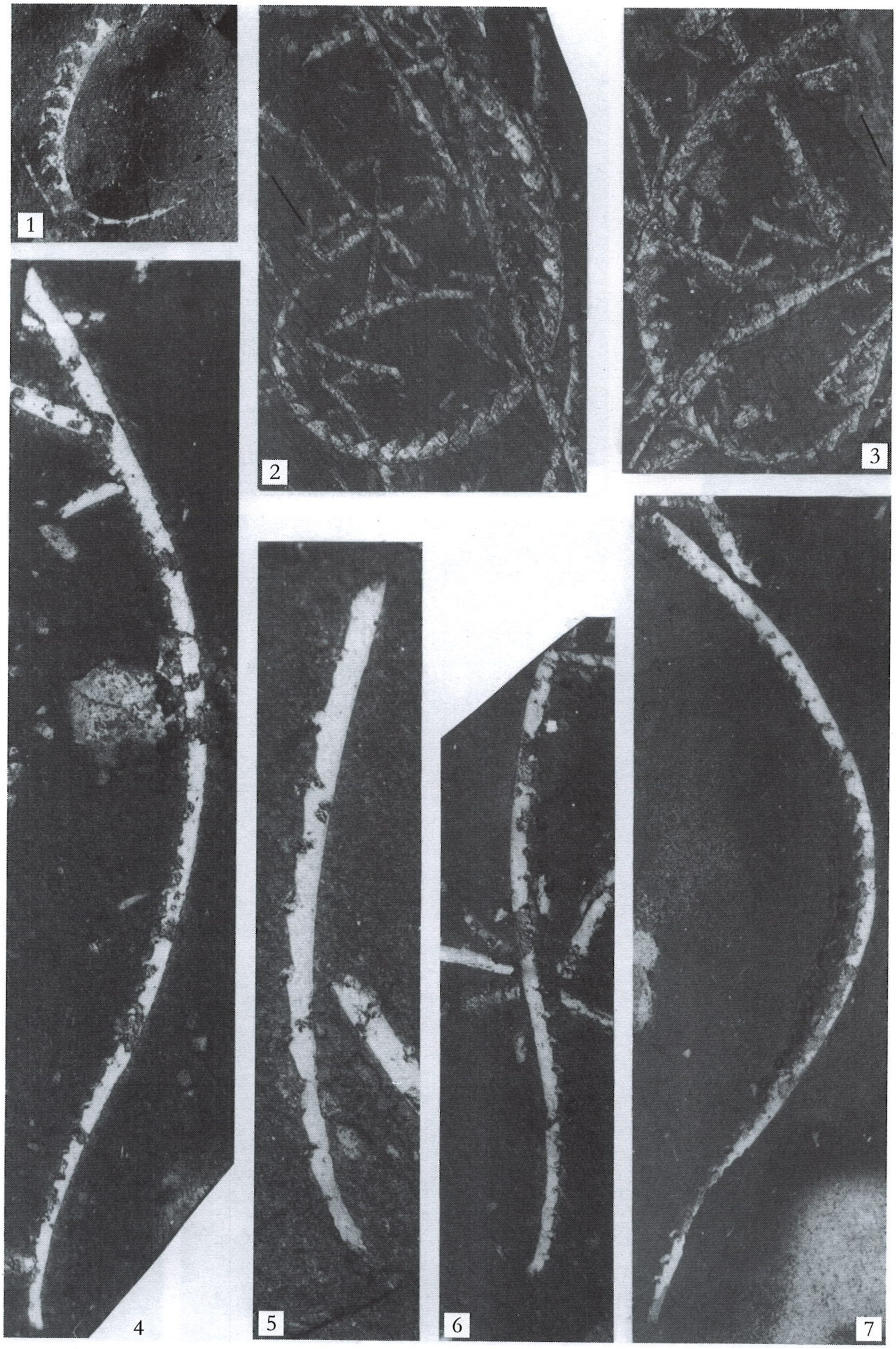


For explanation see p. 134

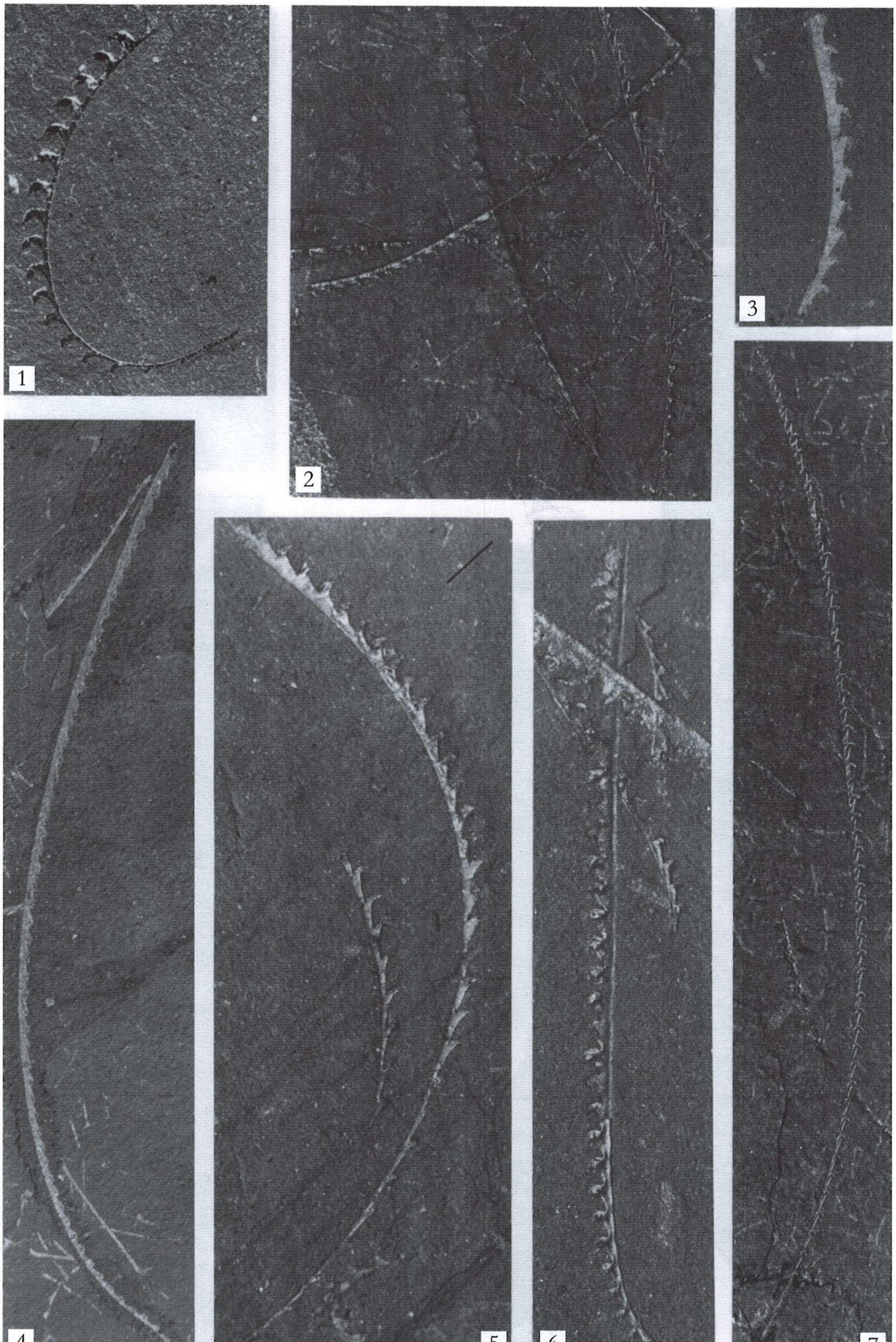
P. Š t o r c h : New data on Telychian (Upper Llandovery, Silurian) graptolites from Spain (Pl. II)



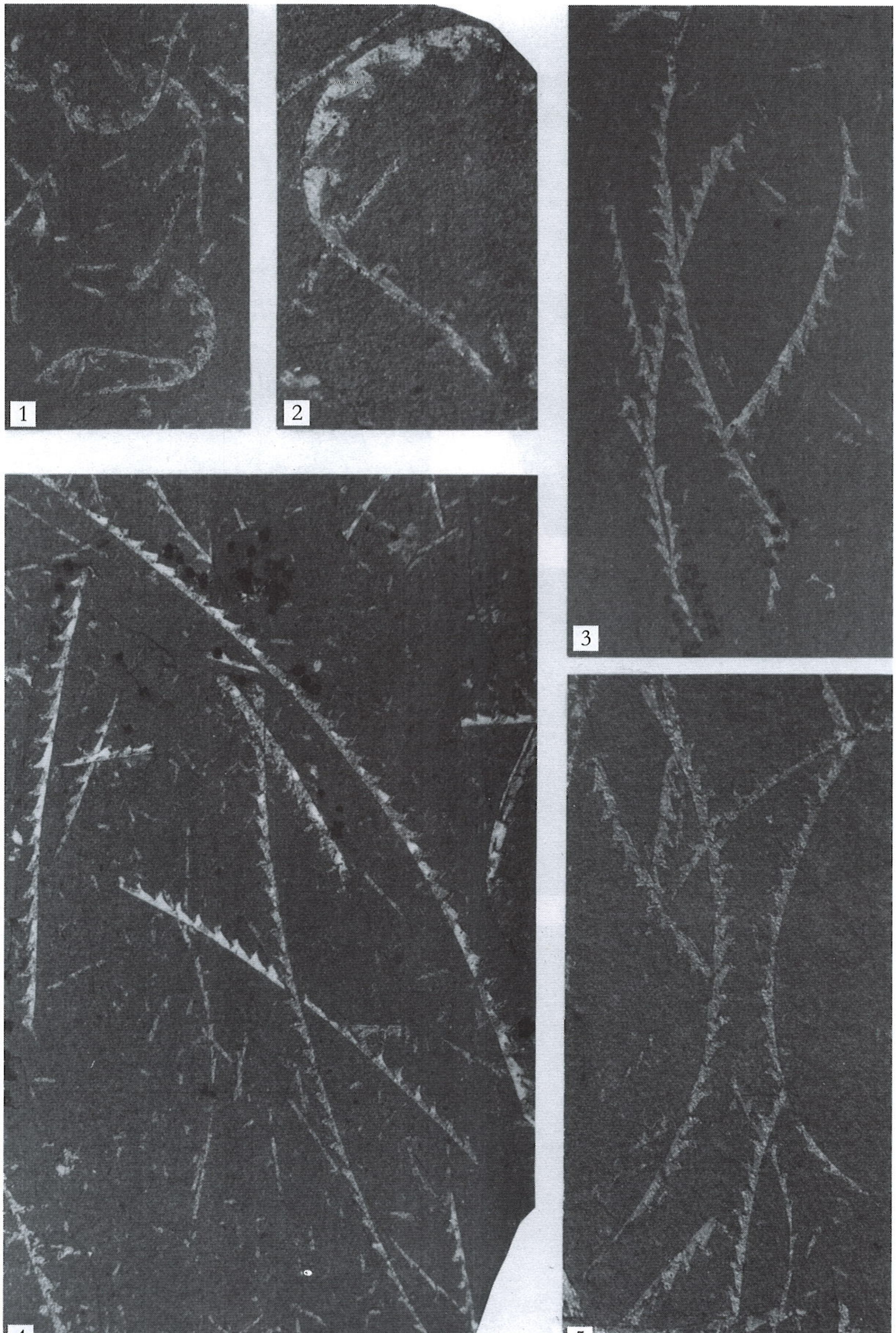
P. Štorch: New data on Telychian (Upper Llandovery, Silurian) graptolites from Spain (Pl. III)



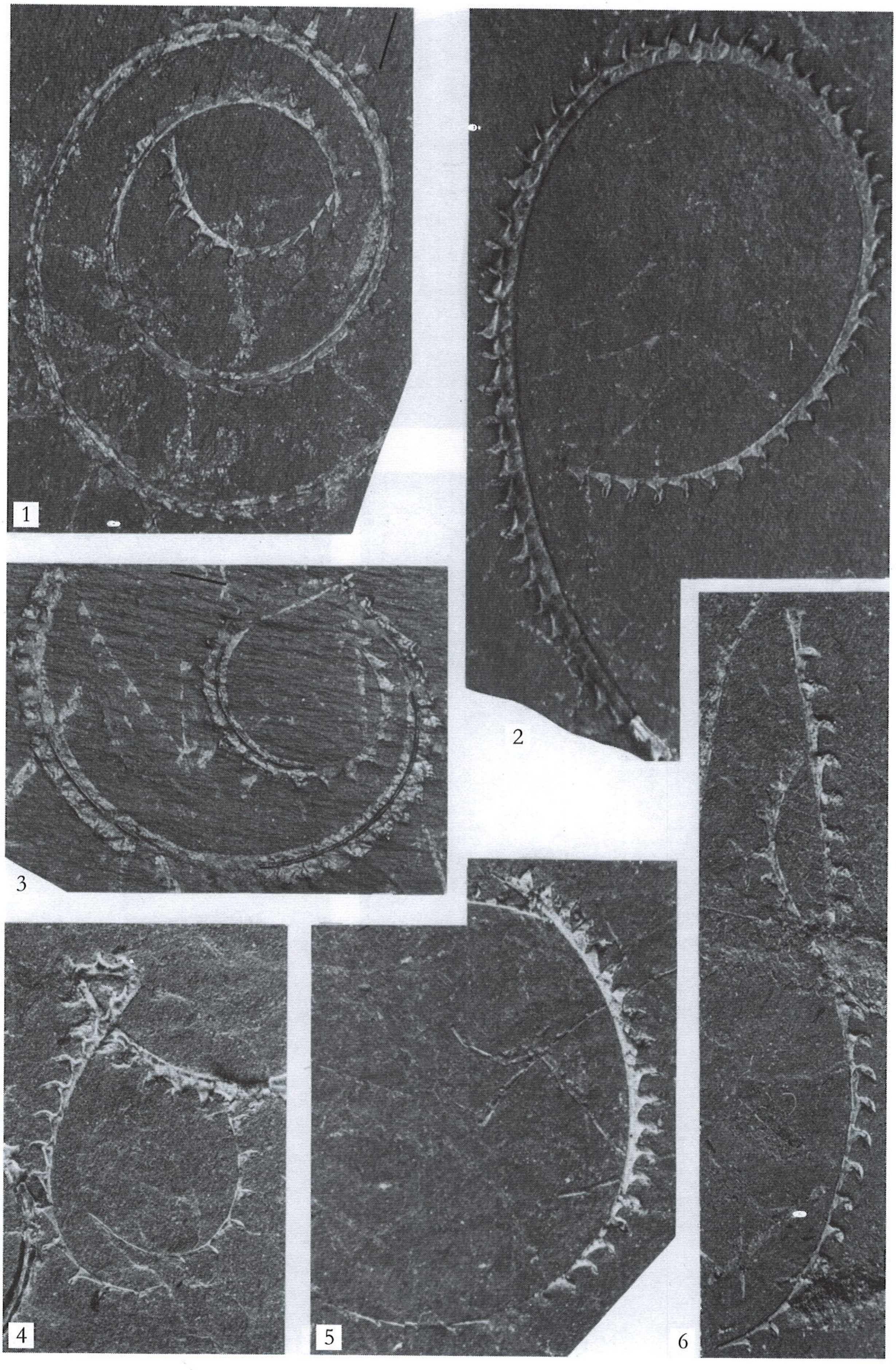
P. Štorch: New data on Telychian (Upper Llandovery, Silurian) graptolites from Spain (Pl. IV)



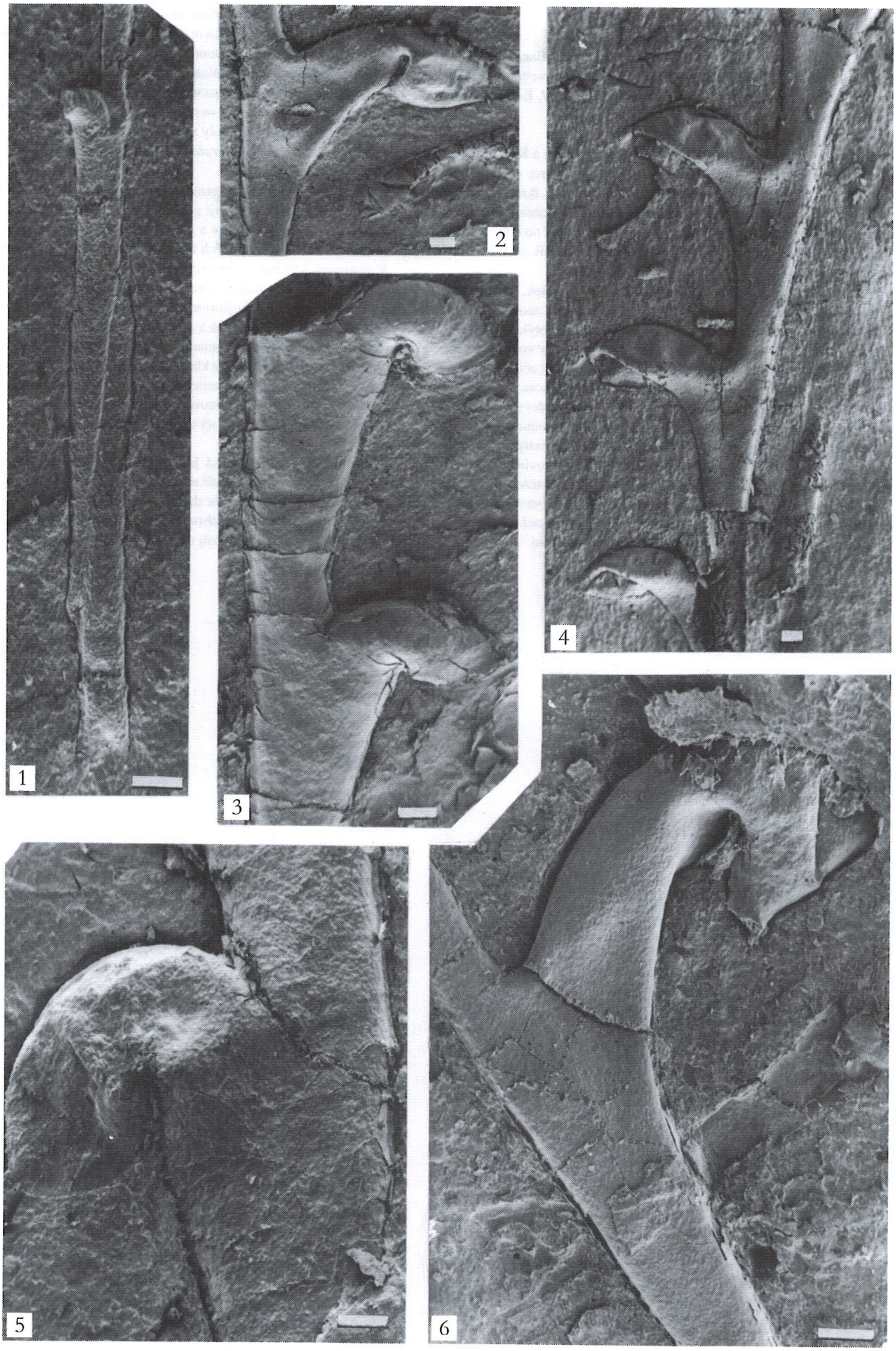
P. Štorch: New data on Telychian (Upper Llandovery, Silurian) graptolites from Spain (Pl. V)



P. Štorch: New data on Telychian (Upper Llandovery, Silurian) graptolites from Spain (Pl. VI)



P. Štorch: New data on Telychian (Upper Llandovery, Silurian) graptolites from Spain (Pl. VII)



RECENZE

P. W. Harben – M. Kužvart: **Industrial Minerals: Global Geology** (1997). – Vydavatel: Industrial Minerals Information Ltd., Park House, Park Terrace, Worcester Park, Surrey, KT4 7HY, England. Cena 198 US dolarů.

Kniha je spojeným 3. vydáním publikace P. W. Harbena a R. L. Batese a 2. vydáním práce M. Kužvarta a je věnována dvěma vyjímečným specialistům v oblasti nerudných surovin, profesoru R. L. Batesovi z Ohio State University a P. M. Tatarinovi z Gornyj Institut, Petrohrad. Deklaruje, že je jakýmsi mostem mezi Východem a Západem, neboť po dobu studené války byly údaje o nerostném bohatství tehdejšího SSSR a jeho satelitů téměř nepřístupné.

Na 462 stránkách, včetně 199 obrázků a 194 tabulek, je abecedně diskutováno 48 komodit, počínaje azbestem a konče zeolity. Diskusi jednotlivých komodit předchází úvod, v němž se autoři dotýkají některých specifik nerudných surovin, které na rozdíl od rudních materiálů nebo energetických surovin mají přednost v tom, že jejich odbyt neustále vzrůstá bez dramatických výkyvů. Tak např. samotná hodnota vytěžených štěrkopísků je ekvivalentní hodnotě vytěženého zlata a převýšila hodnotu mědi, hodnota vytěžených jílových surovin je vyšší než hodnota železných rud. Nerudné suroviny se staly nezastupitelnými materiály v budování moderní společnosti. Je zmíněna role nerudných surovin v životním prostředí a zdravotních disciplínách, dále přechod od dříve těžených nerostů k jiným surovinám. Např. berylium se začíná získávat z bertranditu místo pegmatitového berylu, síra více z recyklovaných surovin než z primárních zdrojů, magnezium z mořské vody než z magnezitu, atd. Aby nedošlo k ohrožení dodávek některých materiálů díky politické nestabilitě v různých částech světa, jsou některé tradiční země, které v nedávné minulosti byly hlavním zdrojem některých komodit, nahrazovány jinými. Jako příklad se uvádí Austrálie, která se díky nálezu obrovských ložisek diamantů doslova z ničeho stala jejich největším producentem (dříve Jižní Afrika) a zároveň si vytvořila vlastní trh a rozešla se s tradičním trhem ovládaným belgickým DeBeers. Konec úvodní kapitoly patří vyjmenování zdrojů odkud autoři čerpali informace, a také doporučení literatury, z níž lze získat další data o nerudných surovinách.

Následuje kapitola „od magmatu k metamorfismu a zpět“, v níž jsou na dvanácti stránkách uvedeny geologické procesy a typy ložisek, od magmatických po sedimentární a metamorfní. Tato kapitola je doplněna přehlednou tabulkou genetických typů ložisek nerudných surovin (5 str.).

V systematické části jsou popisovány jednotlivé komodity. V úvodu ke každé surovině je uvedena mineralogická, chemická a fyzikální charakteristika nerostu nebo horniny, současné použití v průmyslu, včetně výhledu do 21. století, spotřeba a produkce, typy ložisek, což je důležité pro vyhledávání nových akumulací, světová ložiska, vlastnosti a použití jejich suroviny, přičemž se důraz klade na ložiska v USA, střední a východní Evropě a bývalém SSSR, ale nejsou opominuta žádná významná ložiska v kterékoliv části země. Pozornost je rovněž věnována metodám vyhledávání (geochemické, geofyzikální), průzkumu, těžby a úpravy dané suroviny.

Objemné kompendium má jen minimum nedostatků (překlepy, nesprávně uvedené grafy) a patří mezi práce bez nichž se neobejde nejen ložiskový geolog, ale ani řada dalších geovědních a technologických disciplín. Kniha bohužel nezahrnuje stavební suroviny, které by však nepochybně zasluhovaly pro svůj rozsah zvláštní publikaci.

Jaroslav Hak