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Earliest Monograptidae (Graptolithina) in the lower Llandovery sequence of the Prague Basin (Bohemia)

Nejstarší zástupci čeledi Monograptidae (Graptolithina) ze spodního llandoveru pražské pánve (Barrandien)

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Abstract: Monograptid graptolites (23 species and subspecies) of the genera *Atavograptus, Coronograptus, Lagarograptus, Pribylograptus,* biform monograptids ("*Pernerograptus*"), lobiferus group, the earliest *Pristiograptus* and *Campograptus* are described from the Želkovice Formation (lower Llandovery) of the Prague Basin, ranging in age from the Cystograptus vesiculosus Zone to Demirastrites convolutus Zone. *Coronograptus gregarius maxiculus, Lagarograptus helenae* and *Monograptus havliceki* are new, 6 are unnamed forms; 12 are recorded for the first time from Bohemia. The diagnosis of the genus *Campograptus* has been emended. The stratigraphic value and evolution of the described species and lineages are included.

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Introduction

The earliest monograptid graptolite in Bohemia (*Atavograptus atavus*) appears in Cystograptus vesiculosus Zone. A more important part in the graptolite assemblages of the Prague Basin has been attained by monograptids in the following Coronograptus cyphus Zone. Most of the earliest monograptid lineages continued till the Dem. convolutus Zone, rarely up to the Monograptus sedgwickii Zone. The M. sedgwickii Zone is marked by the advent of a new graptolite assemblage showing new monograptid groups.

The present paper describes all monograptid species and evolutionary lineages detected from the Cyst. vesiculosus — Dem. convolutus Zones interval (lower part of the Želkovice Formation) of the Prague Basin. The only exceptions are *Rastrites* and *Demirastrites* described by Přibyl (1942), Přibyl - Münch (1942) and also some more advanced monograptid groups, the first members of which appear in

the Dem. convolutus Zone (*Monoclimacis crenularis*, *Pristiograptus regularis*).

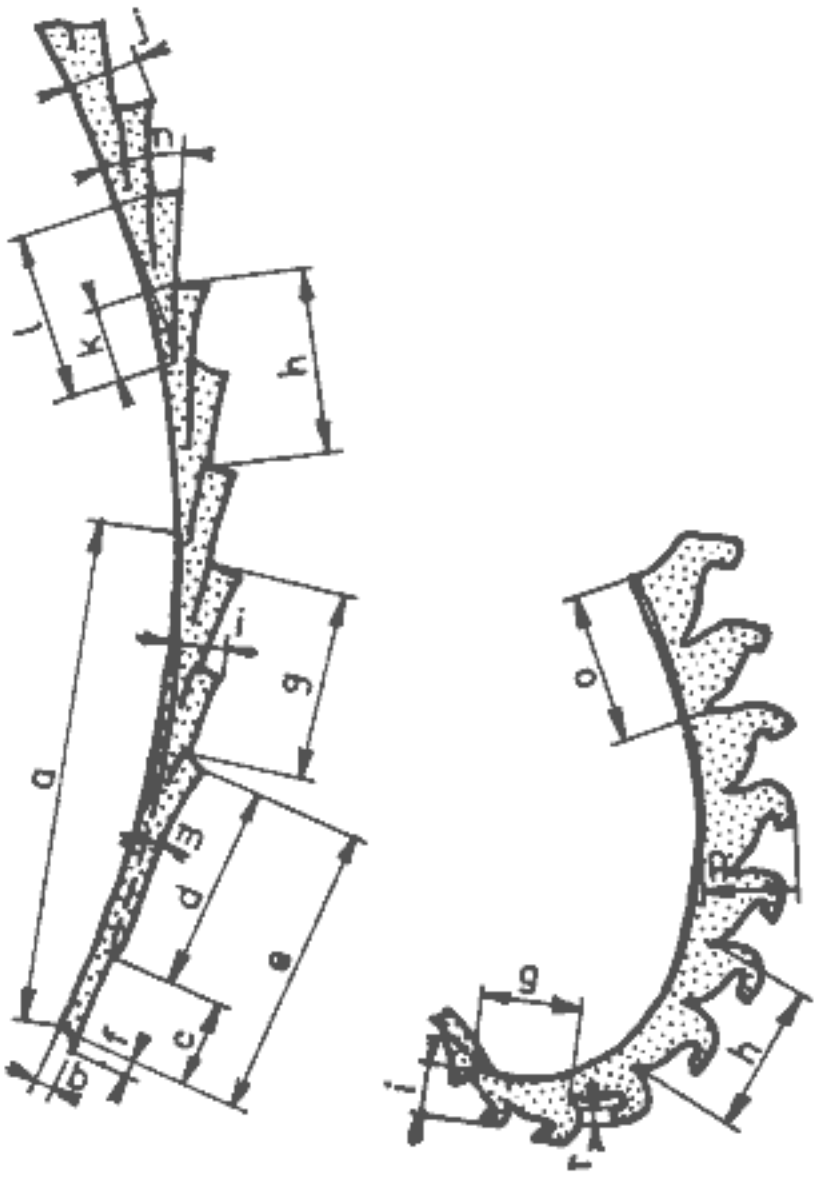
The species described from the Bohemian Silurian by PERNER (1897) and PŘIBYL (1941 a, b, 1945) are redescribed on the newly collected material in connection with recent investigations of monograptid phylogeny and systematics published by OBUT (1949), OBUT - SOBOLEVSKAJA - MERKUREVA (1968), SUDBURY (1958), RICKARDS (1974, 1976), RICKARDS - HUTT - BERRY (1977) and HUTT (1968, 1974). Systematic descriptions are given of 23 species and subspecies of monograptids in this paper, 3 of them are new and 12 are recorded for the first time in Bohemia; 6 forms remain unnamed because of badly preserved or fragmentary material. Also phylogenetic relations of the Bohemian species are commented and depicted on tab. 2.

The composite generic diagnoses have been compiled in this paper. The most probably polyphyletic genus "*Pernerograptus*" PŘIBYL, 1941 embracing several groups of biform monograptids with various thecal types could be included into the genus *Monograptus* s. l. or a new genus could be erected for each group of biform monograptids. The first possibility has been preferred because of insufficient additional morphological informations given by not well-preserved specimens from Bohemia. On the other hand, the diagnosis of *Campograptus* OBUT, 1949 has been emended and the genus has been considered as fully valid. All the species are described on the material from the Prague Basin and compared with both original and recent descriptions of several authors. The synonymies are restricted to the original reference, most important and post-1970 references.

We can easily record several important events during the evolution of the earliest monograptids. The most primitive generalized monograptid form — *Atavograptus ceryx* (RICKARDS et HUTT) characterized by glyptograptid thecae occurs in G. persculptus — Par. acuminatus Zone. Great radiation within the basal part of Cyst. vesiculosus Zone (A. atavus Zone) gives rise to several groups of monograptids characterized by various types of thecae — geniculate atavograptid thecae, introverted pribylograptid thecae and straight elongated coronograptid thecae. Geniculate lagarograptid thecae with ventral apertural processes appear for the first time in the upper part of Cyst. vesiculosus Zone. Major evolutionary expansion of biform monograptids with hooked proximal thecae (revolutus group and austerus group) through the C. cyphus Zone is the second bigger step in monograptid evolution. Finally, the great diversification of the triangulate monograptids of the genera *Demirastrites*, *Rastrites* and *Campograptus* in Dem. triangulatus Zone is the third evolutionary explosion.

The majority of early monograptids is routinely used in practice for stratigraphic correlation. They developed and diversified very quickly like all the new, evolutionary preadapted groups. With regard to their additional world-wide spreading, some of them represent the important zonal guide fossils (*Lagarograptus acinaces*, *Atavograptus atavus*, *Coronograptus cyphus*, *Coronograptus gregarius* and triangulate monograptids). All important species were found in the Silurian of Bohemia (ŠTORCH 1986), their stratigraphical distribution is shown on tab. 1.

The graptolites are mostly flattened without any compression and deformation. The best-preserved rhabdosomes come from Běleč (Cyst. vesiculosus, C. cyphus and Dem. convolutus Zone) and Tmaň (Dem. convolutus Zone). Even tiny details of apertures are well preserved in light, bleached siliceous shales. We are able to observe all the structures of the siculae and thecae (apertural spines, sutures, hooks and hoods) which are pressed through. Dark clayey or siliceous shales from Černošice, Hlásná Třebaň, Karlík and Zadní Třebaň provided well-preserved graptolites, too.



1. The measurement used for descriptions of graptolites in this paper
a – length of the sicula, b – width of the sicula (apertural diameter), c – distance between the sicular aperture and the point of origin of th 1, d – length of th 1, e – distance between the sicular aperture and th 1 aperture, f – length of the virgella, g – $2TRD_2$, h – $2TRD_5$, i – height of th 2 (dorso-ventral width of the rhabdosome at the level of th 2 aperture), j – maximum dorso-ventral width of the rhabdosome, k/l – thecal overlap, m – angle of inclination of the ventral thecal wall (middle part of th 1), n – distal thecal inclination (free ventral thecal wall), o – $2TRD_{10}$, p – height of th 8, r – width of thecal aperture

All the parametres of the rhabdosomes depicted on text-fig. 1 have been measured in as numerous as possible specimens. The thecal spacing has been measured traditionally as the number of thecae in 10 mm both distally and most proximally. Moreover, the two thecae repeat distance method (Howe 1983) appears to be the most valuable in strongly curved rhabdosomes or in rhabdosomes with quick change of thecal count from proximal to distal part. In the last note, the first non-hooked theca is designated th n in biform monograptids.

The present author assembled a large collection of the earliest monograptids from the measured sections (Štorch 1986) from the Prague Basin (Barrandian). This collection (sign. PŠ) is housed in the Geological Survey, Prague. Moreover, type material of A. Přibyl and J. Perner (sign. NM) deposited in the National Museum, Prague and collection of B. Bouček (sign. BB) deposited in Geological Survey, Prague have been revised.

Systematic part

Family *Monograptidae* LAPWORTH, 1873

Genus *Atavograptus* RICKARDS, 1974

Type species: *Monograptus Atavus* JONES, 1909, p. 531, text-fig. 18b from the Llandovery, Rheidol Gorge, Mid Wales; Original designation RICKARDS 1974, p. 141.

Diagnosis: Rhabdosomes long, slender, usually slightly dorsally curved. Long sicula reaches approximately up to the th 1 aperture. Thecae are generally elongatedly glyptograptid, but strictly glyptograptid or almost monoclimacid in some cases.

Evolutionary note: The earliest species — *Atavograptus ceryx* (RICKARDS et HUTT) from the G. persculptus Zone of Great Britain appears to be the earliest recorded monograptid. A distinctive rhabdosome of *A. ceryx* with geniculate glyptograptid thecae is considered to be an ancestral form (HUTT - RICKARDS 1970, RICKARDS 1974) of both all *Atavograptus* species and other earliest monograptids. Also a polyphyletical origin of uniserial graptolites could not be excluded, which was proposed by BJERRESKOV (1975) on the basis of single rhabdosome with climacograptid thecae, found in G. persculptus Zone of Bornholm. Also *Atavograptus atavus* is considered to have great importance in earliest monograptid evolution.

Atavograptus atavus (JONES, 1909)

Pl. I, figs. 1, 2, 3; text-fig. 2A

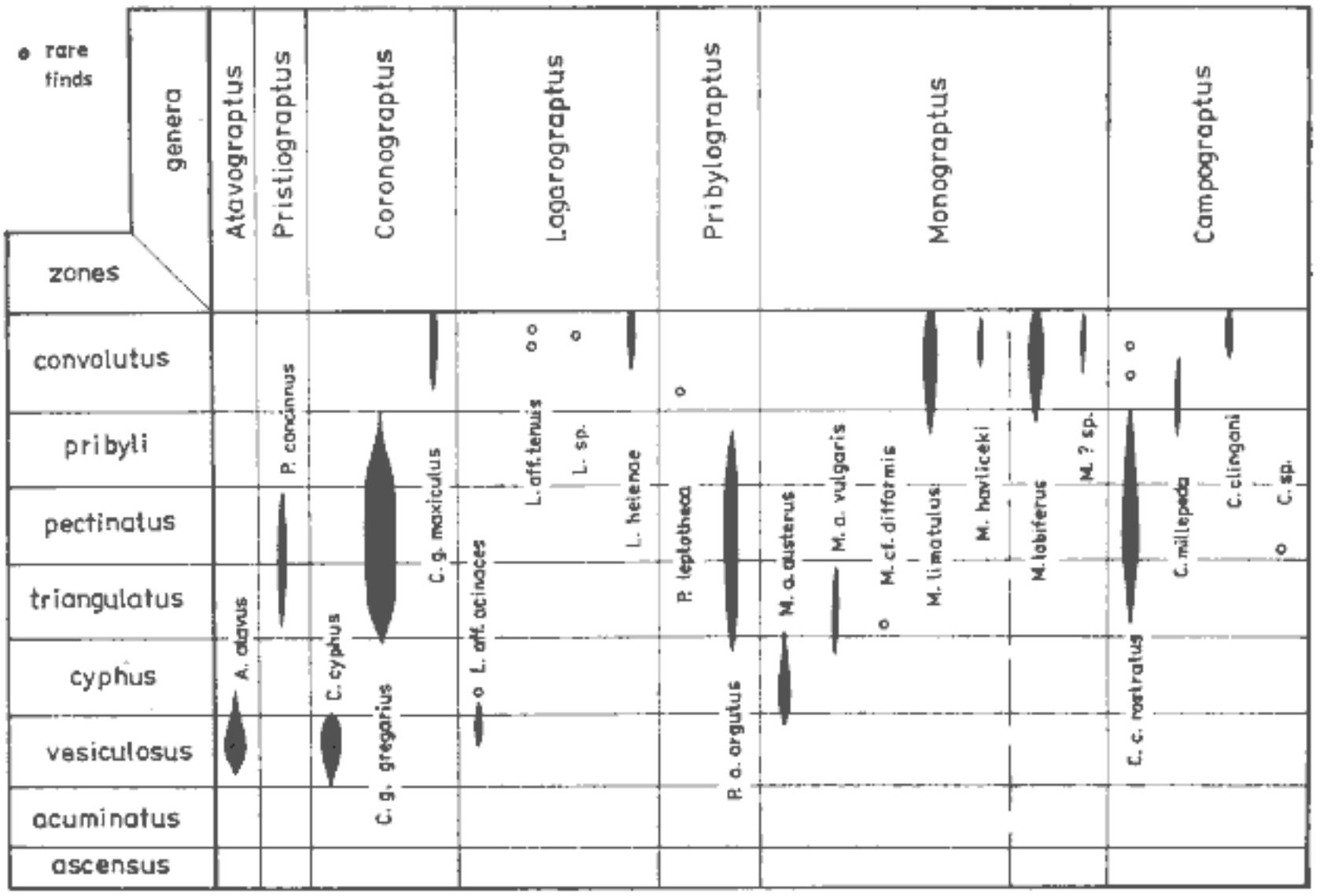
1909 *Monograptus atavus* sp. nov.; JONES, p. 531, text-figs. 18a–d.
1911 *Monograptus atavus* JONES; ELLES - WOOD, p. 403, pl. 39, figs. 1a–d, text-figs. 270b–e (non a).
1970 *Monograptus atavus* JONES, 1909; RICKARDS, p. 65, pl. 5, fig. 6, pl. 6, fig. 1; text-fig. 14, figs. 26, 30; text-fig. 15, text-fig. 16, fig. 6, text-fig. 18, fig. 6.
1970 *Monograptus atavus* JONES, 1909; HUTT-RICKARDS, text-figs. 3a, b.
1974 *Atavograptus atavus* (JONES); RICKARDS, pl. 9, figs. 1, 2.
1975 *Monograptus atavus* JONES, 1909; BJERRESKOV, p. 44, pl. 6, figs. G–H.
1975 *Atavograptus atavus* (JONES, 1909); HUTT, p. 62, pl. 11, fig. 1; pl. 12, figs. 5, 9, 10.

Material: About 30 flattened specimens, mostly not well preserved fragments, both proximal and distal parts.

Description: Very long rhabdosome (over 200 mm) has a slightly dorsally curved proximal part. The thecae are simple tubes with a distinctive geniculum shown on a sigmoidal ventral thecal wall. Thecal apertures are straight and perpendicular to the rhabdosome axis proximally and are slightly everted distally. The sicula and most proximal thecae have not been found in Bohemian material. The most slender proximal part of the rhabdosome is 0.5 mm wide and has thecae numbered 7—8 in 10 mm. The free ventral walls incline at an angle of about 10° to

Table 1

Stratigraphical distribution of the earliest monograptids in the Prague Basin (Barrandian, Bohemia)



the rhabdosome axis, thecae overlap up to 1/3 of their length. Maximum dorso--ventral width of 1.0—1.3 (1.5) mm is reaching distally. The thecal count of distal thecae is 7.5—9.5 in 10 mm, the inclination reaches up to 15° and thecal overlap 1/2.

Remarks and relations: The specimens from the Prague Basin well correspond to those described by RICKARDS (1970), HUTT (1975) and BJERRESKOV (1975) in general. *A. atavus* can be distinguished from the other atavograptids by its greater dorso-ventral width and its slightly but distinctly geniculate thecae with greater angle of inclination. There is also a typical dorsal curvature of *A. atavus*.

Horizon and localities: Cyst. vesiculosus Zone, more abundant in the upper part of the zone, rarely in C. cyphus Zone. Praha - Běchovice, Praha - Řepy, Běleč, Hlásná Třebaň, Zadní Třebaň, Vočkov.

Genus *Pristiograptus* JAEKEL, 1889

Type species: *Pristiograptus frequens* JAEKEL, 1889, p. 669, pl. 28, figs. 1, 2 from the Silurian of Germany. Original designation.

Diagnosis: Rhabdosome straight, eventually slightly dorsally curved. Thecae

simple, cylindrical, with straight or slightly ventrally curved free ventral thecal walls and without any distinctive apertural processes. The apertures straight or somewhat everted.

Evolutionary note: The earliest pristiograptids are recorded by HUTT (1975) from the L. acinaces Zone (Cyst. vesiculosus Zone). Nevertheless, *Pristiograptus fragilis fragilis* represent only one of the possible ancestors of the later pristiograptids. The second one appears to be *Pristiograptus concinnus* (LAPWORTH) from the Dem. triangulatus Zone, which could well have originated a pristiograptid lineage characterized by gradual loss of the geniculum accompanied with an increasing robustness. Gradual loss of the geniculum in the sequence of *A. ceryx* — *A. atavus* — *P. concinnus* well corresponds to their stratigraphical succession as it was mentioned also by HUTT (1975). The thecal shape of two last-named species are very similar. *P. concinnus* has not yet typical straight thecal tubes such as typical pristiograptids (*P. regularis*, *P. nudus*). The later development going from *P. concinnus* to *P. regularis* includes distinctive changes in the shape of both thecae and rhabdosome reflecting most probably important changes in colonial ecology. In spite of the somewhat isolated position of *P. concinnus* in the earliest pristiograptid evolution, the present author prefers to follow RICKARDS (1970) and HUTT (1975) and places *P. concinnus* into this genus.

Pristiograptus concinnus (LAPWORTH, 1876)

Pl. VI, figs. 2, 3, 4; text-fig. 2B

1876 *Monograptus concinnus* sp. nov.; LAPWORTH, p. 320, pl. 11, figs. 1a – e.

1911 *Monograptus concinnus* LAPWORTH; ELLES - WOOD, p. 368, pl. 36, figs. 5a – f, text-figs. 240a to d.

1965 *Pristiograptus concinnus* (LAPWORTH, 1867); OBUT - SOBOLEVSKAYA (et BONDAREV), p. 65, pl. 10, figs. 6, 7 (non 8, 9).

1970 *Pristiograptus concinnus* (LAPWORTH, 1876); RICKARDS, p. 60, pl. 5, fig. 5.

1975 *Pristiograptus concinnus* (LAPWORTH, 1876); HUTT, p. 57, pl. 12, figs. 1, 2, 7, 8. (A long synonymy was given by HUTT).

Material: 16 incomplete flattened specimens.

Description: The rhabdosome is very long (probably over 300 mm) and variously ventrally curved. It attains the maximum dorso-ventral width very gradually. The proximal end with the sicula has not yet been found, nevertheless the most

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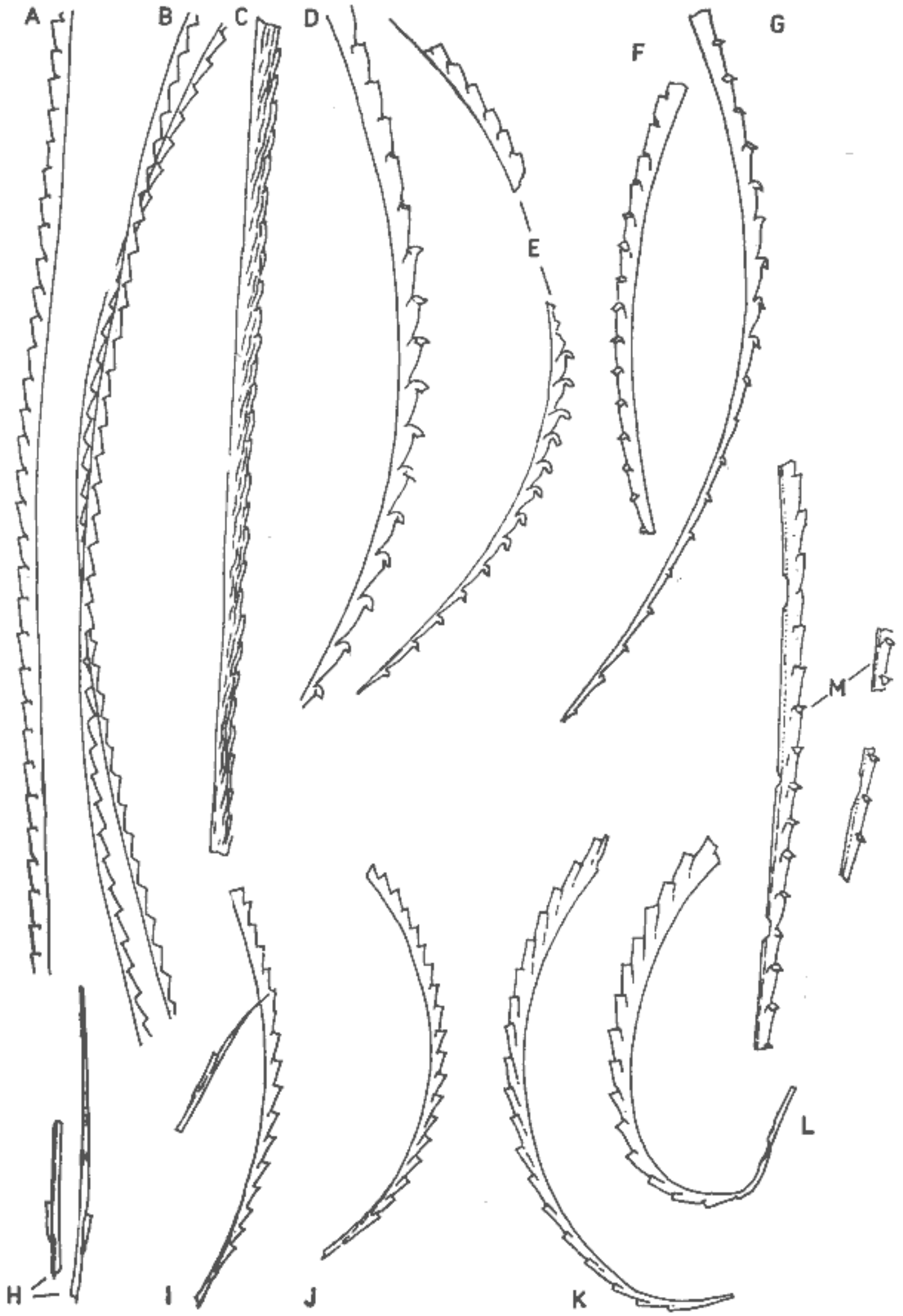
2. *Atavograptus atavus* (JONES): A – PŠ 261, × 4. *Pristiograptus concinnus* (LAPWORTH); B – PŠ 264, × 3.5 (part of very long rhabdosome). *Coronograptus gregarius gregarius* (LAPWORTH): I – PŠ 245, × 3.5; J – PŠ 248, × 3.5. *Coronograptus gregarius maxiculus* subsp. n.: H – PŠ 252, × 3.5 (holotype). *Coronograptus cyphus cyphus* (LAPWORTH): K – BB 638, × 5; L – BB 639, × 5. *Pribylograptus leptotheca* (LAPWORTH): C – NM 35 050, × 3. *Monograptus austerus austerus* TÖRNQUIST: F – PŠ 267, × 5; G – PŠ 224, × 5; M – PŠ 233/1, × 5. *Monograptus austerus vulgaris* HUTT; D – PŠ 204, × 5 (mesial part in detail); E – PŠ 205a, × 4.5


A
B
C
D
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proximal fragments initiated from the width of 0.3 mm and appear to be slig curved dorsally. Such a slight dorsal curvature of proximal portion is mentio also by HUTT (1975). The longest incomplete specimen (over 200 mm) from hemia increases from the initial width of 0.6 mm up to the most distal 0.8 mm. maximum width recorded attains 0.85 mm. Simple tube-like pristiograptid th of *P. concinnus* differ from atavograptid sigmoidal thecae. Thecal apertures o *concinnus* are conspicuously broad, slightly everted more distally and they acco for more than 1/2 the total dorso-ventral width of the rhabdosome. The th overlap appears to be less than 1/4 proximally and up to 1/3 in the distal par the rhabdosome. Thecal inclination increases from the angle of 15° proximally to 20° in distal thecae. Thecae number 8—8.5 in 10 mm.

Remarks and relations: Bohemian material conforms to ELLES - WO (1911), RICKARDS' (1970) and HUTT's (1975) descriptions. It could be distinguis from the similar species of the genus *Pribylograptus* (*Pribylograptus ? jonesi*, *Prib graptus incommodus* and *Pribylograptus sandersoni*) by its straight cylindrical th without any introvertion. The additional differential features appears to be th overlap, thecal inclination and thecal count. From the *Atavograptus atavus* (Jo it differs by less overlapped thecae without a distinctive geniculum and by c spicuously broad apertures. *P. concinnus* is well characterized finally by its flexi and ventrally curved rhabdosome.

Horizon and localities: Želkovice Formation, rarely in Dem. triangul and Dem. pectinatus Zones. Hlásná Třebaň.

Genus *Coronograptus* OBUT et SOBOLEVSKAYA, 1968

Type species: *Monograptus gregarius* LAPWORTH, 1876, p. 317, pl. 10, fig. 12a from the Bir Shales of Dobb's Linn, Scotland. Original designation OBUT et SOBOLEVSKAYA in: OBUT – BOLEVSKAJA - MERKUREVA (1968), p. 92.

Diagnosis: Rhabdosome with moderate to strong dorsal curvature, m species relatively robust. Long straight tube-like overlapping thecae have sli rounded geniculum. Apertural region slightly everted, occasionally rather isola Sicula often very long, more than 10 mm in some forms.

Evolutionary note: The genus *Coronograptus* almost certainly evolved fr *Atavograptus* as was shown by RICKARDS (1970), HUTT (1975) and RICKARD HUTT - BERRY (1977). Such an evolutionary step includes a distinctive increas of robustness and curvature of the rhabdosome, connected with elongation of thecae and sicula. As was recorded by the latter authors, the geniculation rema similar to *Atavograptus*. Both lineage of *Coronograptus cyphus praematurus* (T HILL) - *Coronograptus cyphus cyphus* (LAPWORTH) and especially *Coronograp gregarius* s.l. lineage are characterized by progressive elongation of the sicula. S a trend in *C. gregarius* appears to be accompanied by rapid decrease of the num of thecal tubes in the graptolite colony. Substantial decrease of the number

thecae on higher stratigraphical levels (upper part of Dem. convolutus Zone) presumably marks the extinction of the *C. gregarius* s.l. lineage.

Coronograptus cyphus cyphus (LAPWORTH, 1876)

Pl. II, fig. 1; pl. III, fig. 1; pl. IV, figs. 4, 5; text-fig. 2K, L

1876 *Monograptus cyphus* sp. nov.; LAPWORTH, p. 352, pl. 12, figs. 3a, c (non 3b, d).
non 1897 *Monograptus cyphus* LAPW.; PERNER, p. 19, pl. 13, figs. 7, 8; text-fig. 8.
1911 *Monograptus cyphus* LAPWORTH; ELLES - WOOD, p. 362, pl. 36, figs. 1a–e; text-figs. 236a–e.
1970 *Monograptus cyphus* LAPWORTH, 1876; RICKARDS, p. 62, pl. 4, fig. 11, pl. 5, figs. 1, 2; text-fig. 14, fig. 31. (A long synonymy was given by RICKARDS).
1974 *Coronograptus cyphus* (LAPWORTH); RICKARDS, pl. 9, fig. 8.
1975 *Coronograptus cyphus cyphus* (LAPWORTH, 1876); HUTT, p. 67, pl. 12, figs. 6, 11; pl. 14, figs. 6, 7. (A long synonymy was given by HUTT.)

Material: 3 complete, 7 incomplete flattened rhabdosomes and several fragments.

Description: Rhabdosome arcuate, more than 100 mm long, has nearly straight distal part and strongly curved proximal part. A distinctively more strongly dorsally curved proximal portion (th 1 — th 3; see pl. II, fig. 1 and pl. IV, fig. 4) was shown also by ELLES - WOOD (1911). Slender proximal part bears about 3.6 mm long sicula, reaching up to the level of th 1 aperture. An apertural diameter is about 0.2 mm. The th 1 originates 1.5 mm above the sicular aperture and reaches a length of about 2 mm. Thecal overlap is 1/4 in proximal part of the rhabdosome. Thecae are long, straight tubes, without a distinctive geniculum. Everted apertural margins accompanied with concave free ventral thecal walls has been rarely observed. The rhabdosome is 0.3—0.4 mm wide at the level of th 2 and gradually widens distally; the dorso-ventral width of 1.3 mm is attained at the distance of 90 mm away from the sicula. The maximum width of 1.5—1.6 mm has been measured in several distal fragments. The thecal count is 9—10.5 in 10 mm through the whole rhabdosome ($2\ TRD_2 = 1.9$ mm, $2\ TRD_{10} = 2.0$ mm). Tube-like, about 2 mm long distal thecae with straight apertures overlap more than 1/2 of their length. Distal thecae inclined at an angle of about 20° to the rhabdosome axis, the inclination is relatively lower in proximal thecae.

Remarks and relations: The specimens of *Coronograptus cyphus cyphus* from the Bohemian Silurian correspond well to those described and figured by ELLES - WOOD (1911) and HUTT (1975). *C. cyphus cyphus* differs from the most similar earlier subspecies *C. cyphus praematurus* (TOGHILL) especially by its much longer sicula and robust proximal part. The specimens figured and described by PERNER (1897) as *Monograptus cyphus* LAPW. belong to *Monograptus limatulus* TÖRNQUIST and originated from Dem. convolutus Zone.

Horizon and localities: Želkovice Formation, C. cyphus Zone. Běleč, Hlásná Třebaň, Karlík, Zadní Třebaň.

Coronograptus gregarius gregarius (LAPWORTH, 1876)

Pl. IV, figs. 1, 2, 3; text-figs. 2I, J

1876 *Monograptus gregarius*, sp. nov.; LAPWORTH, p. 317, pl. 10, figs. 12a – c.

1911 *Monograptus gregarius* LAPWORTH; ELLES - WOOD, p. 365, text-figs. 238a – b, pl. 36, figs. 3a – d.

1968 *Coronograptus gregarius gregarius* (LAPWORTH, 1876); OBUT - SOBOLEVSKAYA (et MERKUREVA), p. 92, pl. 20, figs. 1 – 6; pl. 21, fig. 1.

1970 *Monograptus gregarius* LAPWORTH, 1876; HUTT - RICKARDS - SKEVINGTON, p. 13, pl. 3, figs. 63 – 68.

1970 *Monograptus gregarius* LAPWORTH, 1876; RICKARDS, p. 61, text-fig. 14, fig. 35; text-fig. 18, fig. 14. (A long synonymy was given by RICKARDS.)

1975 *Monograptus gregarius* LAPWORTH, 1876; BJERRESKOV, p. 46, pl. 6 F, text-fig. 15 A.

1975 *Coronograptus gregarius gregarius* (LAPWORTH, 1876); HUTT, p. 64, pl. 13, fig. 2; pl. 14, figs. 1, 3; text-fig. 15, figs. 3, 4.

1982 *Coronograptus gregarius gregarius* (LAPWORTH, 1876); LENZ, p. 52, pl. 20, fig. B, ?C, D; text-fig. 4, fig. D, E, ?O, ?Q.

Material: 70 mostly complete flattened specimens.

Description: The rhabdosome is dorsally curved throughout, mostly about 20 mm (max. 35 mm) long. Conspicuously long sicula reaches 5.3—7.5 mm (max. 9 mm) in its length, sicular apertural diameter is 0.2—0.25 mm. The longest siculae come in the stratigraphically highest levels (Dem. pribyli Zone) as was shown also by HUTT (1975) and BJERRESKOV (1975). The sicular aperture is provided with 0.1—0.15 mm long virgella with a broad base. The following description includes populations from the Dem. triangulatus and Dem. pectinatus Zones. The sicular apex reaches to about the level of th 4. The th 1 originates (0.9) 1.0—1.2 (1.4) mm away from the sicular aperture. The length of the th 1 varies between (1.4) 1.5—2.1 (2.3) mm within the framework of one population from one bedding plane. A distance between the sicular aperture and th 1 aperture varies from 2.8 mm up to 3.3 mm within the framework of one population once again. An average length of th 1 appears to stay constant during the three graptolite zones time interval (Dem. triangulatus — Dem. pribyli Zones). The thecae are long simple tubes with slightly expanded and everted apertural region. The free ventral wall seems to be concave, turned somewhat outwards. A prominent geniculum described by HUTT - RICKARDS - SKEVINGTON (1970) in isolated material from Sweden is much less detectable in flattened material because the geniculum has been covered by enlarged apertural region of the foregoing theca. The specimens from the Prague Basin have the thecae numbered 9—11.5 in 10 mm proximally and 10—11 in 10 mm distally ($2TRD_2 = 1.8$—2.3 mm, $2TRD_{10} = 2.0$—2.2 mm). The thecae overlap about 1/2 of their length, the angle of thecal inclination reaches 10—15°. Middle part of the ventral wall of th 1 inclined at an angle of 5° to the rhabdosome axis. The dorso-ventral width of the rhabdosome at the level of th 2 aperture is 0.55—0.65 mm and then gradually increases up to the maximum width of 0.65—0.75 mm which is attained at the level of approximately th 10.

Remarks and relations: The material described from Bohemia originates from the Dem. triangulatus, Dem. pectinatus and Dem. pribyli Zones. In the last-mentioned zone the abundance of *C. gregarius gregarium* rapidly decreases. A gradual enlargement of the sicula could be well documented in Bohemian material. It was described by HUTT (1975) and BJERRESKOV (1975). On the contrary, a tendency to develop larger, more mature rhabdosomes throughout the range of *C. gregarius gregarius* noted by BJERRESKOV (1975) has not been detected.

The latest populations of *C. gregarius gregarius* from Dem. convolutus Zone, well characterized mainly by extremely long, robust sicula, are considered as new stratigraphically valuable subspecies by the present author. The type subspecies *C. gregarius gregarius* is not recorded from Dem. convolutus Zone in Bohemia.

Horizon and localities: Želkovice Formation, abundant in Dem. triangulatus and Dem. pectinatus Zones, not common in Dem. pribyli Zone. Černošice, Hlásná Třebaň, Karlík, Zadní Třebaň.

Coronograptus gregarius maxiculus subsp. n.

Pl. XII, fig. 5; text-fig. 2H

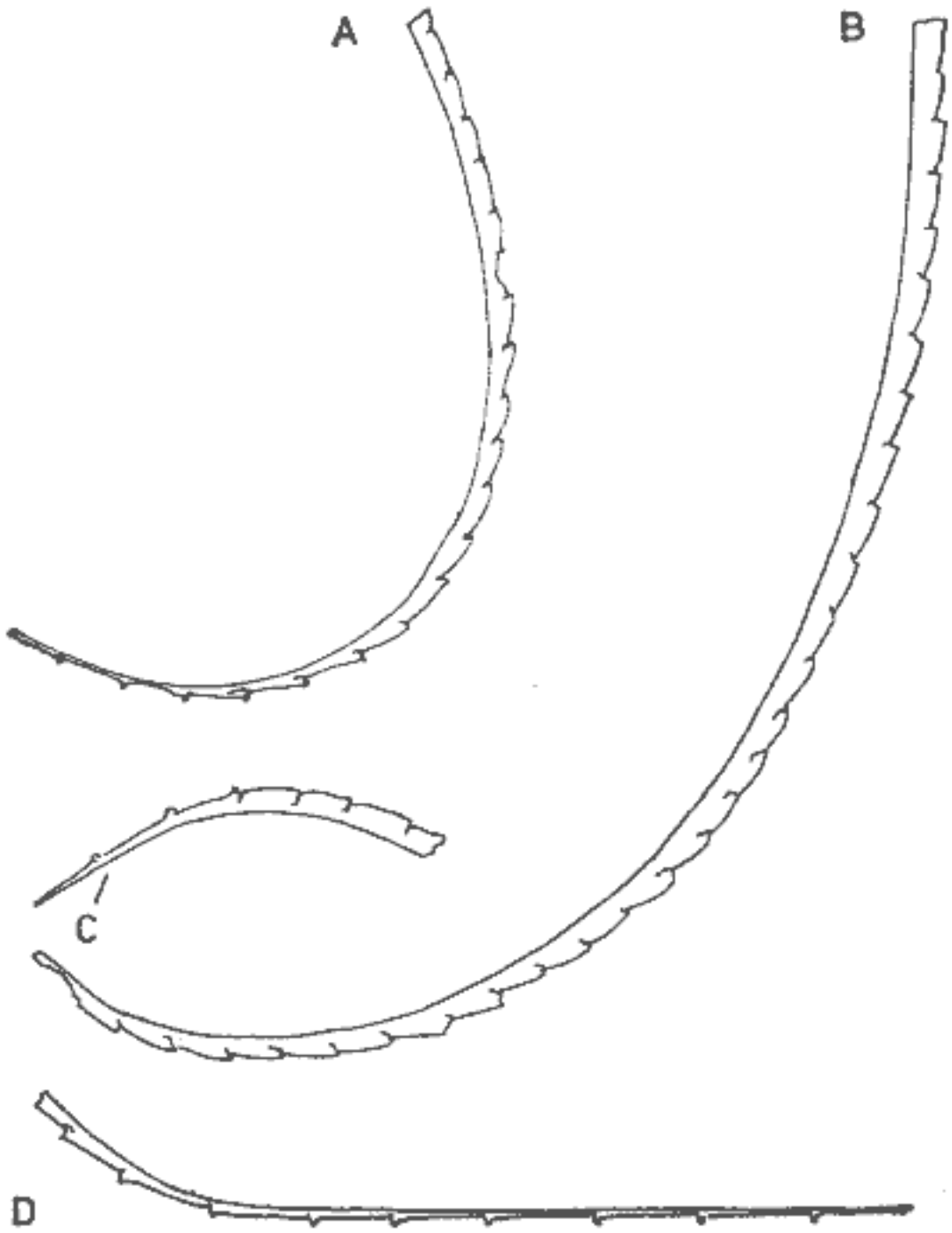
1975 *Coronograptus gregarius gregarius* (LAPWORTH, 1876); HUTT, p. 64, pl. 14, fig. 2; text-fig. 15, figs. 1, 2. (partim)

Holotype: Complete flattened but not compressed rhabdosome no. PŠ 252, Pl. VI, fig. 8; text-fig. 2H. Author's collection housed in the Geological Survey, Prague.
Type horizon: Želkovice Formation, Llandovery, middle part of Dem. convolutus Zone.
Type locality: Tmaň.
Material: 21 "juvenile" rhabdosomes and about 30 siculae.

Diagnosis: Rhabdosome characterized by stout, extremely long (up to 14 mm) slightly dorsally curved sicula from which originates mostly a single tube-like theca. Th 1 differs from the similar one in *C. gregarius gregarius* in its less inclined ventral thecal wall.

Description: The sicula is 10—14 mm long, very slightly dorsally curved. The sicular apertural diameter is 0.28—0.32 mm. About 0.15 mm long virgella originates from a broad base on the sicular aperture (text-fig. 2H). Such a feature was shown by HUTT - RICKARDS - SKEVINGTON (1970) in the isolated rhabdosomes of *C. gregarius gregarius* from Sweden. The Bohemian specimens developed only sicula and the first theca. Th 1 is 1.5—2.0 mm long and originates 1.5—1.8 mm away from the sicular aperture. It seems probable, that some of the first thecae are immature owing to their great variability of thecal length. The thecae are of coronograptid type — simple tubes with rather concave ventral walls inclining at an angle of 0—4° to the sicular axis (measurement in the middle part of the ventral wall). They incline at about 10° in their everted apertural region. The straight thecal apertures are perpendicular to the sicular axis. Maximum width of the rhabdosome at the level of th 1 aperture is 0.52—0.58 mm.

Remarks and relations: HUTT (1975) described immature rhabdosomes of *C. gregarius gregarius* with giant siculae (10—12 mm) from the Monograptus argenteus Zone of the Lake District (corresponds approximately to the lower part of Dem. convolutus Zone in Bohemia). Those specimens developed mostly a single theca (max. 3 thecae). The same feature has been observed in Bohemian specimens



3. *Pribylograptus argutus argutus* (LAPWORTH): A – PŠ 211, × 5; B – BB 633, × 5; C – BB 633, × 5 (the same slab); D – BB 640, × 5

from the middle and upper parts of Dem. convolutus Zone. The lack of more matured rhabdosomes could not be explained by collecting failure. According to HUTT (1975) it is explained biologically, by prolonged growth of the metasicular zooid. A relative increase of the size of sicula accompanied a reduction in the number of thecae has been recorded by URBANEK (1960) in some other graptoloids.

Coronograptus gregarius maxiculus subsp. n. from Dem. convolutus Zone show presumably the terminal member of *C. gregarius* s.l. lineage, which seems to extinct at the top of Dem. convolutus Zone.

C. gregarius maxiculus differs from the other subspecies of *C. gregarius* in its extremely long, stout, nearly straight sicula. An important change of the sicular

length has been stated by HUTT (1975), but there are additional differences. A sole th 1 is mostly developed in *C. gregarius maxiculus* and its ventral thecal wall inclines at lower angle than that o *C. gregarius gregarius*.

Horizon and localities: Želkovice Formation, Dem. convolutus Zone (probably only the middle and upper parts of the zone). Tmaň, Želkovice.

Genus *Lagarograptus* OBUT et SOBOLEVSKAYA, 1968

Type species: *Lagarograptus inexpeditus* OBUT et SOBOLEVSKAYA, 1968, p. 90 from the lower part of Dem. triangulatus Zone, borehole no. N-1, Norilsk region, Siberia. Original designation.

Diagnosis: Rhabdosome long, dorsally curved; sicula long (more than 3.5 mm); thecae strongly geniculate, with genicular hood in some cases. Pronounced ventral apertural processes, probably triangular in shape and generally slightly pendent are common.

Evolutionary note: The genus *Lagarograptus* almost certainly evolved from *Atavograptus* (HUTT 1968, 1975) by increasing of geniculation and developing of genicular hoods and ventral apertural processes. Thecal apertures of lagarograptids are slightly everted, placed in shallow apertural excavations. The sicula has been enlarged and the rhabdosome has been more curved in contrast to atavograptid ancestors. The evolution within the genus Lagarograptus is not yet clear. The specimens from the Dem. convolutus Zone of Bohemia could help to plug the gap between *L. inexpeditus* (Dem. triangulatus Zone) and *L. tenuis* (M. sedgwickii Zone). The three forms described here from Dem. convolutus Zone well correspond to the diagnosis of *Lagarograptus* but all of them lack ventral apertural processes. I am not sure, if this may be explained in terms of insufficient preservation.

Lagarograptus (?) aff. *acinaces* (TÖRNQUIST, 1899)

Text-fig. 4H

aff. 1899 *Monograptus acinaces* n. sp.; TÖRNQUIST, p. 5, pl. 1, figs. 7, 8.
aff. 1911 *Monograptus acinaces* TÖRNQUIST; ELLES - WOOD, p. 364, pl. 36, figs. 2a – d; text-figs. 237a – d.
aff. 1975 *Lagarograptus acinaces* (TÖRNQUIST, 1899); HUTT, p. 69, pl. 13, figs. 5, 6; text-fig. 16, figs. 1, 2, 3.
aff. 1975 *Monograptus acinaces* TÖRNQUIST, 1899; BJERRESKOV, p. 45, pl. 6, fig. I; text-fig. 14 C.

Material: Several mesial fragments of flattened rhabdosomes.

Description: All the fragments are arcuate, up to 20 mm long. The longest one (text-fig. 4H) widens from 0.4 mm up to 0.65 mm. The thecae are geniculate simple tubes with straight apertures, perpendicular to the rhabdosome axis. The apertural region slightly extends ventrally. The thecae overlap for about 1/2 their length and number 7.5 in 10 mm. Thecal inclination is about 8°.

Remarks and relations: The fragments described here could be compared with those of *Lagarograptus acinaces* (TÖRNQUIST) described by BJERRESKOV (1975) and HUTT (1975). Both elongated, tube-like slightly geniculate thecae with straight apertures and rhabdosomal parametres correspond well. Apertural processes described by HUTT (1968) and HUTT - RICKARDS (1970) tend to be only occasionally present even in better-preserved rhabdosomes of *Lagarograptus acinaces*. Our form differs from *Atavograptus strachani* (HUTT et RICKARDS) and *Atavograptus praestrachani* RICKARDS et HUTT in its only slightly geniculate thecae with higher angle of inclination. *Coronograptus cyphus cyphus* which occurs in the succeeding horizon has a distinctively higher thecal count.

Horizon and localities: Želkovice Formation, upper part of Cyst. vesiculosus Zone. Běleč.

Lagarograptus aff. *tenuis* (PORTLOCK, 1843)

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

aff. 1968 *Monograptus tenuis* PORTLOCK; HUTT, p. 252, figs. 1a–h.

Material: One complete flattened specimen, several fragments.

Description The rhabdosome is 15 mm long, dorsally curved throughout. The sicula is over 3.5 mm in length and 0.2 mm in apertural width; it reaches up to the th 2 aperture. The th 1 is 2 mm long and originates 0.95 mm away from the sicular aperture. Geniculate, tube-like thecae have somewhat ventrally expanded apertural region and everted aperture. The aperture is placed in shallow apertural excavation. Ventral apertural processes have not been detected. The dorso-ventral width of the rhabdosome increases from 0.4 mm at the level of th 2 up to the maximum 0.5 mm distally. Thecae number 8.5 in 10 mm ($2TRD_2 = 2.2$ mm); angle of thecal inclination is about 10°.

Remarks and relations: The specimens described above and assigned to the genus *Lagarograptus* may be distinguished from the similarly shaped rhabdosomes of *C. gregarius* owing to the shape of their thecae and apertures. *L.* aff. *tenuis* differs from *L. inexpeditus* in its rhabdosome which widens more gradually but throughout the whole of its length. The second difference is in a higher angle of thecal inclination in *L.* aff. *tenuis*. The chief difference between *L.* aff. *tenuis* and *L. tenuis* is in the proximal thecal count. Our specimens are designated *L.* aff. *tenuis* until further, better-preserved specimens are available.

Horizon and localities: Želkovice Formation, Dem. convolutus Zone. Tmaň.

Lagarograptus tenuis (PORTLOCK, 1843)

Text-fig. 5B, C, D

1843 *Graptolithus tenuis*; PORTLOCK, p. 319, pl. 19, fig. 7.

1911 *Monograptus tenuis* (PORTLOCK); ELLES-WOOD, p. 407, pl. 40, figs. 2a–e; text-figs. 273a–d.

1966 *Pribylograptus tenuis* (PORTLOCK); OBUT-SOBOLEVSKAYA, p. 33.
1968 *Monograptus tenuis* PORTLOCK; HUTT, p. 252, text-figs. 1a–h.
1970 *Monograptus tenuis* (PORTLOCK); CHURKIN-CARTER, p. 43, pl. 4, figs. 2, 3; text-fig. 18D.
1975 *Lagarograptus tenuis* (PORTLOCK 1843); HUTT, p. 70, pl. 11, fig. 2; text-fig. 10, fig. 5.

Material: 8 fragments of different parts of flattened rhabdosomes.

Description: Rhabdosome is arcuately dorsally curved, becoming straighter distally. The fragments studied here are up to 42 mm long. No proximal end with sicula has been found. The most proximal fragments have 0.4 mm in dorso-ventral width, excluding ventral apertural processes and 0.75 mm including these processes. Dorso-ventral width increases gradually up to 1.2 mm. Thecae number is 5—5.5 in 10 mm proximally (2TRD = up to 3.7 mm), distally decreases to 6 thecae in 10 mm. Thecal length and overlap could not be measured due to insufficient preservation of these specimens. Apertures of geniculate tube-like thecae are placed in shallow apertural excavations, well visible especially in proximal thecae. Thecal apertures of distal thecae are in addition distinctively extended ventrally. The angle of thecal inclination is 6° proximally and it reaches 16° in distal thecae. Thecae are provided by triangular ventral apertural processes which have been described by HUTT (1968). These apertural processes (about 0.4 mm long) are preserved in some Bohemian specimens too, especially in the proximal part of the rhabdosome.

Remarks and relations: Several fragments which have been found in the Prague Basin could be well assigned to *Lagarograptus tenuis* (PORTLOCK). They slightly differ from the specimens described by HUTT (1968, 1975) by their more widely spaced distal thecae and lower angle of thecal inclination. The ancestor of *L. tenuis* could be looked for within the lagarograptid graptolites described here from the Dem. convolutus Zone.

Horizon and locality: Želkovice Formation, M. sedgwickii Zone, Hýskov — test-pit DB 226.

Lagarograptus sp.

Pl. II, fig. 2; text-fig. 4B

Material: One complete flattened specimen.

Description: An extremely slender rhabdosome is strongly dorsally curved and 11 mm long. The sicula is 0.1 mm wide, more than 3 mm long and provided by short virgella. The distance between th 1 aperture and sicular aperture is 3.8 mm, the first theca originates 0.9 mm away from the sicular aperture. Thecae are extremely long, slender tubes with expanded apertures which are perpendicular to the rhabdosome axis. Thecae are geniculate, with shallow apertural excavations. Thecae are similar in shape to those figured by HUTT (1968) in her redescription of *L. tenuis*. However the ventral apertural processes, a diagnostic feature of *Lagarograptus* have not been detected. The rhabdosome of *Lagarograptus* sp. is 0.3 mm

wide at the level of th 2 aperture and reaches its maximum width of 0.4 mm at the th 5 level. Free ventral thecal walls are nearly parallel to the rhabdosome axis, except expanded and everted apertural region. Thecae number about 2.8 in 5 mm (5.5 in 10 mm, $2TRD_2 = 3.4$ mm); thecal overlap is indiscernible in the specimen described here.

Remarks and relations: This form is assigned to the genus *Lagarograptus* due to its typical lagarograptid thecae even if the ventral apertural processes have not been found. It differs from the proximal part of *L. inexpeditus* OBUT et SOBOLEVSKAYA in its more slender rhabdosome and in lower thecal count of its very long thecae. *L.* sp. may be distinguished from *L. tenuis* (PORTLOCK) by its shorter sicula, lower angle of thecal inclination and strongly dorsally curved rhabdosome.

Horizon and localities: Želkovice Formation, rare in Dem. convolutus Zone. Tmaň.

Lagarograptus helenae sp. n.

Pl. XII, fig. 3; text-fig. 4D

Holotype: Complete flattened specimen no. PŠ 274, Pl. XII, fig. 3; text-fig. 4D. The author's collection housed in the Geological Survey, Prague.
Type horizon: Želkovice Formation, middle part of the Dem. convolutus Zone.
Type locality: Tmaň.
Material: 8 flattened mostly complete specimens, several fragments.

Diagnosis: Rhabdosome dorsally arcuate; dorso-ventral width increases slowly from 0.35 mm proximally up to 0.5 mm most distally. Sicula approximately 0.5 mm in length, reaches about half-way between the apertures of th 2 and th 3. Thecae geniculate with small excavations and apertural expansion. Thecae number 7.5—8.5 in 10 mm proximally and 9—10 in 10 mm distally.

Description: Dorsally curved rhabdosome attains its maximum length of about 20 mm. The prominent sicula is 4.8—5.1 mm long, the sicular apex reaches a level half-way between the apertures of th 2 and th 3, width of sicular aperture is 0.2 mm. Th 1 originates 1.1—1.5 mm away from the sicular aperture and is 1.9—2.1 mm long so that the distance between sicular aperture and th 1 aperture reaches about 3.4 mm. The thecae are long tubes with distinctive geniculum. The apertural margin is slightly everted and extends ventrally; no ventral apertural processes were detected in Bohemian material. Shallow apertural excavations could

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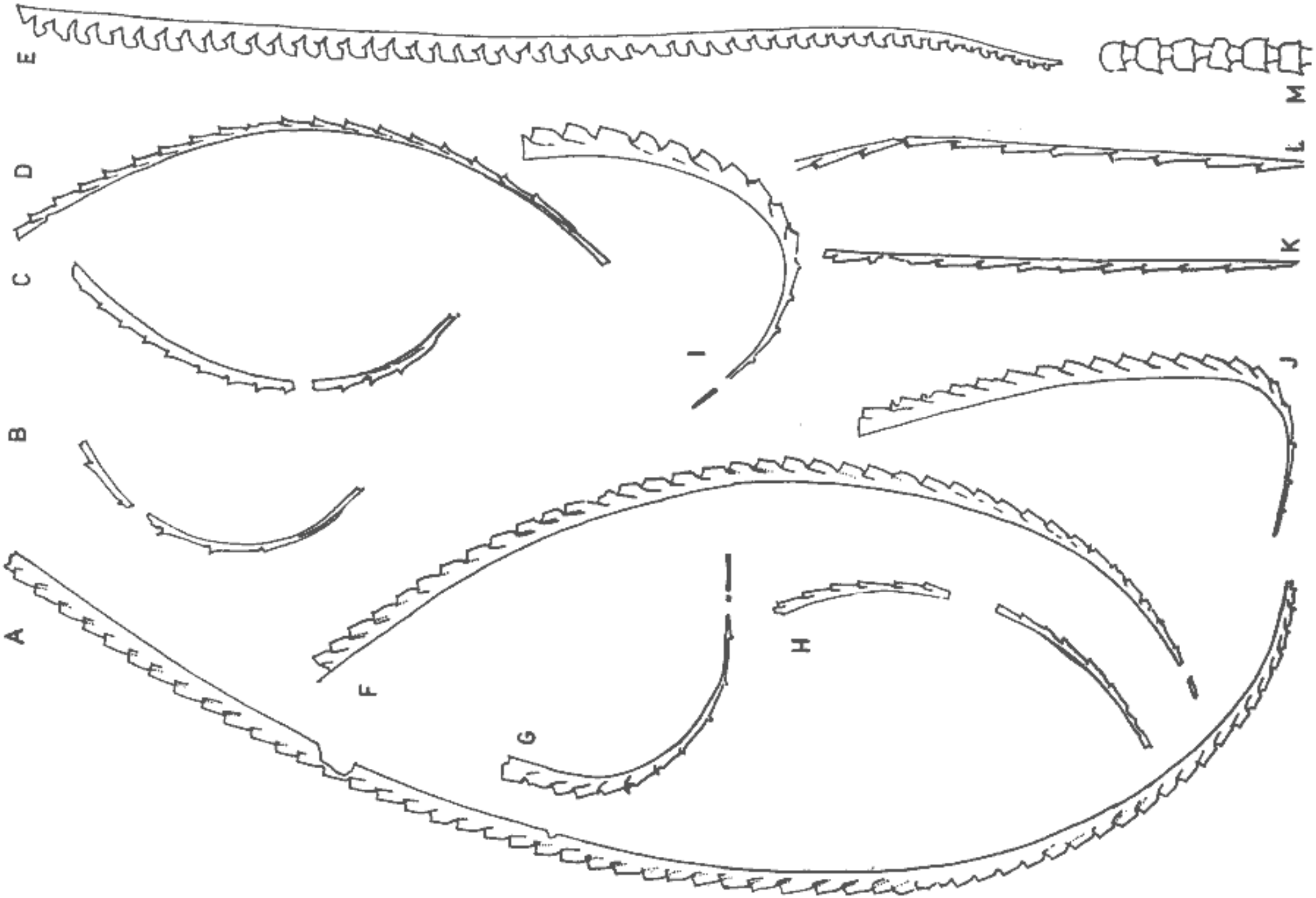
4. *Lagarograptus* sp.: B – PŠ 254b, × 4. *Lagarograptus* aff. *tenuis* (PORTLOCK): C – PŠ 234, × 4. *Lagarograptus helenae* sp. n.: D – PŠ 274, × 4 (holotype). *Lagarograptus* aff. *acinaces* (LAPWORTH): H – PŠ 239, × 3. *Monograptus havliceki* sp. n.: A – PŠ 269, × 4 (holotype), F – PŠ 268, × 4. *Monograptus limatulus* TÖRNQUIST: G – PŠ 251, × 5; I – PŠ 270/1, × 6.5; J – PŠ 232, × 4. *Monograptus lobiferus* (MC COY): E – PŠ 272, × 2.5; M – PŠ 271, × 4 (dorso-ventrally flattened specimen, in detail). *Monograptus* ? sp.: K – PŠ 276, × 5.5; L – PŠ 269, × 5.5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mostly be observed. Distal thecae overlapped at about 1/3 of their length. The mesial part of the free ventral wall of the thecae inclines at an angle of about 3° to the rhabdosome axis and up to 20° inclines at the apertural part. The thecal count is 7.5—8.5 in 10 mm proximally ($2TRD_2$ = 2.5—2.7 mm, $2\ TRD_{10}$ = 2.2 mm) and 9—10 in 10 mm distally. Dorso-ventral width of the rhabdosome increases very gradually; from 0.35 mm at the level of th 2 aperture and 0.4 mm at th 2 aperture up to 0.45—0.5 mm most distally.

Remarks and relations: The new species described here has been assigned to *Lagarograptus* on account its dorsally arcuately curved rhabdosome, long sicula and long, slightly geniculate tube-like thecae with ventrally expanded apertural margins. Apertures are everted, with small and shallow apertural excavations. Also *L. helenae* has been assigned to *Lagarograptus* with reservation, because of lacking of ventral apertural processes, a diagnostic feature of *Lagarograptus*. *L. helenae* may be distinguished from *L. tenuis* by its generally higher thecal count and wider proximal part with the sicula reaching a level between apertures of th 2 and th 3. The dorso-ventral width of *L. helenae* increases more gradually. *L. helenae* may be distinguished from *L. inexpeditus* by its longer sicula and by the different distance of point of th 1 origin from the sicular aperture. The thecae of *L. inexpeditus* have stronger geniculum and ventral thecal walls subparallel to the rhabdosome axis.

Lagarograptus helenae sp. n. may be evolved from ancestors of *L. tenuis*. As shown in this paper, there are several most probably lagarograptid species in Dem. convolutus Zone in Bohemia. All these forms have a problem with lacking of ventral apertural processes. The lacking of apertural processes in lagarograptids in regard of insufficient preservation is in contrast to the most of graptolite species found in Tmaň locality which have preserved the most delicate structures (spines, membranous bodies etc.).

Horizon and localities: Želkovice Formation, uncommon in Dem. convolutus Zone. Tmaň.

Genus *Pribylograptus* OBUT et SOBOLEVSKAYA, 1966

Type species: *Monograptus incommodus* TÖRNQUIST, 1899, p. 11, pl. 2, figs. 1–5 from the Llandovery of Sweden. Original designation OBUT - SOBOLEVSKAYA 1966, p. 33.

Diagnosis: Rhabdosome variously dorsally curved or straight; with flexuous curvature in some slender species. Apertures markedly introverted, transversely extended, often into paired lateral horns. Genicular hoods are present in some cases.

Evolutionary note: HUTT - RICKARDS (1970) record the earliest pribylograptid — *Pribylograptus* cf. *incommodus* from the upper part of A. atavus Zone. This form has similar apertural introversion, but slightly less transversely extended apertural region as the type species *Pribylograptus incommodus* (TÖRNQUIST) from succeeding C. cyphus Zone. The chief evolutionary trend shows a gradual development of introverted transversely expanded thecae of the later pribylograptids and

placed the origin of the whole group into the atavograptid ancestors (resp. *A. atavus*). The lateral paired apertural horns come in *P. incommodus* and the genicular hoods appear in the more advanced *Pribylograptus argutus argutus* (LAPWORTH) and *Pribylograptus leptotheca* (LAPWORTH). The complex apertural apparatus has been developed and the robustness of the rhabdosome increased during the evolution of pribylograptids. *Pribylograptus sandersoni* (LAPWORTH) is referred to *Pribylograptus* although it is standing somewhat out of the chief evolutionary trend of the group (RICKARDS - HUTT 1970).

The most interesting problem appears to be the phylogenetic relations of well known *P. argutus argutus* (LAPWORTH). The specimens referred to *P. argutus* in the Prague Basin seems to have not introverted proximal thecae. Their proximal portions have diminutive hook-like metathecal processes, similar but much less developed, as those in *Monograptus sudburiae* HUTT. Nevertheless, the misidentification with *M. sudburiae* may be excluded. Hook-like processes of Bohemian specimens need to be discovered with respect to detailed morphology before we are able to say if they correspond to the hooked proximal metathecae of *Monograptus revolutus* KURCK and *Monograptus sudburiae* HUTT.

A close relationship within the *P. argutus argutus*, *M. sudburiae* and *M. revolutus* has been commented by HUTT (1974) but the proximal part of *P. argutus* has not been described. RICKARDS - RUSHTON (1968) considered *P. incommodus* as the ancestor of *P. argutus*. The evolution leading from *P. incommodus* through *P. argutus* to *P. leptotheca* seems to be unlikely, if comparing their thecal apparatus and character of the rhabdosome. A great similarity of *P. argutus* to *M. sudburiae* could be recognized, their only difference is in proximal thecae. *P. argutus* presumably give rise to *M. sudburiae* (resp. to *M. revolutus*). *M. revolutus* could, alternatively, have evolved from the *P. argutus* ancestors itself with regard to its stratigraphical range (tab. 1).

A tendency to develop hooks, a strong influence in the C. cyphus Zone, probably affected both *Pribylograptus* and, independently, a form giving rise to M. austerus group of biform monograptids. On the other hand, HUTT (1974) mentioned that the only evidence of thecal introvertion is in pribylograptids. If we conclude these facts, we can say that *P. argutus argutus*, *M. sudburiae* and *M. revolutus* comprise a compact group evolved from the early pribylograptids (*P. incommodus*) and formed an independent, well-characterized monograptid genus. With regard to the insufficient recognition of the proximal thecae of *P. argutus*, presumed evolutionary scheme could not yet be verified and a new genus could not be responsibly erected.

Pribylograptus argutus argutus (LAPWORTH, 1876)

Pl. V, figs. 1, 2, 3, 4; text-fig. 3A, B, C, D

1876 *Monograptus argutus* sp. nov.; LAPWORTH, p. 318, pl. 10, figs. 13a–c.

non 1897 *Monograptus argutus* LAPW.; PERNER, p. 18, pl. 13, fig. 16.

1911 *Monograptus argutus* LAPWORTH; ELLES - WOOD, p. 408, pl. 40, figs. 3a–e, text-figs. 274a–f.
1968 *Monograptus argutus* LAPWORTH; RICKARDS - RUSHTON, p. 266, text-fig. 1.
1970 *Monograptus argutus argutus* LAPWORTH, 1876; RICKARDS, p. 67, text-fig. 17, fig. 13.
1975 *Pribylograptus argutus argutus* (LAPWORTH, 1876); HUTT, p. 72, pl. 16, figs. ?4, ?9; text-fig. 15, fig. 6.

Material: 23 almost complete flattened specimens, numerous fragments.

Description: The rhabdosome is dorsally arcuate, more than 30 mm long (rarely over 50 mm). The proximal part is over 20 mm long, slender and nearly straight. The sicula has not been detected in Bohemian material. Low, elongated proximal thecae seem to have hooked apertural region. The dorso-ventral width of the rhabdosome is 0.17—0.25 mm throughout the whole proximal part. Rapid widening of the rhabdosome appears in its strongly dorsally curved mesial part. The 2TRD = 1.8—1.95 mm is in the mesial part of the rhabdosome. The thecal count decreases proximally ($2TRD_{prox.}$ = 2.7 mm, 6.5 thecae in 10 mm) and increases distally ($2TRD_{dist.}$ = 1.6—1.7 mm, 12 thecae in 10 mm). Thecal overlap is nearly indistinctive in slender proximal part and increases up to 1/2 distally. The maximum dorso-ventral width of 0.55—0.7 mm is attained more gradually in the distal part of the rhabdosome. The distal thecae of pribylograptid type have an introverted transversely extended apertural region. The genicular hoods have been recorded in some specimens. Tube-like, nearly straight thecae with slight introvertion are present in the mesial part of the rhabdosome. A diminutive hook-like metathecae of elongated proximal thecae, detected in some specimens, changes gradually into the nearly straight mesial thecae and intoverted distal thecae.

Remarks and relations: The features of both *P. argutus* (LAPWORTH) and *M. sudburiae* (HUTT) are mixed in the present description. Greater overlap and apertural hoods correspond to *P. argutus* but hooked proximal thecae give evidence for *M. sudburiae*. Metathecal hooks are much less developed in our specimens than those in *M. sudburiae*. The proximal part of *P. argutus* has not been well known up to this time and furthermore it is difficult to tell, from the preservation of Bohemian specimens, whether these comprise the true hooked proximal metathecae. The relationship of *M. revolutus* and *M. sudburiae* to *P. argutus* has been discussed above. It is suggested in conclusion that additional observations of best-preserved material must be worked out before a new genus or subgenus are created.

Horizon and localities: Želkovice Formation, Dem. triangulatus — Dem. pribyli Zones, rare in the upper part of C. cyphus Zone. Černošice, Hlásná Třebaň, Karlík, Zadní Třebaň.

Pribylograptus leptotheca (LAPWORTH, 1876)

Pl. VI, fig. 1; text-fig. 2C

1876 *Monograptus leptotheca* sp. nov.; LAPWORTH, p. 352, pl. 12, figs. 4a–e.

1911 *Monograptus leptotheca* LAPWORTH; ELLES - WOOD, p. 371, pl. 37, figs. 2a–d; text-figs. 242a–c.
1941b *Pristiograptus leptotheca* (LAPWORTH, 1876); PŘIBYL, p. 6, pl. 2, figs. 6, 7.
1968 *Monograptus leptotheca* LAPWORTH; RICKARDS - RUSHTON, p. 268, text-figs. 2a–e, 3a, b.
1970 *Monograptus leptotheca* LAPWORTH, 1876; RICKARDS, p. 68, pl. 6, figs. 3–4; text-fig. 14, fig. 37; text-fig. 16, fig. 2. (A long synonymy was given by RICKARDS.)
1974 *Pribylograptus leptotheca* (LAPWORTH); RICKARDS, pl. 9, fig. 9.
1975 *Pribylograptus leptotheca* (LAPWORTH, 1876); HUTT, p. 73, pl. 16, figs. 1, 2, 3, 7.

Material: 4 fragments from the author's collection and the type material of A. Přibyl.

Description: All fragments are straight, mesial or distal parts of the rhabdosomes, up to 40 mm in length. Maximum dorso-ventral width is 0.9—1.1 mm. Extremely long (over 4 mm) tube-like thecae are straight and about 0.2 mm wide. Thecae overlap for 2/3—1/2 their length and number 8—8.5 in 10 mm. An introverted transversely extended apertures have been observed in some specimens. Paired lateral apertural horns and genicular hoods have not been detected with regard to preservation. The thecal inclination is about 10°.

Remarks and relations: In spite of insufficient preservation, the Bohemian material may be well assigned to *Pribylograptus leptotheca* (LAPWORTH). *P. leptotheca* can be distinguished from the other species of *Pribylograptus* by its extremely long thecae with great overlap and by its robust rhabdosome. The chief difference from other early monograptids is in its introverted thecae. The complex apertural apparatus of *P. leptotheca* with lateral horns and apertural hoods may be seen in well-preserved rhabdosomes.

Horizon and localities: Želkovice Formation, rarely in Dem. convolutus Zone. Hlásná Třebaň, Praha - Velká Chuchle (Barrande's "colony Haidinger").

Genus *Monograptus* GEINITZ, 1852 (sensu lato)

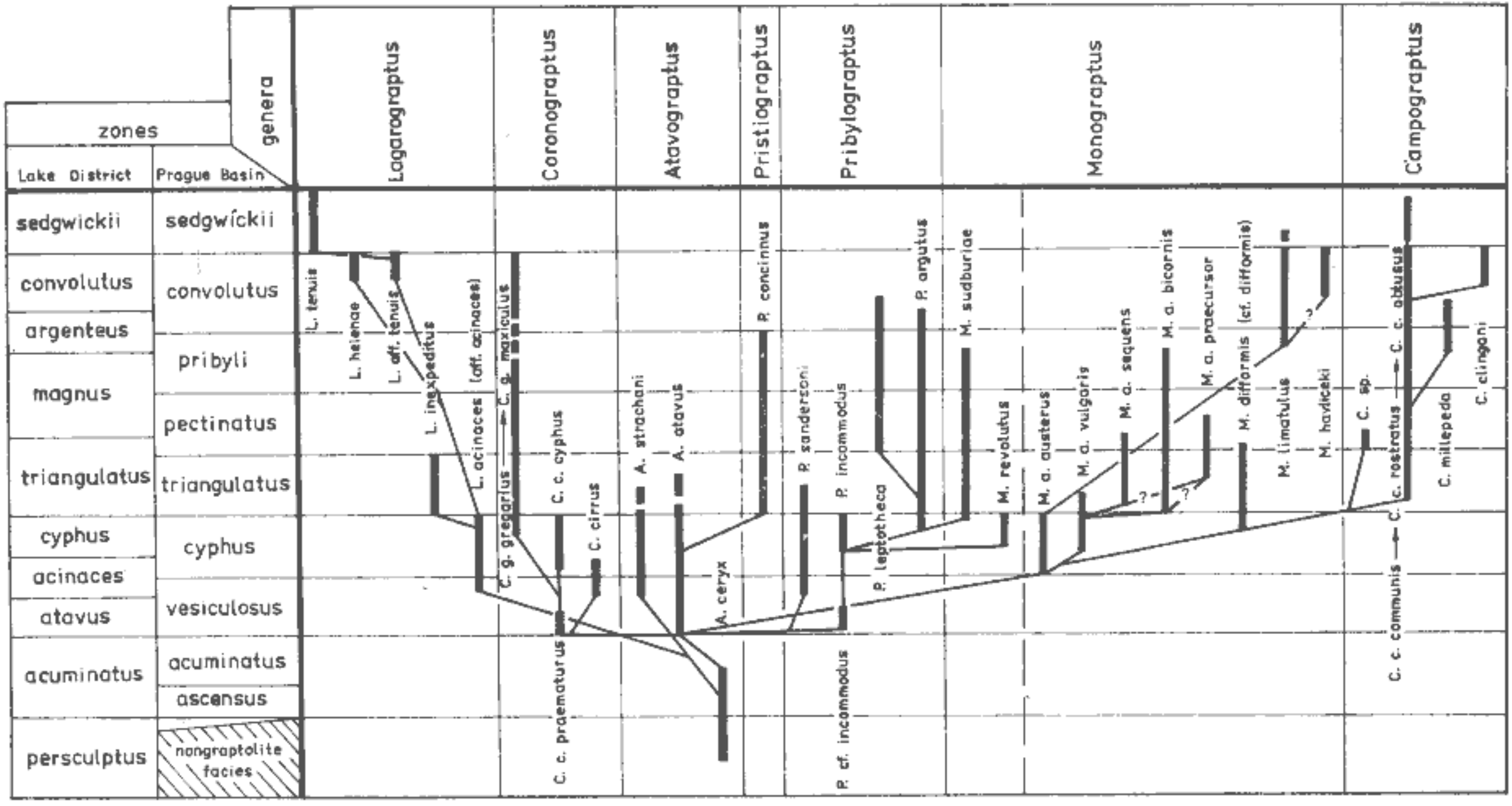
(pro *Lomatoceras* BRONN, 1835; *Monoprion* BARRANDE, 1850; ICZN opinion 198)
syn. *Pomatograptus* JAEKEL, 1889; *Spirograptus* GURICH, 1908 (partim); *Demirastrites* EISEL, 1912 (partim); *Pernerograptus* PŘIBYL 1941; *Mediograptus* BOUČEK et PŘIBYL, 1948; *Globosograptus* BOUČEK et PŘIBYL, 1948.

Type species: *Lomatoceras priodon* BRONN, 1835, p. 56, pl. 1, fig. 13 from the Silurian of Germany. Subsequent designation BASSLER 1915, p. 822.

Remarks to the diagnosis: Systematically, the genus *Monograptus* is by the majority of authors (BULMAN 1970, RICKARDS 1970, HUTT 1975, BJERRESKOV 1975 etc.) used according to BULMAN's (1970) diagnosis — "Scandent uniserial rhabdosome without cladia; thecae and shape of rhabdosome variable" — as a sort of "waste basked" which may serve for placing there most of the described genera of the family *Monograptidae*. Nevertheless, a great deal of work has been done during the last 15 years at discovering of graptolite evolution and systematics. Several monograptid genera have been erected or redefined and excluded from *Mono-*

Table 2

Suggested evolutionary scheme for the earliest monograptid groups, showing phylogenetic relations of the species recorded from Bohemia. Triangulate monograptids of Dem. triangulatus group and the genus *Rastrites* which used to be evolved from early biform monograptids are excluded



graptus GEINITZ, 1852 at this time (*Atavograptus*, *Coronograptus*, *Lagarograptus* and *Pribylograptus*). On the contrary, some of the more or less valuable genera (*Demirastrites*, *Spirograptus*, *Pernerograptus* etc.) appear to be evidently polyphyletic and after study of the morphology and evolutionary relationships they should be subsequently redefined.

The genus *Demirastrites* is being used in the sense of M. triangulatus group in this paper. The genus *Campograptus* OBUT, 1949 has been redefined here and excluded from the "waste basked" of *Monograptus*. On the other hand, the genus *Pernerograptus* PŘIBYL, 1941, the species of which have been studied in detail by HUTT (1974), embraces several groups of biform monograptids with various thecae. The type species "*Pernerograptus*" *argenteus* (NICHOLSON) seems to be somewhat out of the other lineages of so-called biform monograptids. In conclusion, "*Pernerograptus*" is preferred to remain in *Monograptus* s.l.

Biform monograptids

The lower Silurian biform monograptids (the genus "*Pernerograptus*") are characterized by dorsally arcuate rhabdosomes with hooked proximal thecae and more or less straight distal thecae. The tube-like distal thecae with straight apertures belong to the M. austerus group which originates (HUTT 1974) from *Atavograptus* (atavus group). *M. sudburiae* and *M. revolutus* have introverted distal thecae with dorso-lateral apertural horns (HUTT 1974). They correspond to the M. revolutus group which originates by parallel evolution from *Pribylograptus* (incommodus group). The two subgroups have been distinguished by HUTT (1974) and RICKARDS - HUTT - BERRY (1977) within the M. austerus group. The representatives of the first one, characterized by simple hooked proximal thecae and straight tube-like distal thecae, were found in Bohemia.

The relationships of *M. limatulus* and *M. havliceki* (Dem. convolutus Zone) are not yet quite clear. They may represent a similar evolutionary trend (strongly geniculate thecae with ?genicular hoods proximally) as gave rise to *Monoclimacis*. Both of them could be evolved from the most generalized *M. a. austerus*-like form with simply hooked and tube-like thecae. A distinctive relationship to *Atavograptus strachani* could not be excluded because of its similar geniculate thecae from which may be evolved also proximal hooks or hoods of *M. limatulus* and *M. havliceki*. Proximal hooks may have been developed by the same influence which originates other groups of biform monograptids.

Monograptus austerus austerus TÖRNQUIST, 1899

Pl. III, figs. 2, 3, 4; text-figs. 2F, G, M

1899 *Monograptus revolutus* KURCK var. *austerus*; TÖRNQUIST, p. 12, pl. 2, figs. 12–14.

1911 *Monograptus revolutus* var. *austerus* TÖRNQUIST; ELLES - WOOD, p. 385, pl. 38, fig. 2a–c, ? text-fig. 254b.

1941a *Pernerograptus revolutus austerus* (TÖRNQUIST, 1899); PŘIBYL, p. 11, pl. 2, figs. 5, 6.
1958 *Monograptus revolutus* var. *austerus*; SUDBURY, p. 539.
1974 *Monograptus austerus austerus* TÖRNQUIST, 1899; HUTT, p. 199, text-fig. 6a.

Material: About 30 incomplete flattened specimens and more fragments.

Description: The rhabdosome with characteristic gentle open dorsal curvature widens gradually from the initial width at the level of $th_{n\ -\ 25}$ (0.2 mm) and 0.6—0.7 mm at th_n up to the maximum width of 0.85 mm. About 30 axially elongated simply hooked thecae are in proximal part of the rhabdosome. No thecal overlap has been observed in proximal thecae. The thecal count is $2TRD_{n\ -\ (20\ -25)} =$ = 2.3 mm most proximally, $2TRD_{n\ -\ (10\ -20)} = 2.9$ mm and decreases to 2.0 to 2.1 mm at the level of th_n. The specimens from Běleč show slight lateral extension of apertural margin of hooked dorsal thecal wall of proximal thecae. Numerous rhabdosomes are in subscalariform orientation (pl. III, fig. 3; text-fig. 2M) as shown by shifted position of the virgula. The true shape of the apertures with transversely extended dorsal apertural margin may be visible owing to this subscalariform orientation. Hooked proximal thecae change into the straight simple tubes with straight apertures in mesial part of the rhabdosome. The distal thecae overlap for more than 1/3 their length and the free ventral thecal walls incline at an angle of about 15° to the rhabdosome axis. The thecal count is 9—10 in 10 mm distally.

Remarks and relations: The Bohemian specimens referred to *M. a. austerus* TÖRNQUIST well correspond to those described by HUTT (1974). The only difference is in slight transversal extension of the aperture in Bohemian material. Furthermore, the lateral extension is accented by flattening in our specimens. In all other features, the specimens described herein fit *M. austerus austerus* TÖRNQUIST. Detailed comparison of *M. a. austerus* with other similar biform monograptids was given by HUTT (1974).

Horizon and localities: Želkovice Formation, abundant in C. cyphus Zone, especially in its lower part. Běleč, Hlásná Třebaň, Karlík.

Monograptus austerus vulgaris HUTT, 1974

Pl. VII, figs. 1, 2, 4, 5; pl. VIII, figs. 1, 2, 4; text-fig. 2D, E

1899 *Monograptus revolutus* KURCK; TÖRNQUIST, p. 11, pl. 2, figs. 6–11.
1911 *Monograptus revolutus* KURCK; ELLES - WOOD, p. 384, pl. 38, fig. 1a–d, ?e; ? text-fig. 254a, (non 254b).
1941 *Pernerograptus revolutus revolutus* (KURCK, 1882); PŘIBYL, p. 3, pl. 2, figs. 1–4.
1958 *Monograptus revolutus* A; SUDBURY, p. 533, text-figs. 26a, 28.
1974 *Monograptus austerus vulgaris* subsp. nov.; HUTT, p. 199, text-fig. 6b.

Material: 2 almost complete rhabdosome and several fragments from the author's collection and the type material of A. Přibyl.

Description: The rhabdosome is more than 70 mm long, with dorsal curvature accentuated mesially. It widens very gradually. The sicula has not been found in Bohemian material. More than 20 axially elongated hooked thecae without a distinctive overlap are present in proximal part. The change to straight tube-like distal thecae has taken place over 5 or 6 thecae in strongly curved mesial part. The initial dorso-ventral width of 0.3 mm increases up to 0.6—0.7 mm mesially. The apertures of distal thecae seem to be straight but the true shape could not be positively identified in our material. The maximum width of 0.85 (1.0) mm and maximum thecal overlap (more than 1/2) are attained in most distal part of the rhabdosome. The 2TRD reaches 2.6 mm in most proximal part; usually the proximal thecae number 8.5—9 in 10 mm. The distal thecae number 10—10.5 in 10 mm.

Remarks and relations: The rhabdosomes referred to *M. austerus vulgaris* HUTT well correspond both to HUTT's (1974) original description and to ELLES - WOOD's (1911) description of *M. revolutus*. The only difference is in higher thecal count in Bohemian specimens. Very difficult appears to distinguish our specimens from those of *M. revolutus* until the true character of distal apertures is recognized. The present material has not introverted thecal apertures but it is not sufficiently preserved for an ultimative decision. A complete comparison of *M. a. vulgaris* with other biform monograptids was given by HUTT (1974).

Horizon and localities: Želkovice Formation, uncommon from the upper part of C. cyphus Zone to the lower part of Dem. triangulatus Zone. Hlásná Třebaň, Karlík, Zadní Třebaň.

Monograptus cf. *difformis* TÖRNQUIST, 1899

Pl. VIII, fig. 3; text-fig. 5A, 6E

cf. 1899 *Monograptus difformis* n. sp.; TÖRNQUIST, p. 13, pl. 2, figs. 15–17.
cf. 1911 *Monograptus difformis* TÖRNQUIST; ELLES - WOOD, p. 386, pl. 38, figs. 4a–c (? non 4d); text-fig. 256a (? non 256b).
1941a *Pernerograptus* cf. *difformis* (TÖRNQUIST, 1899); PŘIBYL, p. 12, pl. 2, figs. 2, 3; pl. 2, fig. 7.
cf. 1974 *Monograptus difformis* TÖRNQUIST; HUTT, text-fig. 1c.
cf. 1975 *Monograptus difformis* TÖRNQUIST, 1899; HUTT, p. 88, pl. 15, fig. 4; text-fig. 17, fig. 4.

Material: Specimen no. NM 27051 figured by PŘIBYL (1941), one incomplete rhabdosome and several fragments collected by present author.

Description: Arcuately dorsally curved rhabdosome (the length of our incomplete specimen is 24 mm) widens gradually from the initial dorso-ventral width of 0.6 mm. The most proximal thecae and sicula are not preserved. The rhabdosome attains its maximum width of 0.9—1.1 mm in the most strongly curved mesial part. Axially elongated proximal thecae change into almost triangular mesially. Their thecal height increases up to 0.9—1.1 mm and the thecal length shortens up to 1.0 mm. Ventral thecal walls become slightly convex, dorsal walls incline at an angle of about 60° to the rhabdosome axis. Highly triangular hooked mesial

thecae change distally into simple tube-like thecae inclining at 25—30° to the rhabdosome axis. There are 21 hooked thecae preserved in the specimen described herein. The thecal overlap appears in place of a strong dorsal curvature (mesial part) and reaches up to 1/2 of thecal length most distally. The 2TRD of distal thecae is about 2 mm.

Remarks and relations: The specimens described by PŘIBYL (1941) and by the present author are referred to *Monograptus difformis* TÖRNQUIST with a question. They seem to correspond well in most of the features to the specimens described by HUTT (1974, 1975). Nevertheless, there are some remarkable differences if it is compared with the specimens from Lake District. The hooked mesial thecae of Bohemian specimen are more elongated axially, the thecal height/length ratio attains 1 : 1. The dorso-ventral wall is not perpendicular to the rhabdosome axis. A single specimen of *Monograptus* cf. *difformis* from Bohemia may eventually represent a deformed specimen of *M. a. vulgaris*. An ultimate decision on the specimens discussed herein depends on further finds.

Horizon and localities: Rare in Dem. triangulatus Zone. Zadní Třebaň, Všeradice.

Monograptus limatulus TÖRNQUIST, 1892

Pl. X, figs. 1, 6, 7; pl. XI, fig. 3; text-fig. 4G, I, J

1892 *Monograptus limatulus* n. sp.; TÖRNQUIST, p. 9, pl. 1, fig. 7 (non figs. 6, 8).
1897 *Monograptus limatulus* TÖRNQUIST; PERNER, p. 19, pl. 13, fig. 9.
1897 *Monograptus cyphus* LAPW.; PERNER, p. 19, pl. 13, figs. 7, 8; text-fig. 8.
1911 *Monograptus limatulus* TÖRNQUIST; ELLES - WOOD, p. 390, pl. 38, figs. 7a – c (? non fig. 7d); text-figs. 259a – c.
1941a *Pernerograptus limatulus* (TÖRNQUIST, 1892); PŘIBYL, p. 5, pl. 1, fig. 6, pl. 2, figs. 8 – 10.
1970 *Monograptus limatulus* TÖRNQUIST, 1892; RICKARDS, p. 70, text-fig. 16, fig. 10; text-fig. 18, fig. 11. (A long synonymy was given by RICKARDS.)
1971 *Monograptus (Pernerograptus) limatulus* TÖRNQUIST; SCHAUER, p. 69, pl. 25, figs. 20 – 22.
1975 *Monograptus limatulus* TÖRNQUIST, 1892; BJERRESKOV, p. 53, pl. 7, fig. I; text-fig. 16B.
1975 *Monograptus limatulus* TÖRNQUIST, 1892; HUTT, p. 93, pl. 15, figs. 1, 2; text-fig. 23, figs. 1 – 6.

Material: 15 almost complete flattened rhabdosomes, more fragments.

Description: The rhabdosome has nearly straight, long and slender proximal part, strongly dorsally curved mesial part and the distal part dorsally bent with a tendency to become straight. The sicula has not yet been detected in Bohemian specimens. Slender proximal parts attain the length of max. 12 mm, distal part is usually more than 30 mm long. The longest proximal parts have up to 7 extremely axially elongated thecae. These thecae with no overlap seem to have diminutive hooked metathecae. The character of the apertural region has not been recognized in detail. The initial dorso-ventral width of the rhabdosome is 0.15 mm. The width increases slightly until the strongly curved mesial part of the rhabdosome is at-

tained. Then, the width rapidly increases up to 0.55—0.65 mm within the 3—4 thecae interval. Thecal overlap increases up to 1/4—1/3. The shape of the thecae changes and thecal ?hooks are rapidly reduced during the mesial part (3—4 thecae) of the rhabdosome. Distally the thecae become simply tube-like with a small geniculum and straight apertures. Prolonged hook-like dorsal thecal wall in mesial thecae resembling a genicular hood in monoclimacids have been reduced distally. It looks to be a prominent hook-like dorsal thecal wall more likely than genicular hood created by following theca. The tube-like thecae immediately distal of the mesial part bear a more distinctive geniculum than those in the most distal part of the rhabdosome. The thecal count increases from $2TRD_{n-(6-8)} = 2.2$—2.5 mm to $2TRD_{n-1} = 1.3$—1.4 mm and decreases distally to 10 in 10 mm. Free ventral walls of distal thecae incline at an angle of 25° to the rhabdosome axis. In the distal part of the rhabdosome the thecae overlap for 1/2 their length; dorso-ventral width reaches there up to 0.75—0.95 mm.

Remarks and relations: The Bohemian specimens of *Monograptus limatulus* TÖRNQUIST well correspond to those described by TÖRNQUIST (1892), HUTT (1975) and BJERRESKOV (1975). The differences in proximal thecal count could be probably affected by measurement of different interval on the rhabdosome or by deformation of the specimens. The mesial thecae of our rhabdosomes fit the specimen figured by BJERRESKOV (1975, text-fig. 16B). Alternative relations to *M. a. austerus*, *A. strachani* and the earliest monoclimacids could be recognized only in best-preserved, three-dimensional material.

Horizon and localities: Želkovice Formation, common in the Dem. convolutus Zone. Běleč, Hlásná Třebaň, Tmaň, Želkovice, Praha - Velká Chuchle, Praha - Řepy.

Monograptus havliceki sp. n.

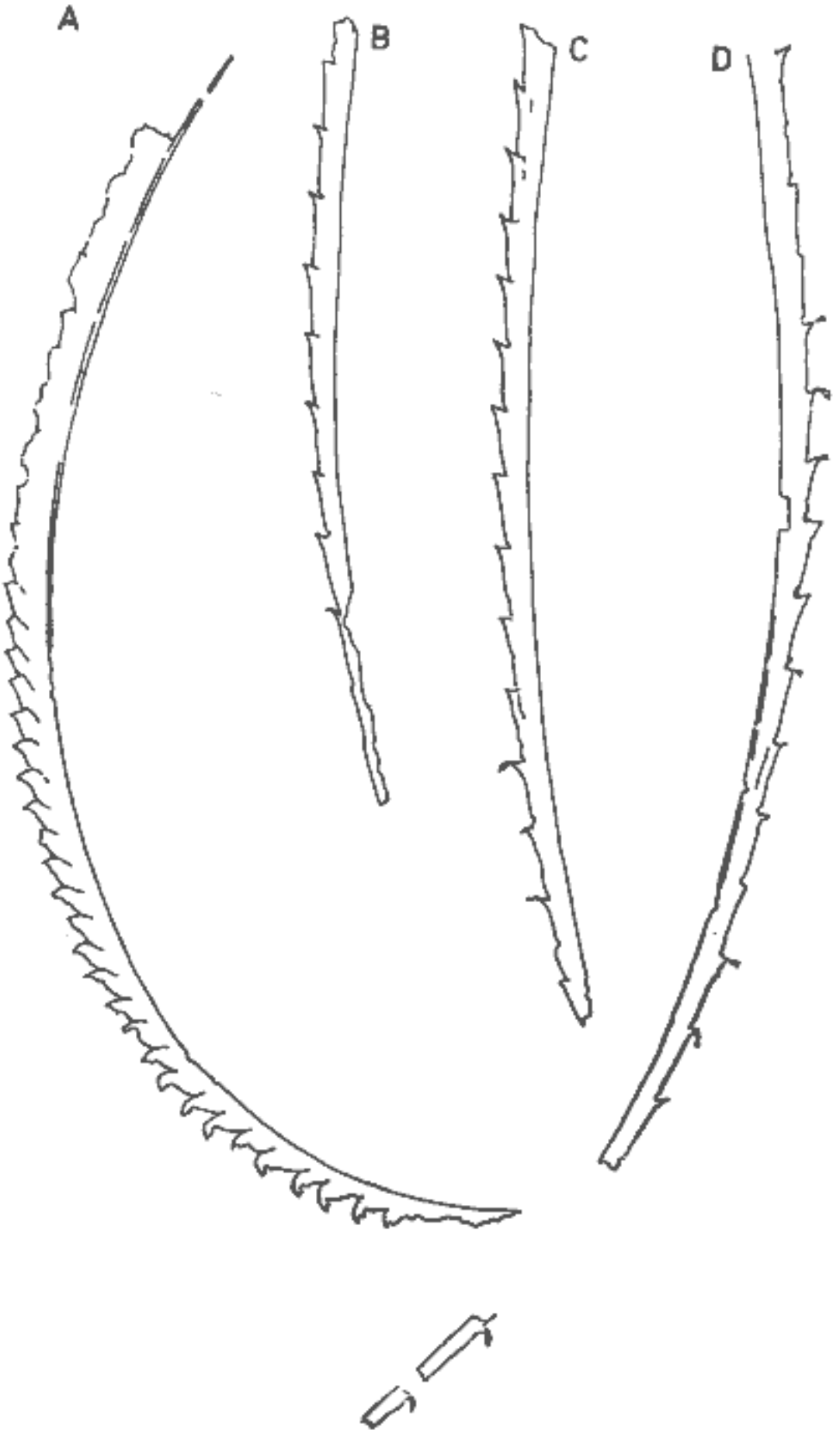
Pl. XI, figs. 1, 2; pl. XII, fig. 4; text-fig. 4A, F

Holotype: Incomplete flattened specimen no. PŠ 269, pl. XI, fig. 1; text-fig. 4A. The author's collection housed in the Geological Survey, Prague.
Type horizon: Želkovice Formation, Llandovery, middle part of Dem. convolutus Zone.
Type locality: Tmaň.
Material: 11 incomplete flattened specimens, several fragments.

Diagnosis: Rhabdosome dorsally arcuate, dorso-ventral width gradually increases from the slender proximal part up to 0.9 mm in most distal part. There are several ?hooked monoclimacis-like thecae in proximal part, numbering 12—13 in 10 mm. Proximal hooked or hooded thecae change into the straight tube-like geniculate distal thecae. Geniculum prominent in proximal thecae gradually disappears distally.

Description: The arcuate rhabdosome is over 50 mm long. A sole extreme proximal end that has been found is badly preserved. The proximal thecae are

elongated with small overlap (up to 1/4), with prominent geniculum and hook or hood-like apertural region. Apertures of more than 6 proximal thecae have a structure resembling a hooked dorsal thecal wall or genicular hood similar as in *M. limatulus*. Apertures placed in small, shallow apertural excavations face rather ventrally. Succeeding, more distal thecae become straight, tube-like cylindrical in shape. Thecae number 12—13 in 10 mm proximally ($2TRD_n$ = 1.6—1.7 mm). The dorso-ventral width of the rhabdosome increases gradually from the initial 0.2 mm up to the maximum distal width of 0.9 mm (50 mm away from the proximal end). The early tube-like distal thecae have a distinctive genicular curvature which



5. *Lagarograptus tenuis* (PORTLOCK): B — PŠ 173/2, × 3.7; C — PŠ 173/1, × 3.7; D — PŠ 171, × 3.7. *Monograptus* cf. *difformis* TÖRNQUIST A — PŠ 310, × 3.5

becomes less and less prominent more distally. Distal thecae are simple tubes with straight apertures perpendicular to the rhabdosome axis; thecae overlap for about 1/2 their length; free ventral thecal walls incline at an angle of 10—13° to the rhabdosome axis. Thecal apertures are 0.35—0.4 mm wide. Thecal count slightly decreases distally to 10.5—12 in 10 mm.

Remarks and relations: *Monograptus havliceki* n. sp. appears to be close to *M. limatulus* TÖRNQUIST in some features (especially in distal part). The chief differences between the two species are open arcuated rhabdosome and slowly increased dorso-ventral width of the former. The changes of thecal shape and width of the rhabdosome are not strongly accentuated in strongly curved mesial part as in the case of *M. limatulus*. *M. havliceki* seems to lack extremely elongated thecae of slender proximal part which are developed in *M. limatulus*. The origin of *M. havliceki* is not clear. Characteristically biform thecae place the origin of *M. limatulus* and *M. havliceki* into the ancestors from M. austerus group. If their proximal "hooks" represent genicular hoods in reality, they could resemble even monoclimacids — *Monoclimacis* ? sp. (HUTT 1975). Distally, the hook or genicular hood has retreated exposing apertures with nearly straight margins. Geniculate tube-like distal thecae resemble some atavograptids (*A. strachani*) which is considered to be a praecursor of monoclimacids.

Horizon and localities: Želkovice Formation, uncommon in Dem. convolutus Zone. Tmaň.

The earliest members of some monograptid groups from Demirastrites convolutus Zone

Monograptus lobiferus (Mc COY, 1850)

Pl. XII, figs. 1, 2, 6; text-fig. 4E, M

1850 *Graptolites lobiferus* (M'COY); Mc COY, p. 270.
1897 *Monograptus lobiferus* M'COY; PERNER, p. 32; pl. 10, fig. 19; text-fig. 16.
1897 *Monograptus lobiferus* var. *undulatus* m.; PERNER, p. 33, pl. 10, figs. 18a, 22b; text-fig. 18.
? 1897 *Monograptus lobiferus* var. *Lapworthi* m.; PERNER, p. 33, pl. 10, figs. 20, 21; text-fig. 17.
1913 *Monograptus lobiferus* (M'COY); ELLES - WOOD, p. 448, pl. 45, figs. 1a – f, text-figs. 308a – e.
1975 *Monograptus lobiferus* (Mc COY, 1850); HUTT, p. 94, pl. 18, figs. 1, 3; pl. 19, fig. 6; text-fig. 24, figs. 4a, b. (A long synonymy was given by HUTT.)
1975 *Monograptus lobiferus lobiferus* (M'COY, 1850); BJERRESKOV, p. 66, pl. 10D, text-fig. 20C.

Material: More than 30 flattened specimens, some of them are complete.

Description: The rhabdosome is up to 100 mm long, straight, slightly dorsally curved in the most proximal part. The following slight ventral curve of post-proximal part of the rhabdosome occassionally occurs. The sicula bears short virgella and is up to 1 mm long and 0.2 mm wide (the apertural diameter). The sicular apex

reaches the level of th 1 aperture. The lobate most proximal thecae are slightly elongated, numbering 8.5—10.5 in 10 mm ($2TRD_2$ = 2.3 mm, $2TRD_{10}$ = 2.2 to 1.9 mm). The thecae with no overlap and with lobate recurved metathecae have apertures facing proximo-dorsally. Some specimens show short (up to 0.4 mm) paired lateral apertural processes noted also by HUTT (1975) and BJERRESKOV (1975). The distal thecae are strongly hooked, lobate and with apertures facing more dorsally, numbered 8.5—9.5 in 10 mm. The dorso-ventral width increases gradually from 0.4 mm at the th 2 level up to 1.9 mm in the most distal fragments.

Remarks: The flattened rhabdosomes from the Bohemian Silurian referred to *M. lobiferus* could not be separated from those of *M. lobiferus harpago* TÖRNQUIST, 1899 redescribed by BJERRESKOV (1975). Both of the diagnostic features mentioned by the latter author (the dorso-ventral width and lobation of the thecae) depend, to a certain extent, on flattening of Bohemian material.

The line producing forms with high lobate thecal type represented by succession of *M. lobiferus lobiferus* — *M. lobiferus harpago* — *M. knockensis* could be proposed in agreement with BJERRESKOV (1975) and RICKARDS - HUTT - BERRY (1977) while the origin of lobate monograptids could be placed into the genus *Campograptus*.

Horizon and localities: Želkovice Formation, common in Dem. convolutus Zone. Černošice, Hlásná Třebaň, Tmaň, Želkovice.

Monograptus ? sp.

Pl. I, figs. 4, 5; text-fig. 4K, L

Material: about 20 flattened ?distal fragments.

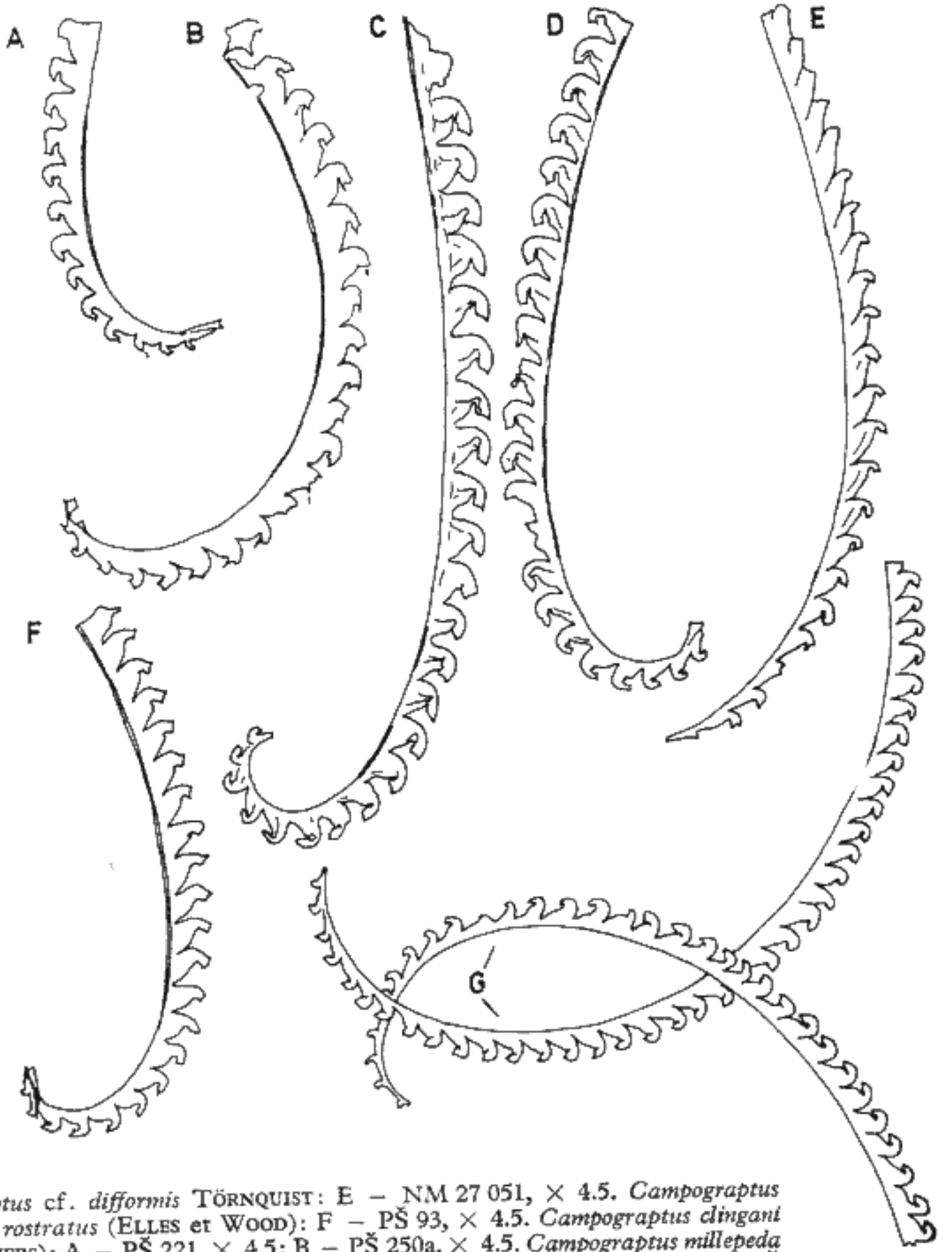
Description: The rhabdosome of this species appears to be extremely slender and nearly straight. The dorso-ventral width of all fragments is 0.25—0.35 mm and increases very gradually. The maximum length attained is about 30 mm in our fragments. Thecae apertures are covered by tiny hoods (text. fig. 4K,L). The thecal overlap reaches up to 1/4, thecal count is 7.5—8.5 in 10 mm (2TRD about 2.5 mm). The ventral walls of the thecae are inclined at an angle of 4—6° to the rhabdosome axis.

Remarks and relations: The characters of the apertural regions caused the difficulties with the generic attribution of the specimens described here. The apertural hoods tend to attribute our specimens to the genus *Pribylograptus* but straight thecae with slightly everted apertures show similarity with the *Pristiograptus fragilis*-like forms.

At first glance *Monograptus* ? sp. seems to be close to *Pristiograptus fragilis* (RICKARDS, 1970) but differs in having apertural hoods and greater thecal overlap. *M.* ? sp. is similar also to *Monograptus jonesi* RICKARDS, 1970 figured by BJERRESKOV

(1975). A sole distinctive difference is in apertural hoods once again. On the other hand, thecal apertural margin with apertural hood resembles some fragments of isolated rhabdosomes of *Monograptus* sp. 1. described by HUTT - RICKARDS - SKEVINGTON (1970).

Horizon and localities: Želkovice Formation, uncommon in Dem. convolutus Zone. Tmaň.



6. *Monograptus* cf. *difformis* TÖRNQUIST: E – NM 27 051, × 4.5. *Campograptus communis rostratus* (ELLES et WOOD): F – PŠ 93, × 4.5. *Campograptus clingani* (CARRUTHERS): A – PŠ 221, × 4.5; B – PŠ 250a, × 4.5. *Campograptus millepeda* (MC COY): C – PŠ 222a, × 4.5; D – BB 634, × 4.5. *Campograptus* sp.: G – PŠ 227, × 3

Genus *Campograptus* OBUT, 1949

Type species: *Monograptus convolutus* var. *communis* LAPWORTH, 1876, p. 358, pl. 13, figs. 4a, b from the lower Silurian, Llandovery, Scotland. Original designation OBUT (1949), p. 24.

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 dorsal and ventral walls, terminated by nearly rounded apertures. Up to 5 axially elongated most proximal hooked thecae are present.

Evolutionary note: The character of highly triangular hooked campograptid thecae has been studied detailedly by SUDBURY (1958) on the three-dimensional material. Owing to her investigations the original OBUT's (1949) diagnosis could be supplied at present.

The origin of the *Camp. communis* group used to be placed in *Monograptus difformis* TÖRNQUIST (HUTT 1974) or in *Monograptus austerus sequens* HUTT (RICKARDS, HUTT et BERRY 1977). The most proximal axially elongated thecae gradually change into higher and shorter triangular thecae in both cases. Only a small number of axially elongated most proximal thecae remain in *Campograptus*. The earliest triangular thecae occur in mesial part of *M. difformis*. In *M. a. sequens* progressive development of distal hooked thecae on the other side can be observed.

During the evolution of *Campograptus* a subsequent reduction of axially elongated most proximal thecae may be observed. The latest species have no axially elongated thecae — *Campograptus communis obtusus* (RICKARDS), *Campograptus millepeda* (MC COY) and *Campograptus clingani* (CARRUTHERS) as was shown by RICKARDS - HUTT - BERRY (1977).

Campograptus communis rostratus (ELLES et WOOD, 1913)

Pl. IX, figs. 1, ?2, 5; text-fig. 6F

1913 *Monograptus communis* (LAPWORTH) var. *rostratus* var. nov.; ELLES - WOOD, p. 481 (pars), pl. 49. fig. 2b (non a, c), text-fig. 337.

1913 *Monograptus communis* (LAPWORTH); ELLES - WOOD, p. 480 (pars), pl. 49, fig. 1b (non text-figs. 336a, b; pl. 49, figs. 1a, c–e).

1945 *Spirograptus communis communis* (LAPWORTH, 1876); PŘIBYL, p. 29, pl. 8, fig. 1–3.

1958 *Monograptus communis rostratus* ELLES et WOOD; SUDBURY, p. 522, text-fig. 21, pl. 23, figs. 102–105.

1970 *Monograptus communis rostratus* ELLES et WOOD, 1913; RICKARDS, p. 85, text-fig. 13, fig. 18.

1975 *Monograptus communis rostratus* ELLES et WOOD, 1913; BJERRESKOV, p. 64, pl. 10, fig. B; text-fig. 19A.

1975 *Monograptus communis rostratus* ELLES et WOOD, 1913; HUTT, p. 83, text-fig. 17, fig. 3.

Material: 15 complete flattened specimens, more than 20 fragments.

Description: Over 70 mm long rhabdosome with strongly dorsally curved

proximal part becomes nearly straight most distally. The sicula is up to 1 mm long with an apertural diameter of about 0.22 mm. The sicular apex attains just below th 1 aperture. The two initial thecae are axially elongated, the following thecae become higher, almost triangular with a broad prothecal basis. Nearly straight apertures of simply hooked metathecae face proximally in proximal part of the rhabdosome, in distal part they are not so strongly hooked and face somewhat ventrally. No thecal overlap has been observed. The dorso-ventral width of the rhabdosome (thecal height of 0.4—0.5 mm at the level of th 2 and 1.3 mm at th 8 level) increases up to 1.6 (1.7) mm most distally. The $2TRD_2 = 1.4—1.55$ mm, $2TRD_2 = 1.55—1.7$ mm, $2TRD_{10} = 1.65—1.8$ mm and $2TRD_{20} = 1.9—2.2$ mm so that the thecae numbered 13 in 10 mm proximally and 9—10.5 distally.

Remarks and relations: *Campograptus communis rostratus* (ELLES et WOOD) differs from the type subspecies by presence of only two axially elongate thecae. Its somewhat shorter and higher distal thecae face rather proximo-ventrally. The specimens from Bohemia correspond to *Camp. communis rostratus* in all these features. Some differences seem to be in both proximal and distal thecal count (the thecal count is higher proximally and lower distally in our specimens). Nevertheless, RICKARDS (1970) and HUTT (1975) referred the thecal count in general.

The rhabdosomes of similar species "*Demirastrites*" *denticulatus* TÖRNQUIST have been mostly figured by PERNER (1897) in place of *Camp. communis*. A great deal of Perner's type material is not sufficiently preserved for determination.

Horizon and localities: Želkovice Formation, Dem. triangulatus — Dem. pribyli Zone, rare in Dem. convolutus Zone. Černošice, Hlásná Třebaň, Karlík, Praha - Velká Chuchle (Barrande's "colony Haidinger"). Tmaň.

Campograptus millepeda (Mc COY, 1850)

Pl. IX, fig. 2; pl. X, fig. 4; text-fig. 6C, D

1850 *Graptolites millepeda* M'COY; MC COY, p. 270.
1913 *Monograptus millepeda* (M'COY); ELLES - WOOD, p. 465, pl. 46, figs. 10a – d, text-figs. 323a – c.
1968 *Campograptus curtus* OBUT et SOBOLEVSKAYA sp. nov.; OBUT - SOBOLEVSKAYA (et MERKUREVA), p. 104, pl. 25, figs. 7, 8.
1975 *Monograptus millepeda* (MC COY, 1850); HUTT, p. 96, pl. 22, figs. 1, 5; text-fig. 19, fig. 4. (A long synonymy was given by HUTT.)
1982 *Monograptus millepeda* (MC COY, 1850); LENZ, p. 88, pl. 7, figs. M, O; pl. 25, figs. D, G, H.

Material: 3 complete, 1 incomplete rhabdosome, several fragments.

Description: More than 35 mm long rhabdosome is strongly dorsally curved in proximal part and nearly straight distally. The robust sicula is 0.7—0.8 mm long and reaches up to the th 1 level. The sicular aperture attains the diameter of 0.4 mm. The th 1 originates just above the sicular aperture similarly as in other campograptids. Even the th 1 becomes triangular in profile with a generally convex ventral wall. Large hooked metathecae are retroverted to face the ventral wall;

presumably circular apertures are up to 0.5 mm wide in flattened Bohemian material. No thecal overlap is present. The th 1 height of 0.5 mm increases rapidly to a maximum of 1.3—1.4 mm. The thecal count of 13—14.5 in 10 mm in proximal part decreases to 9.5—10.5 in 10 mm distally ($2TRD_2$ = 1.4 mm; $2TRD_5$ = = 1.55 mm; $2TRD_{10}$ = 1.9 mm and $2TRD_{20}$ = 2.2 mm).

Remarks and relations: The specimens from the Prague Basin could be well compared with those described by ELLES - WOOD (1913) and HUTT (1975). However, the Bohemian specimens have lower thecal count (13—14.5 in contrast to 15) and narrower rhabdosome which corresponds more likely to the specimens described by LENZ (1982) from northern Canada. The characteristic thecal shape of *Camp. millepeda* is well recognizable in all cases.

Horizon and localities: Želkovice Formation, uncommon in the uppermost part of Dem. pribyli Zone and in lower part of Dem. convolutus Zone. Černošice, Hlásná Třebaň, Tmaň.

Campograptus clingani (CARRUTHERS, 1867)

Pl. IX, figs. 2, 3, 5; text-fig. 6A, B

1867 *Graptolithus Clingani* CARRUTHERS, p. 369, pl. 2, fig. 8.
non 1897 *Monograptus Clingani* BARR.; PERNER, p. 38, pl. 11, figs. 14–17, 21.
1913 *Monograptus Clingani* (CARRUTHERS); ELLES - WOOD, p. 463, pl. 46, figs. 11a–f, text-figs. 322a, b.
1969 *Monograptus clingani* (CARRUTHERS); STRACHAN, p. 195, pl. 5, figs. 1–5.
1975 *Monograptus clingani* (CARRUTHERS, 1867); HUTT, p. 82, pl. 23, figs. 5–7; text-fig. 19, fig. 9. (A long synonymy was given by HUTT.)
1982 *Monograptus clingani* (CARRUTHERS, 1867); LENZ, p. 65, pl. 5, figs. U, V; pl. 21, figs. E, K.

Material: 6 complete flattened specimens, several fragments.

Description: The rhabdosome is strongly dorsally curved at proximal end and becomes more or less straight distally. Our specimens attain up to 20 mm in length. The prominent sicula is 0.26 mm wide and 1.0—1.1 mm long. The sicular apex reaches up to th 1 level. The dorso-ventral width increases from 0.6 (0.8) mm (height of th 1) up to the maximum distal width of 1.3—1.4 mm attained at the level of th 9 — th 10. Metathecal hooks involve both dorsal and ventral walls and occupy 1/3—1/2 of the total width of the rhabdosome. Broad prothecal bases grow from a broad common canal. No thecal overlap has been observed. Short (0.1 mm) tiny lateral apertural spines have been detected in three specimens. Thecal count decreases from 13.5 in 10 mm proximally to 10 in 10 mm distally ($2TRD_2$ = = 1.4 mm; $2TRD_2$ = 1.55 mm; $2TRD_{10}$ = 1.8 mm and $2TRD_{20}$ = 1.9 mm).

Remarks and relations: Several rhabdosomes well comparable with *Campograptus clingani* (CARRUTHERS) were found at Tmaň. They have typical broad prothecae, hooked metathecae, broad common canal and in general robust proximal end of the rhabdosome. The Bohemian specimens differ from the type material of

Elles - Wood (1913), Strachan (1969), and Hutt (1975) in their higher thecal count and slightly narrower rhabdosomes. The same little differences found also in other campograptids from Bohemia could be explained by deformation regarding flattening. In some specimens (PŠ 221, PŠ 251) tiny lateral apertural spines can be observed. The only evidence of such spines in campograptids has been recorded by Bjerreskov (1975) in *Camp. communis rostratus* (Elles et Wood).

Horizon and localities: Želkovice Formation, upper part of Dem. convolutus Zone. Tmaň.

Campograptus sp.

Pl. IX, fig. 4; text-fig. 6G

Material: 2 incomplete flattened specimens.

Description: Over 35 mm long rhabdosome with triangular hooked thecae is dorsally arcuated throughout. The sicula and probably 1—3 initial thecae have not been found. The first theca preserved in our rhabdosomes is designated th n. It is 0.6 mm high in both specimens. There are about 5 axially elongated most proximal thecae with proximally facing apertures. The following thecae become shorter and higher, the apertures of their hooked metathecae direct proximally to proximodorsally. The dorso-ventral width increases gradually up to 1.35—1.4 mm in the most distal part of the rhabdosome. $2TRD_2 = 1.6$, 1.85 mm; $2TRD_{n+5} = 1.75$, 1.95 mm; $2TRD_{n+10} = 1.9$, 2.0 mm and $2TRD_{n+20} = 2.0$, 2.15 mm. Distal thecae number 10.5 in 10 mm.

Remarks and relations: The two specimens described here markedly differ from all the other campograptids. Their rhabdosomes are arcuated throughout, the dorso-ventral width increases gradually up to the most distal part. Regarding its number of axially elongated proximal thecae and its distal thecae shape, *Campograptus* sp. seems to be close to *Campograptus communis communis*. *Campograptus* sp. may represent one of the most primitive early campograptid forms evolving from biform monograptids.

Horizon and localities: Želkovice Formation, rare in the lower part of Dem. pectinatus Zone. Černošice.

K tisku doporučil J. Kraft

Přeložil autor

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Explanation of plates

Photographs by the author.

Pl. I

Atavograptus atavus (Jones): 1 – PŠ 262, × 2.5; 2 – PŠ 261, × 2.5; 3 – PŠ 255/2, × 2.5. *Monograptus* ? sp.: 4 – PŠ 274, × 7.25; 5 – the same slab, × 7.25. Localities: 1, 2 – Praha - - Běchovice, 3 – Běleč, 4, 5 – Tmaň.

Pl. II

Coronograptus cyphus cyphus (Lapworth): 1 – PŠ 230, × 3. *Lagarograptus* sp.; 2 – PŠ 254a, × 5. *Lagarograptus* aff. *tenuis* (Portlock): 3 – PŠ 234, × 5. Localities: 1 – Běleč, 2, 3 – Tmaň.

Pl. III

Coronograptus cyphus cyphus (LAPWORTH): 1 – PŠ 265, × 3. *Monograptus austerus austerus* TÖRNQUIST: 2 – PŠ 267, × 5; 3 – PŠ 233/1, × 5; 4 – PŠ 224, × 5. Locality: 1–4 Tmaň.

Pl. IV

Coronograptus gregarius gregarius (LAPWORTH): 1 – PŠ 246, × 5; 2 – PŠ 248, × 5; 3 – PŠ 248 (the same slab), × 5. *Coronograptus cyphus cyphus* (LAPWORTH): 4 – BB 639, × 5; 5 – BB 638, × 5. Locality: 1–5 – Hlásná Třebaň.

Pl. V

Pribylograptus argutus argutus (LAPWORTH): 1 – PŠ 247a, × 5; 2 – PŠ 211, × 5; 3 – BB 633, × 5; 4 – PŠ 263/1, × 5. Locality: 1–4 – Hlásná Třebaň.

Pl. VI

Pribylograptus leptotheca (LAPWORTH): 1 – NM 35050, × 5. *Pristiograptus concinnus* (LAPWORTH): 2 – PŠ 264 (in detail), × 5; 3 – PŠ 264, × 2.5; 4 – BB 637, × 2.5. Localities: 1 – Praha - Velká Chuchle (Barrande's "colony Haidinger"), 2–4 – Hlásná Třebaň.

Pl. VII

Monograptus austerus vulgaris HUTT: 1 – PŠ 205a, × 5; 2 – PŠ 204 (distal part in detail), × 7.5; 3 – BB 635, × 5; 4 – PŠ 204 (mesial part in detail), × 7.5; 5 – PŠ 205b, × 5. Localities: 1, 2, 4, 5 – Hlásná Třebaň, 3 – Zadní Třebaň.

Pl. VIII

Monograptus austerus vulgaris HUTT: 1 – PŠ 204, × 2.5; 2 – PŠ 92, × 5; 4 – PŠ 203, × 5. *Monograptus* cf. *difformis* TÖRNQUIST: 3 – NM 27051, × 5. Localities: 1, 2, 4 – Hlásná Třebaň, 3 – Zadní Třebaň.

Pl. IX

Campograptus communis rostratus (ELLES et WOOD): 1 – PŠ 207, × 2.5; 3 – PŠ 239 (compressed specimen from silicite), × 2.5; 5 – PŠ 93, × 5. *Campograptus millepeda* (Mc COY): 2 – PŠ 222a, × 5. *Campograptus* sp.: 4 – PŠ 227, × 2.5. Localities: 1, 2, 5 – Hlásná Třebaň, 3, 4 – Černošice.

Pl. X

Monograptus limatulus TÖRNQUIST: 1 – PŠ 255/2, × 5; 6 – PŠ 251/2, × 5; 7 – PŠ 232, × 5. *Campograptus clingani* (CARRUTHERS): 2 – PŠ 249/2, × 5; 3 – PŠ 221, × 5; 5 – PŠ 250a, × 5. *Campograptus millepeda* (Mc COY): 4 – BB 634, × 5. Locality: 1–7 – Tmaň.

Pl. XI

Monograptus havliceki sp. n.: 1 – PŠ 269, × 4; 2 – PŠ 268, × 5. *Monograptus limatulus* TÖRNQUIST: 3 – PŠ 270/1, × 5. Locality: 1–3 – Tmaň.

Pl. XII

Monograptus lobiferus (Mc COY): 1 – PŠ 272, × 3; 2 – PŠ 275, × 3; 6 – PŠ 271, × 5 (scalariform view – dorso-ventral compression, in detail). *Lagarograptus helenae* sp. n.: 3 – PŠ 274, × 5. *Monograptus havliceki* sp. n.: 4 – PŠ 269, × 5 (on the same slab as holotype). *Coronograptus gregarius maxiculus* subsp. n.: 5 – PŠ 252, × 5. Locality: 1–6 – Tmaň.

Nejstarší zástupci čeledi Monograptidae (Graptolithina) ze spodního llandoveru pražské pánve (Barrandien)

(*Résumé anglického textu*)

Petr Štorch

Předloženo 24. dubna 1985

V předložené studii jsou zpracováni nejstarší zástupci čeledi *Monograptidae* ze spodního llandoveru (želkovické souvrství) pražské pánve. První jednořadí graptoliti se v českém siluru objevují během zóny Cystograptus vesiculosus. Nejrozsáhlejší radiaci prodělávají starobylé monograptidní rody během zón Coronograptus cyphus a Demirastrites triangulatus. Většina studovaných vývojových linií vymírá do konce zóny Demirastrites convolutus a jen v ojedinělých případech přechází výše (Lagarograptus tenuis). Během zóny Dem. convolutus se na jejich místě objevují nové, pokročilejší skupiny monograptidů (*M.* ex gr. *lobiferus*, *Monoclimacis* ex gr. *crenularis*, *Pristiograptus* ex gr. *regularis*).

V práci je popsáno celkem 23 druhů a poddruhů řazených k rodům *Atavograptus*, *Pristiograptus*, *Coronograptus*, *Lagarograptus*, *Pribylograptus*, *Campograptus*, k biformním monograptidům ("*Pernerograptus*") a k dalším monograptidům jejichž počátky sahají do zóny Dem. convolutus (*M. lobiferus*, *M.* ? sp.). Z celkového počtu jsou 3 druhy nové (*Coronograptus gregarius maxiculus*, *Lagarograptus helenae* a *Monograptus havliceki*), 12 druhů bylo doloženo z českého siluru poprvé, zatímco 6 druhů bylo pro nedostatečný materiál ponecháno v otevřené nomenklatuře. Kromě popisů jsou u všech taxonů uvedeny a diskutovány jejich předpokládané fylogenetické vztahy a znázorněno jejich stratigrafické rozšíření. Práce se rovněž zabývá rodovou klasifikací starobylých monograptidů. Studie Sudburyové (1958) a Huttové (1974) ukázaly, že rod *Pernerograptus* (Přibyl 1941a) zahrnuje několik různých skupin biformních monograptidů, lišících se tvarem ték a jejich ústí. Navíc je nejasné postavení typického druhu "*Pernerograptus*" *argenteus*. Proto je rod *Pernerograptus* v souhlase s uvedenými autorkami stažen zatím do synonymiky široce pojatého rodu *Monograptus* s.l. Rod *Campograptus* (Obut 1949) naopak považuji za samostatný platný, dobře vymezitelný rod, jehož fylogenezi objasnili již Rickards - Hutt - Berry (1977). Rod *Campograptus* s upravenou diagnózou vyjímám ze synonymiky rodu *Monograptus* s.l.

V předložené práci jsou na základě studia nového materiálu revidovány rovněž druhy popsané z českého siluru Pernerem (1897) a Přibylem (1941a,b), ale nejsou

zde zahrnuti zástupci rodů *Rastrites* a *Demirastrites*, zpracovaní PŘIBYLEM (1942) a PŘIBYLEM a MÜNCHEM (1945).

Древнейшие представители семейства Monograptidae (Graptolithina) из нижнего лландовери Пражского бассейна (Барранднен)

Из нижних слоев желковицкой свиты Пражского бассейна (нижний лландовери) описаны 23 вида и подвида граптолитов, относящихся к родам *Atavograptus*, *Coronograptus*, *Lagarograptus*, *Pribylograptus*, к двуобразным моногаптидам („*Pernerograptus*“) к моногаптидам группы *M. lobiferus* и к родам *Pristiograptus* и *Campograptus*. Из всего числа виды *Coronograptus gregarius maxiculus*, *Lagarograptus helenae* и *Monograptus havliceki* являются новыми, 12 видов доказано впервые в силуре Чехии и 6 видов оставляется в открытой номенклатуре. Род *Campograptus* оснащен новым, расширенным диагнозом. Автор занимается в представленной статье также стратиграфическим значением и распространением, а также филогенетическими отношениями описываемых видов и эволюционных линий.

Přeložil A. Kříž

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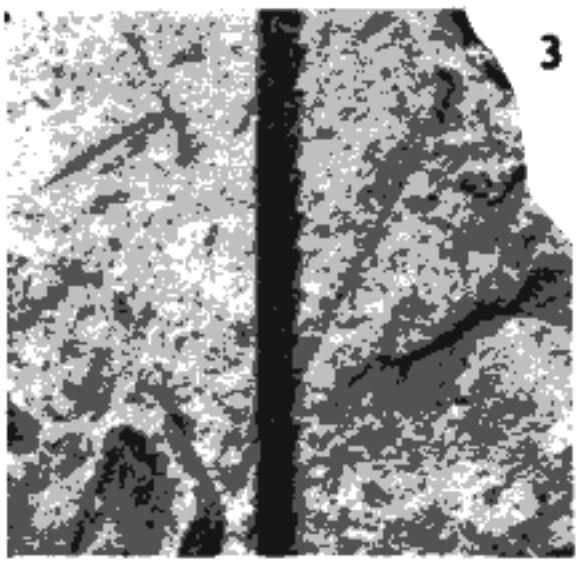

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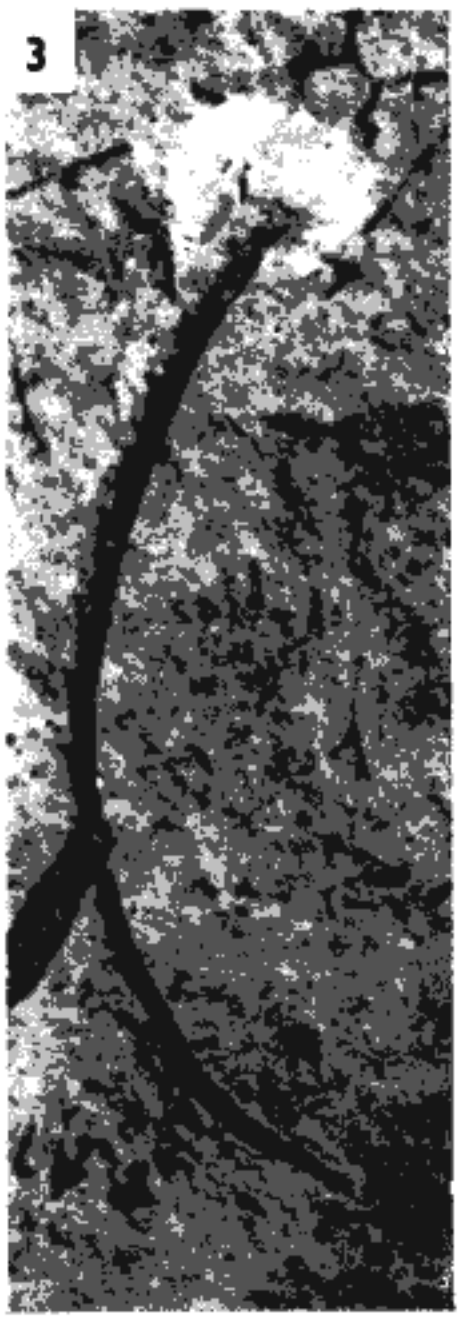
Pl. II



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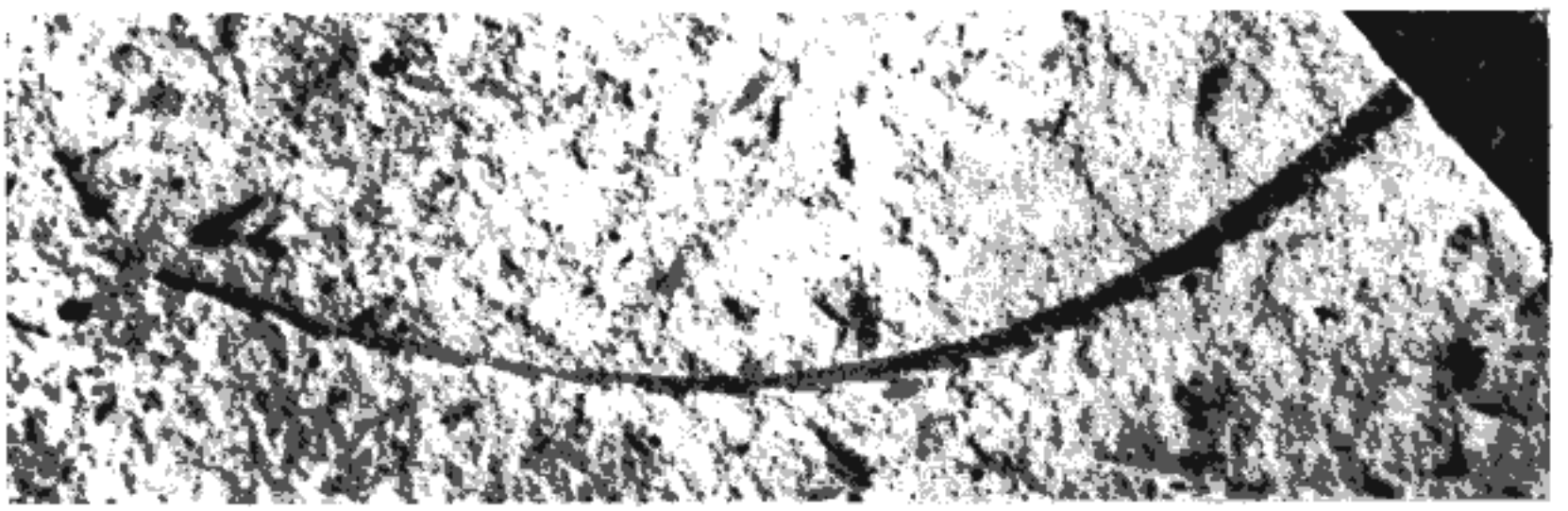

Pl. IV


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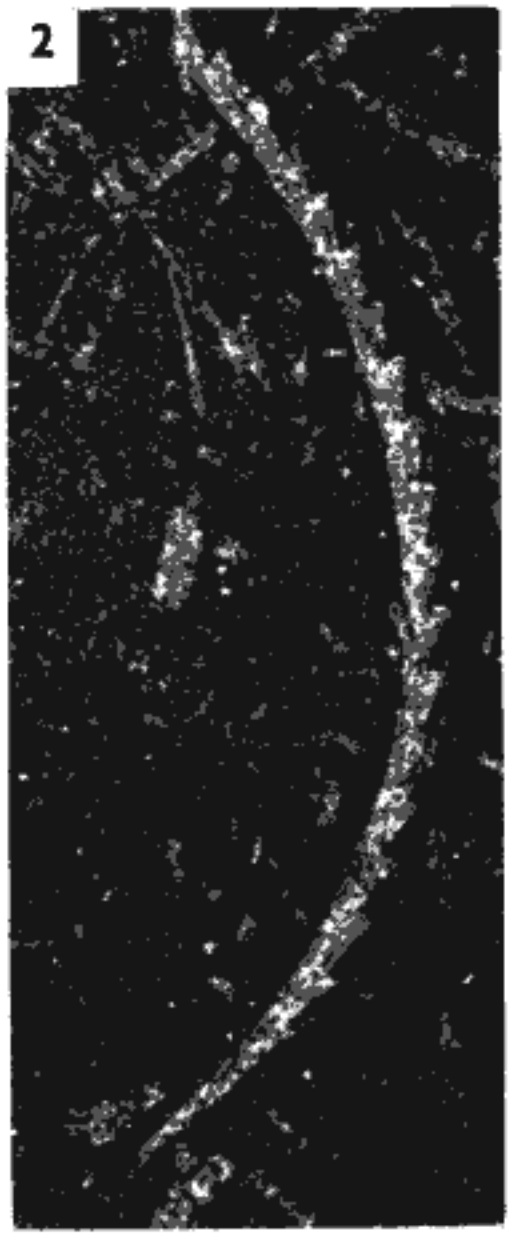
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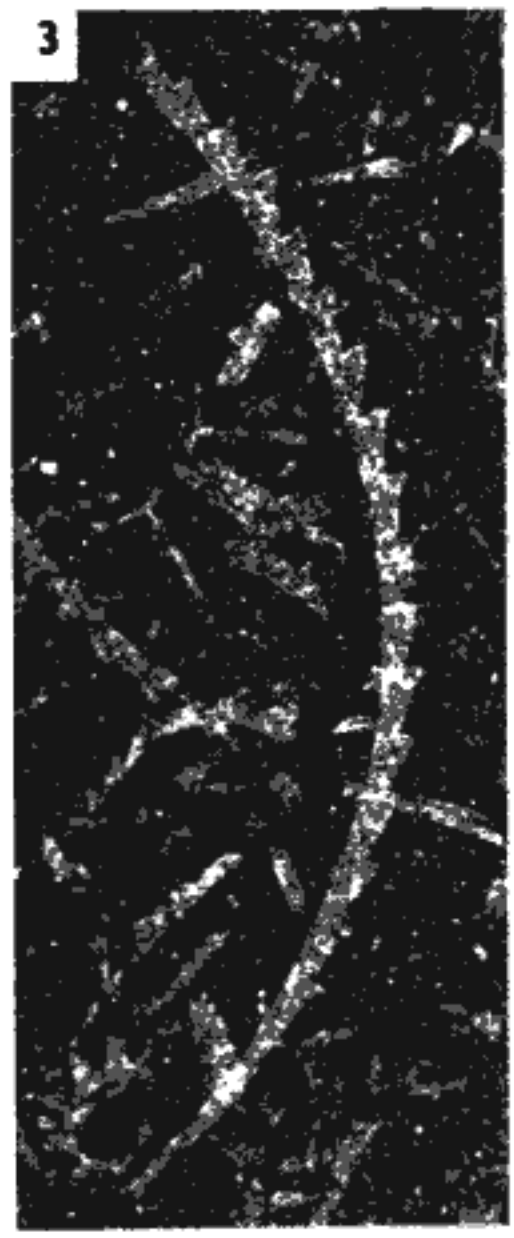
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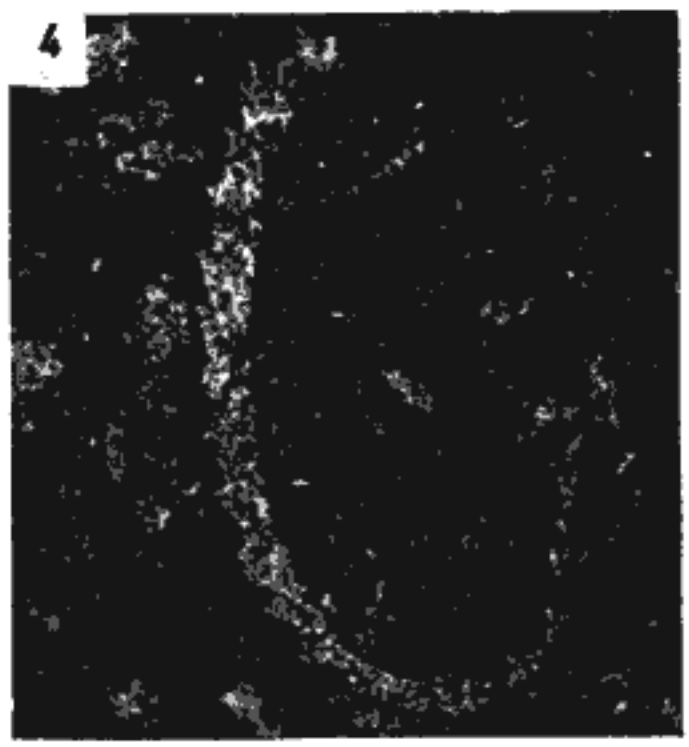
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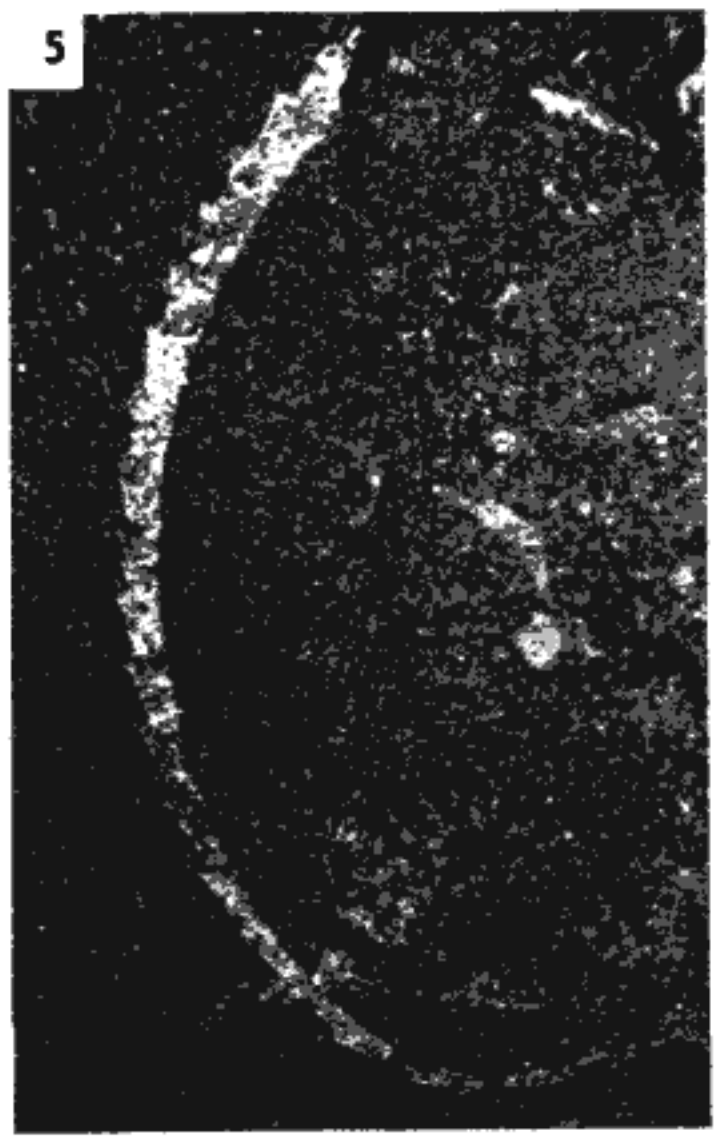
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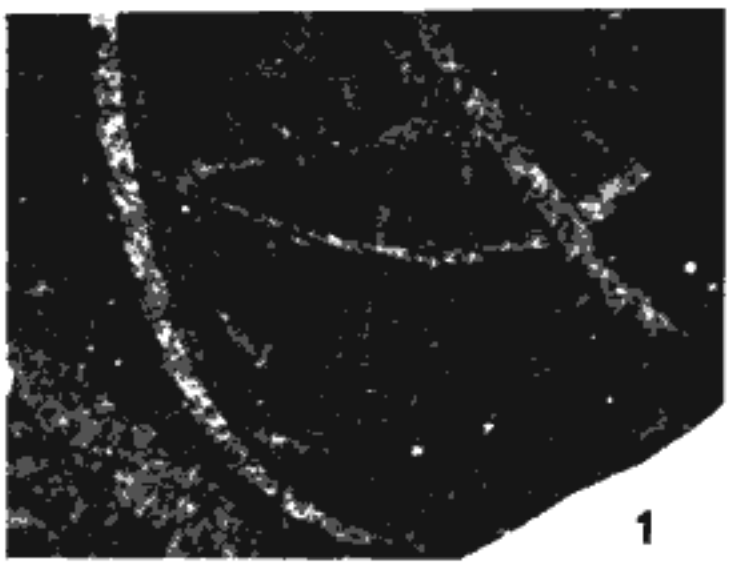

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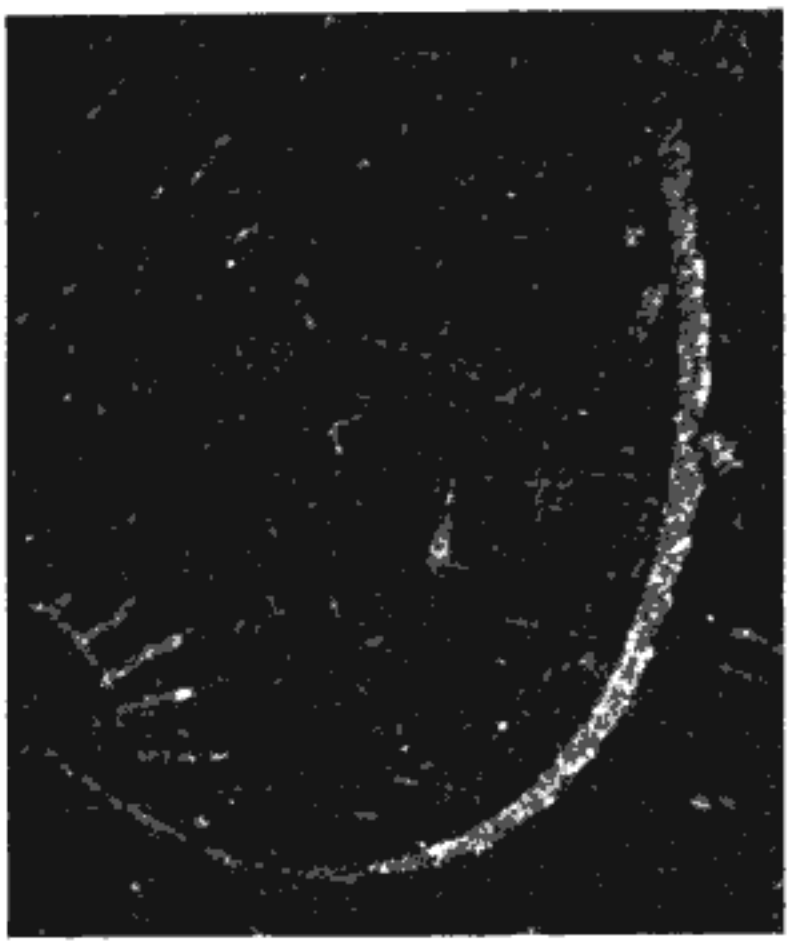

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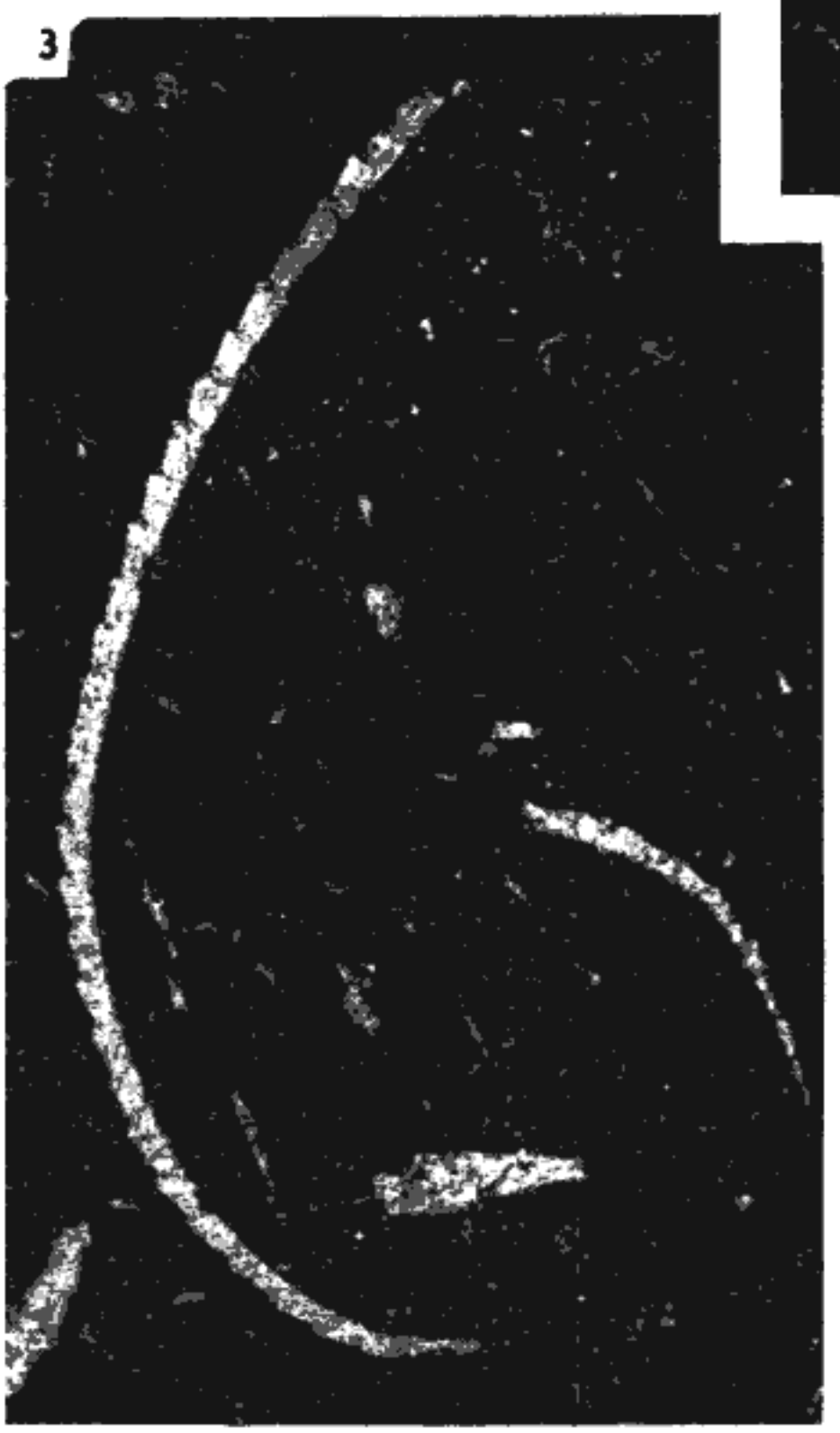

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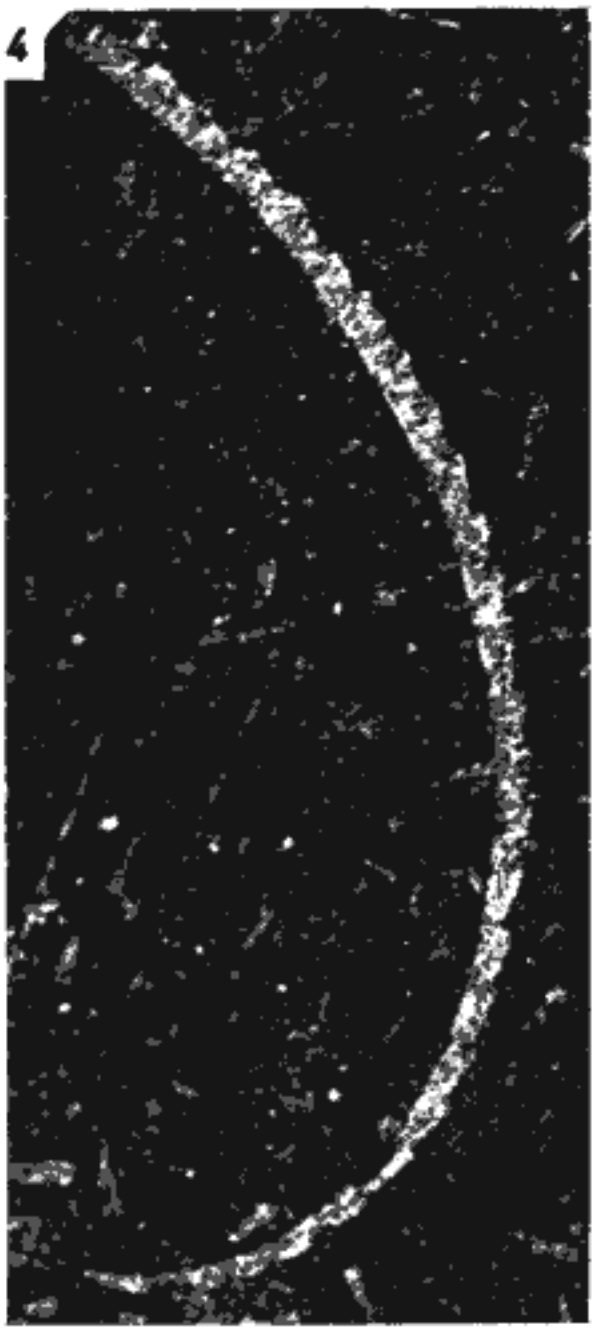

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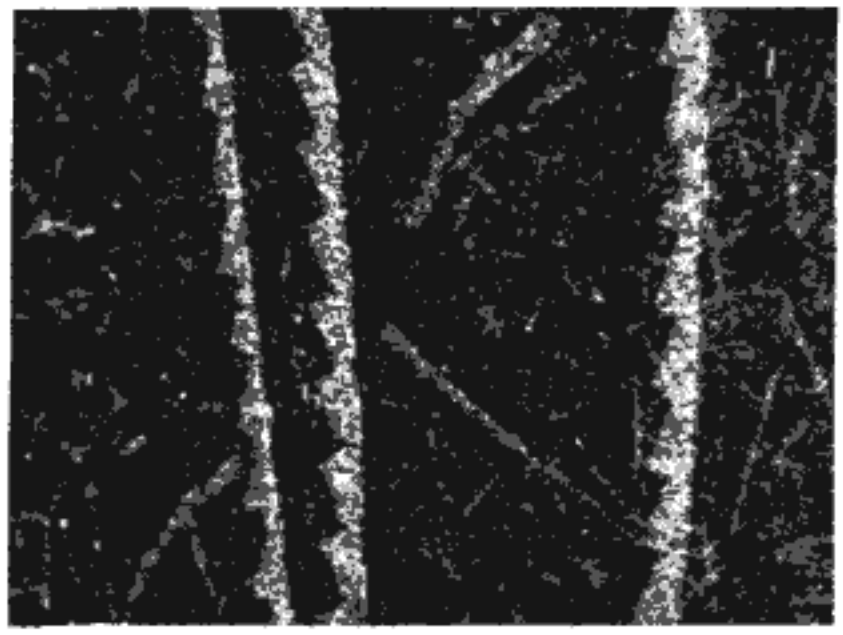

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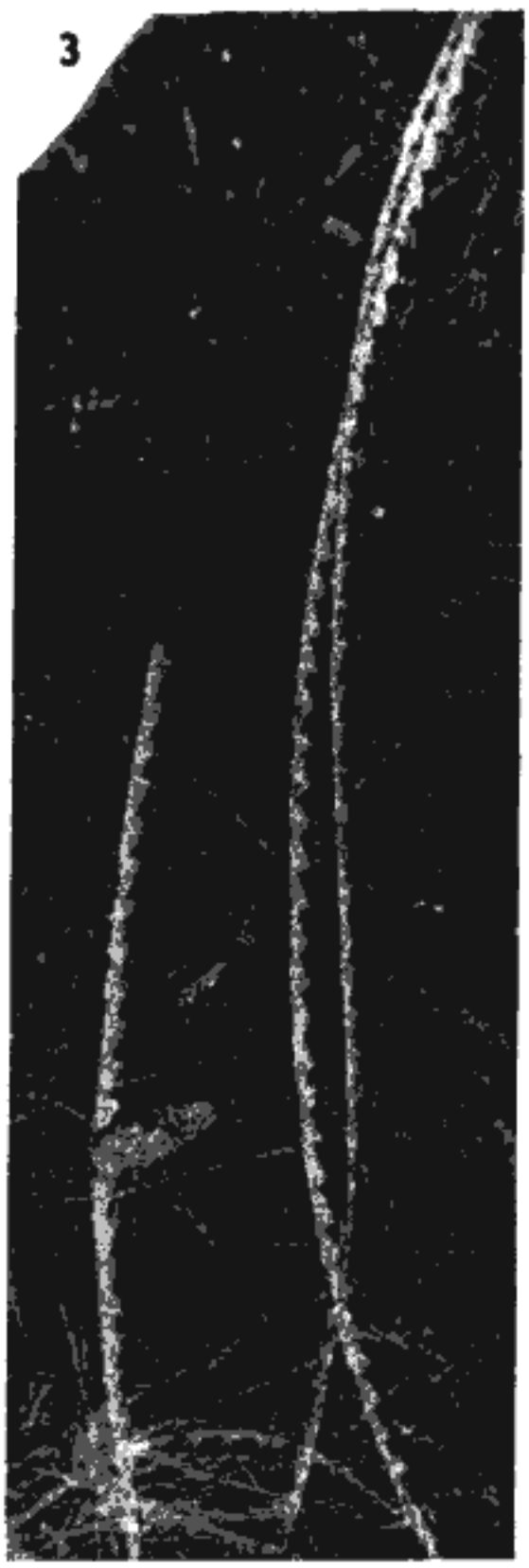

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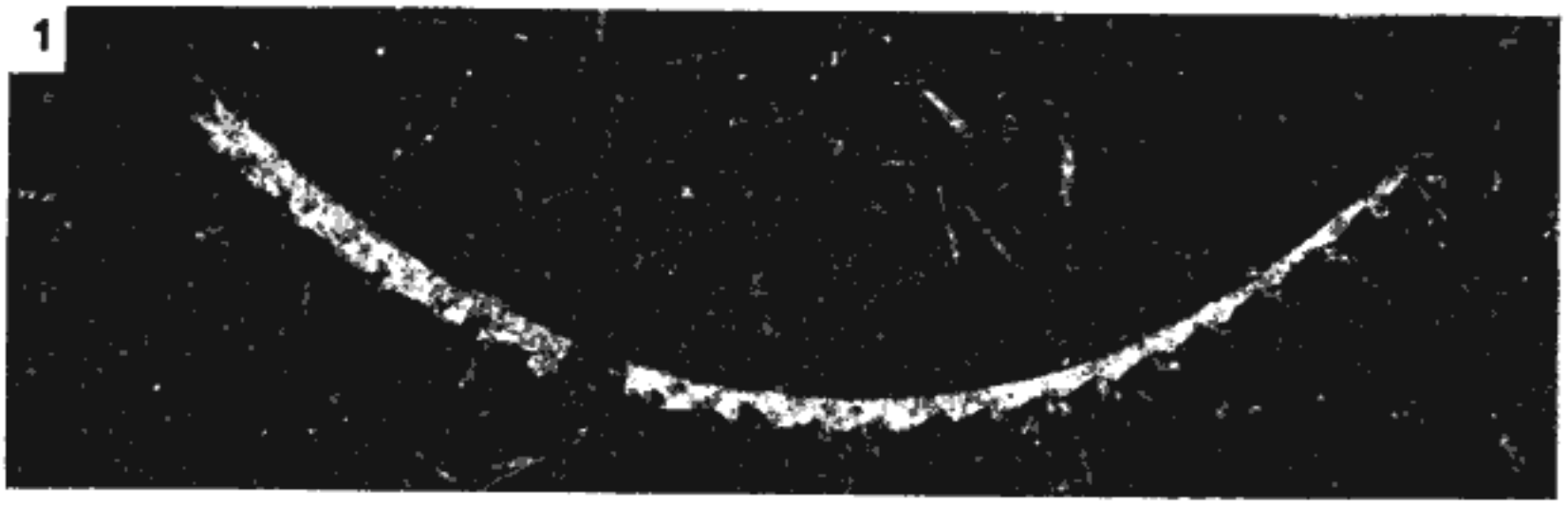

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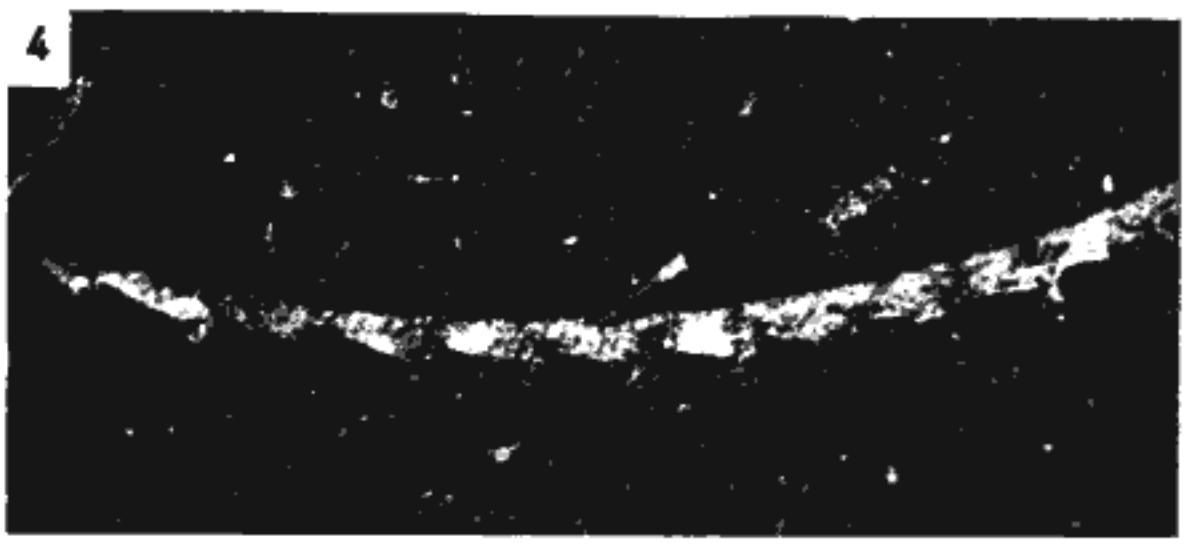

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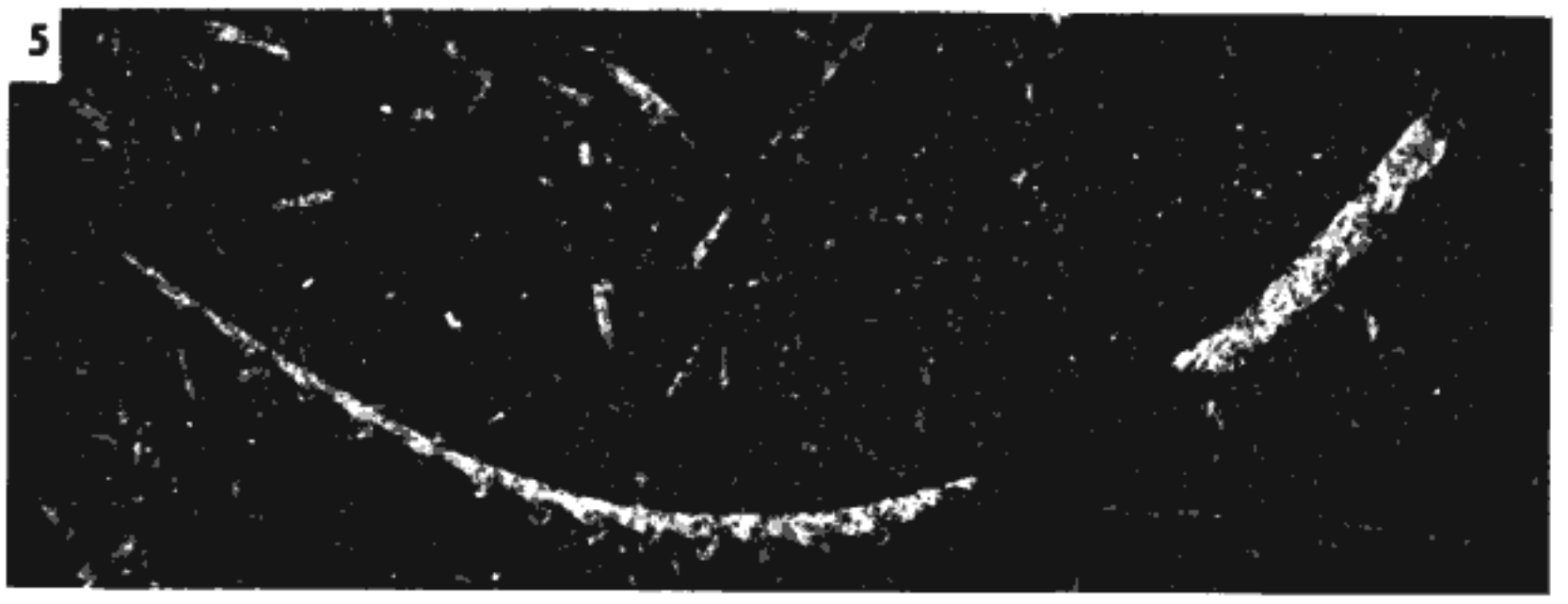
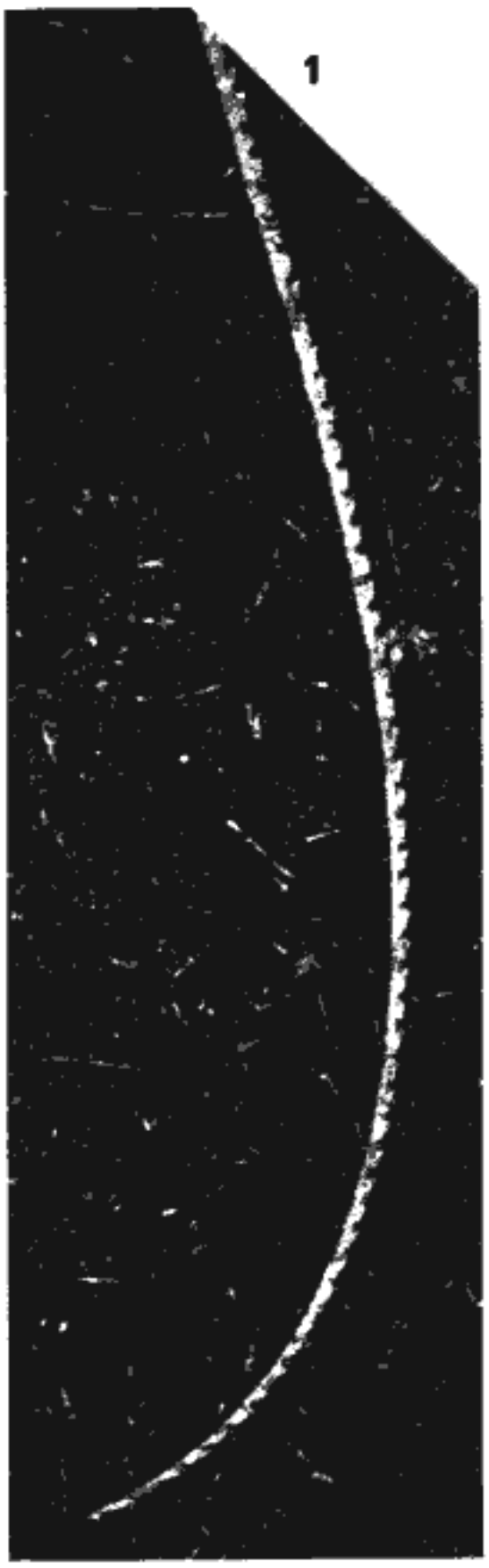
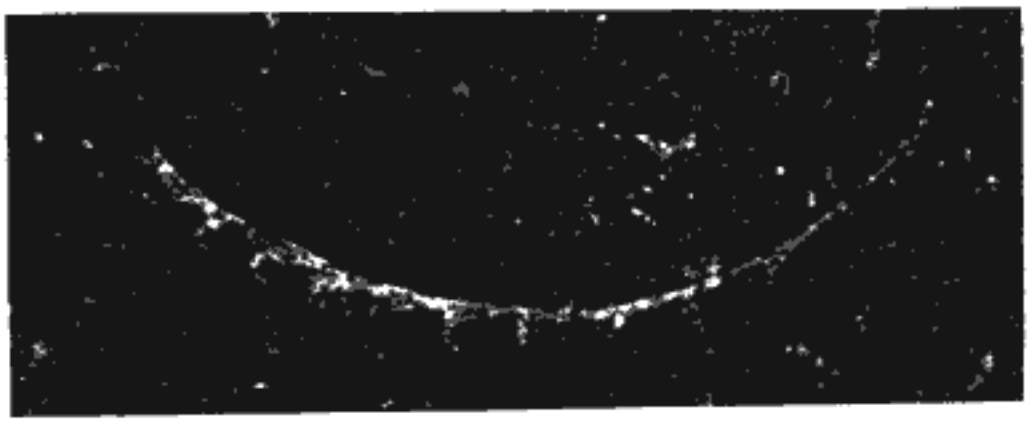
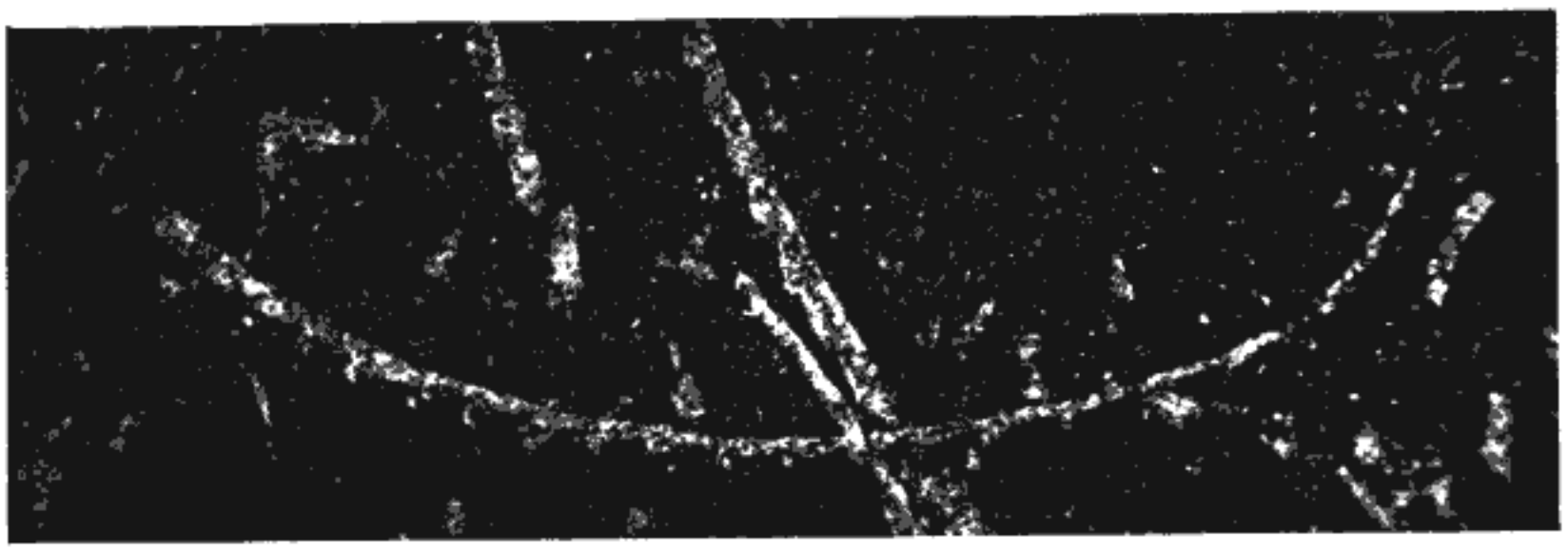
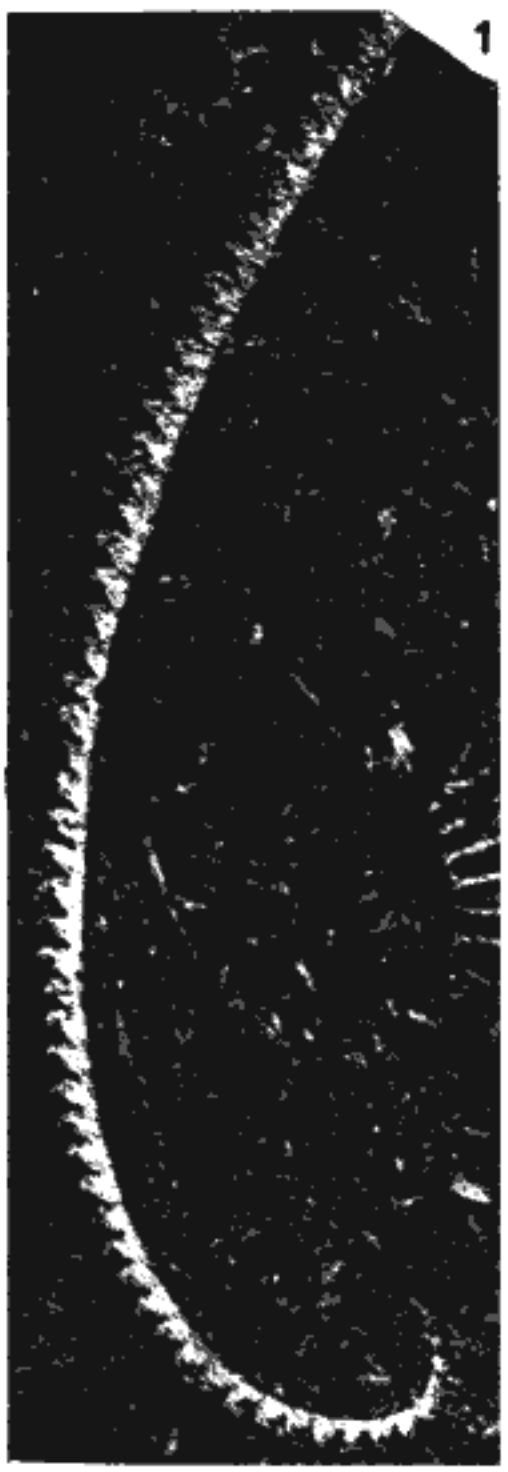


Pl. VIII





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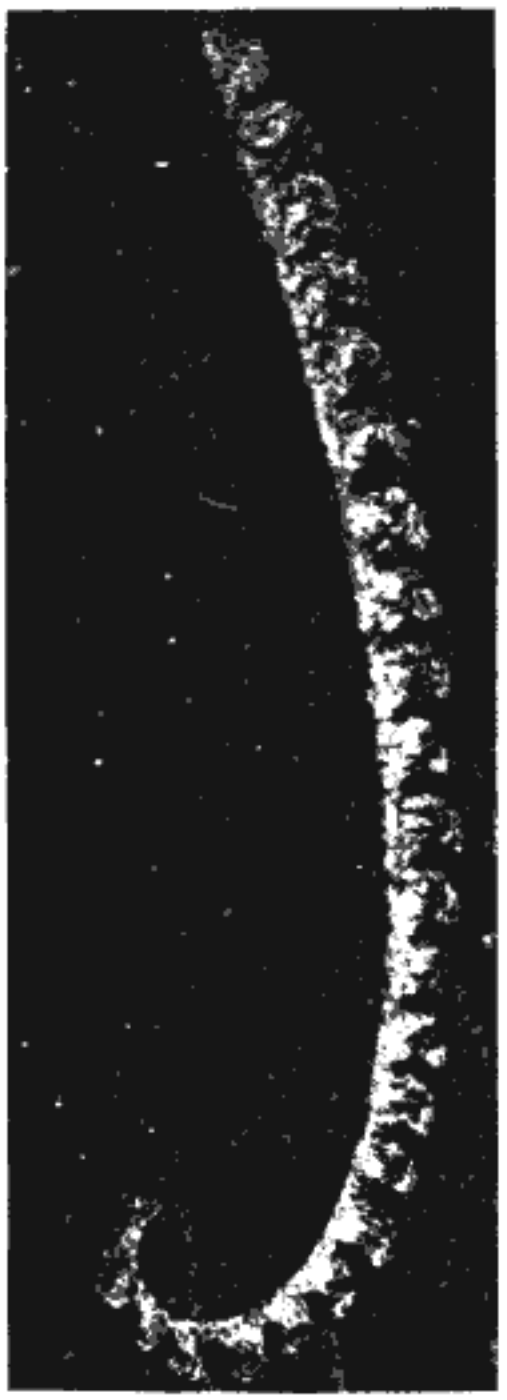
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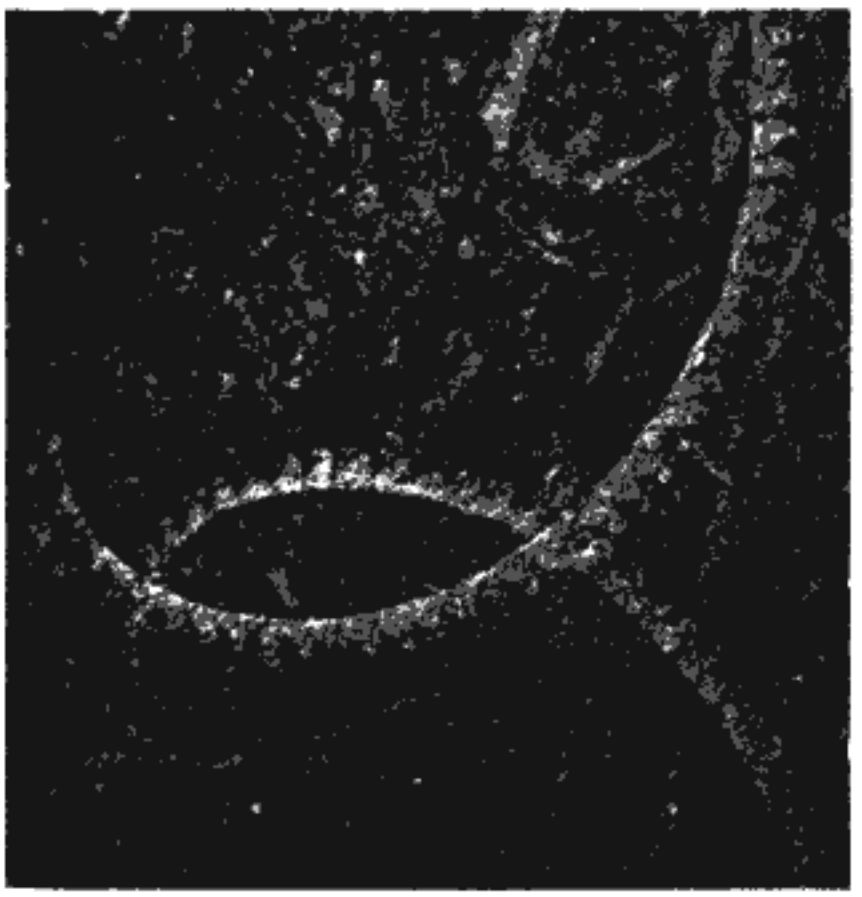
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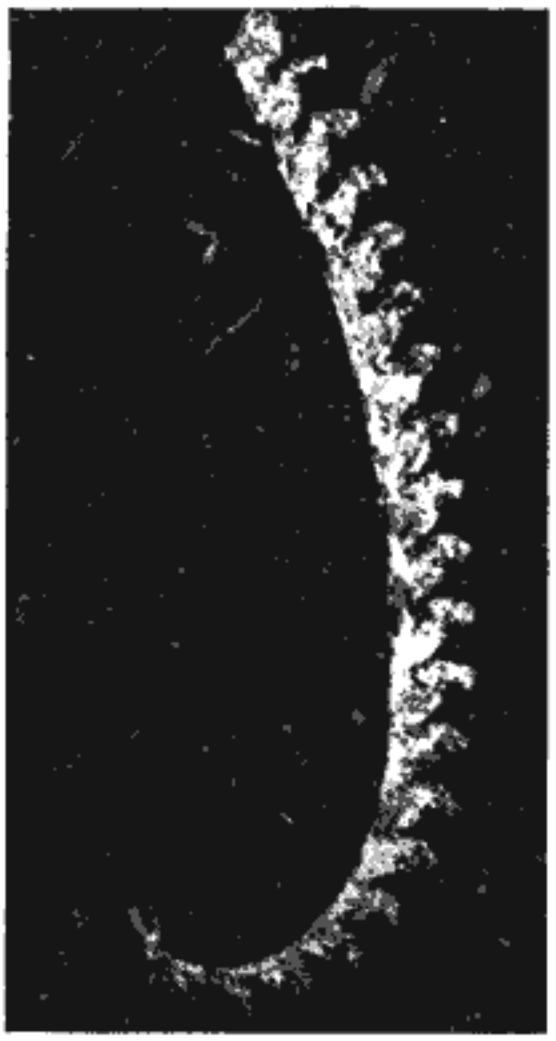
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Pl. X


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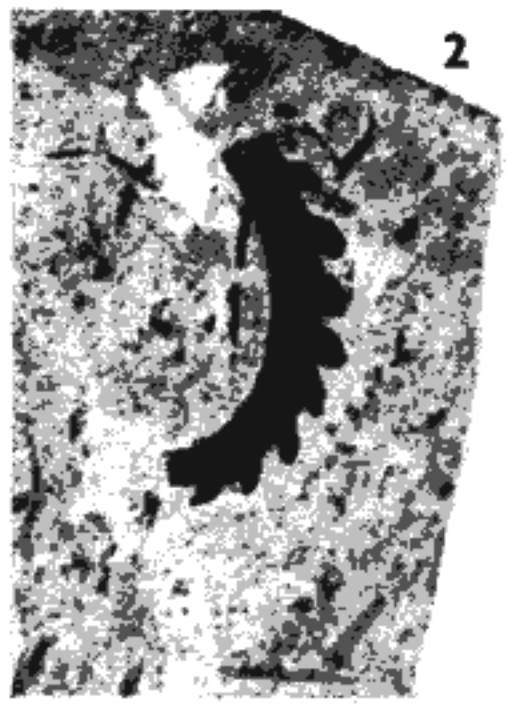
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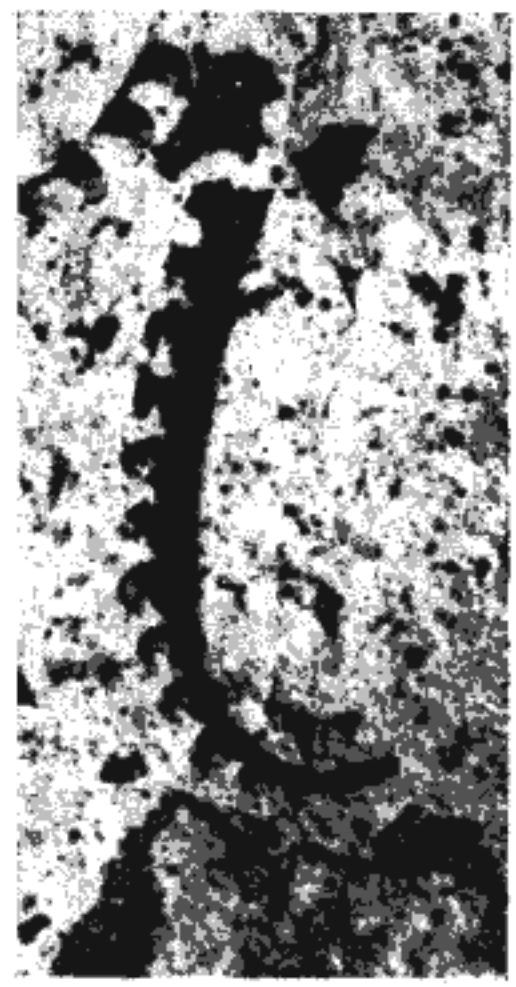
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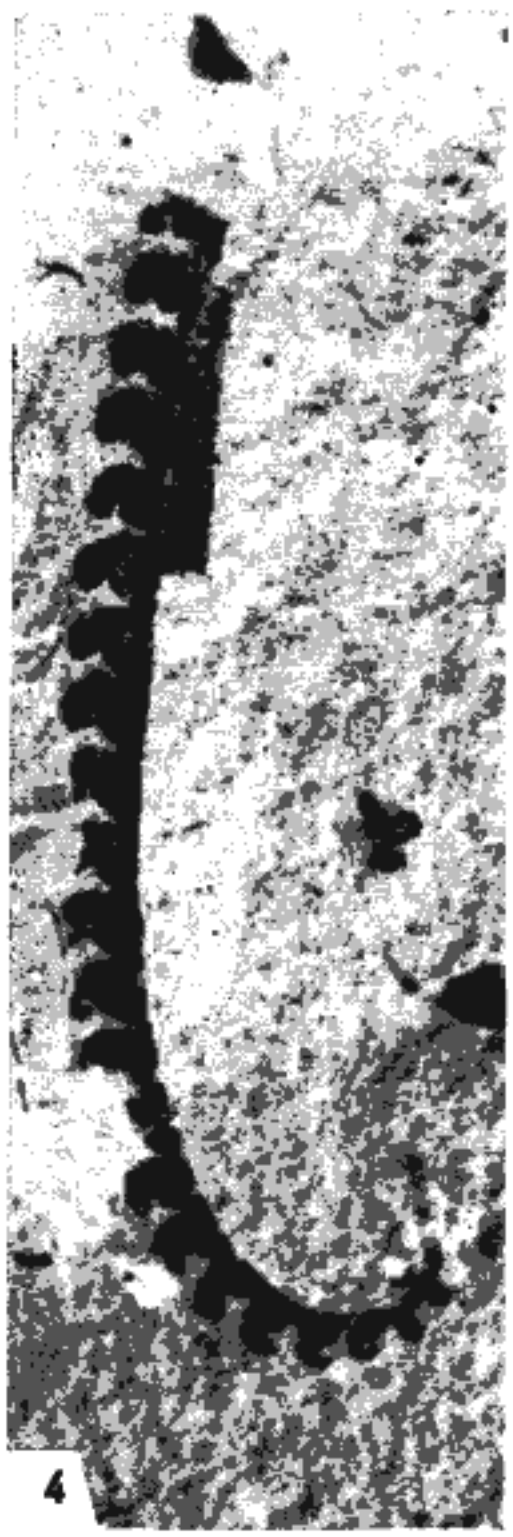
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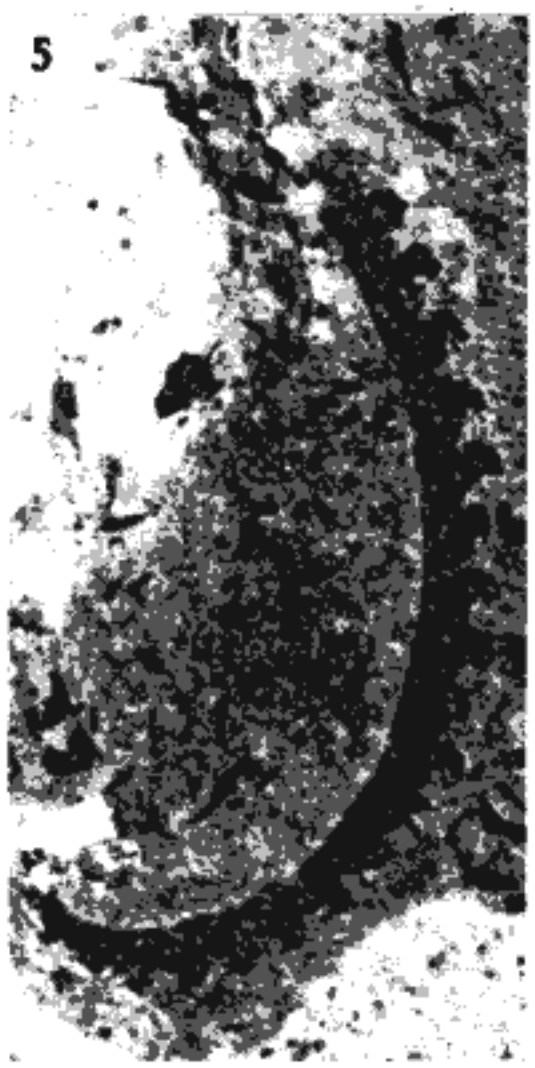
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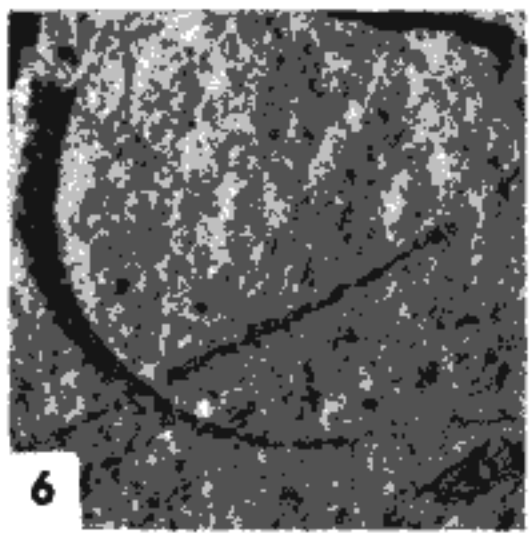
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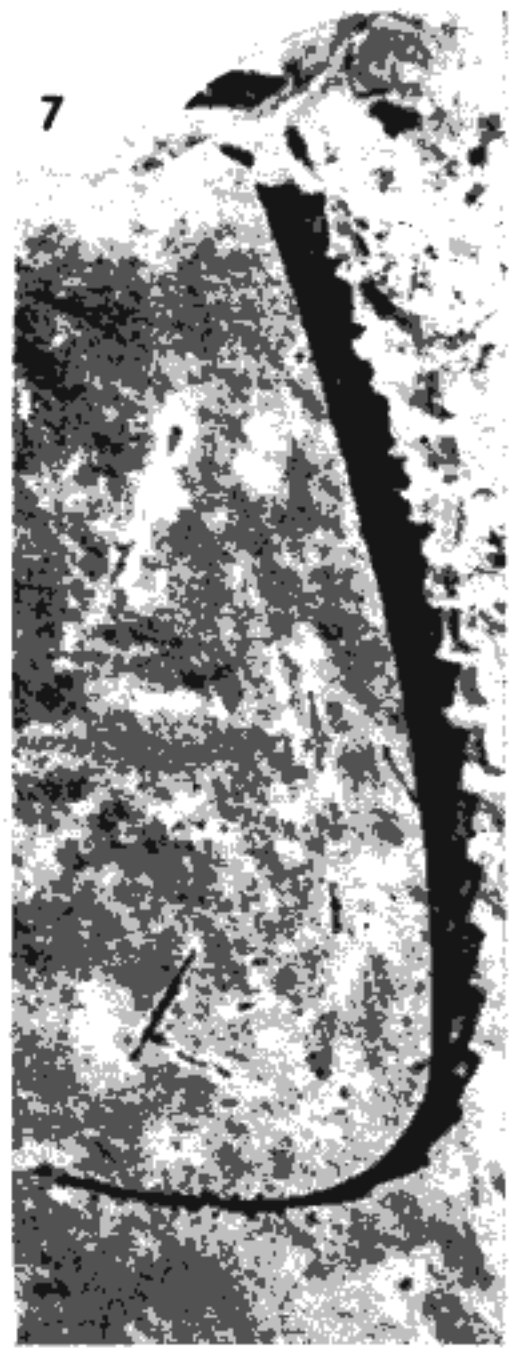
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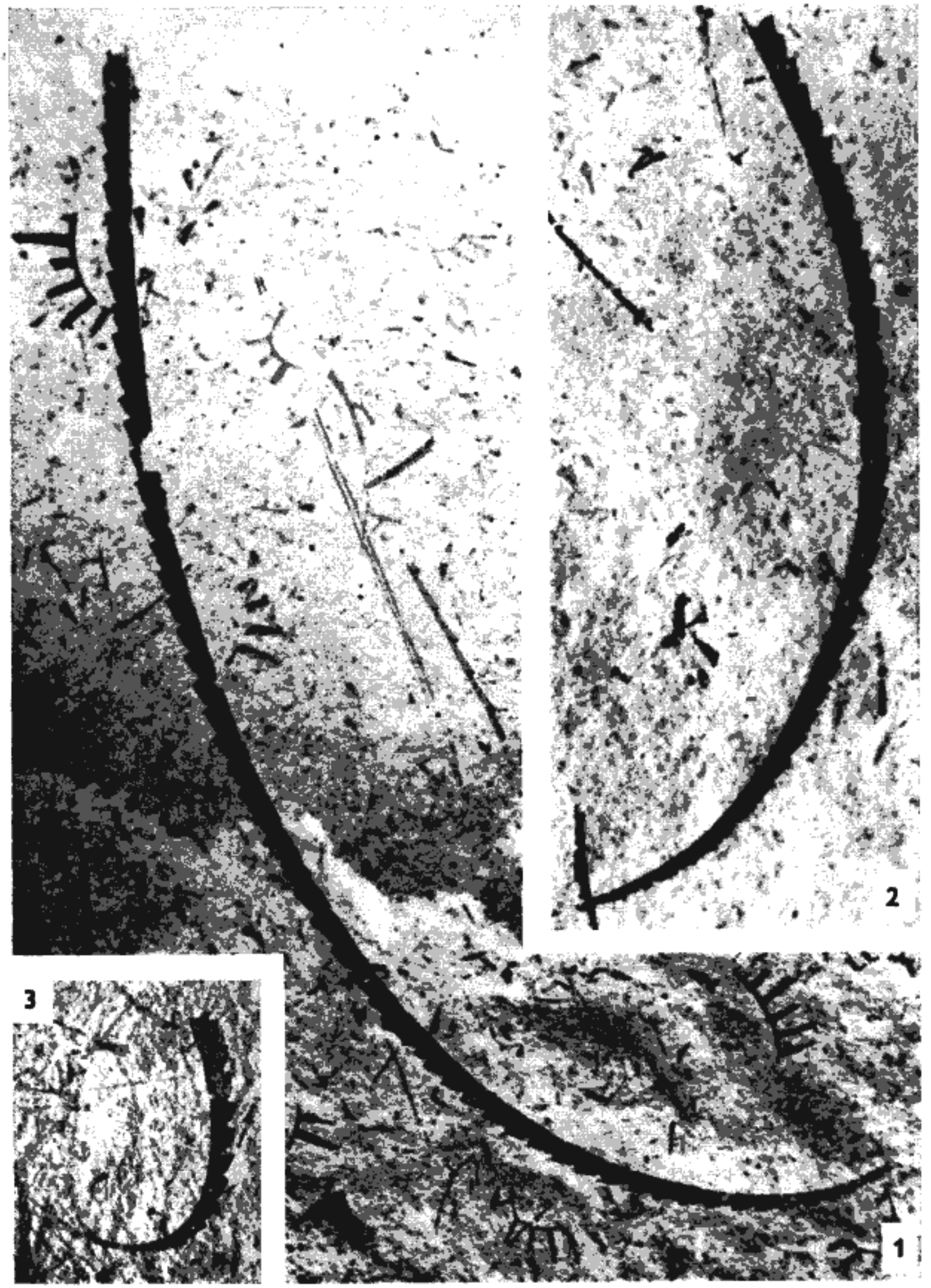
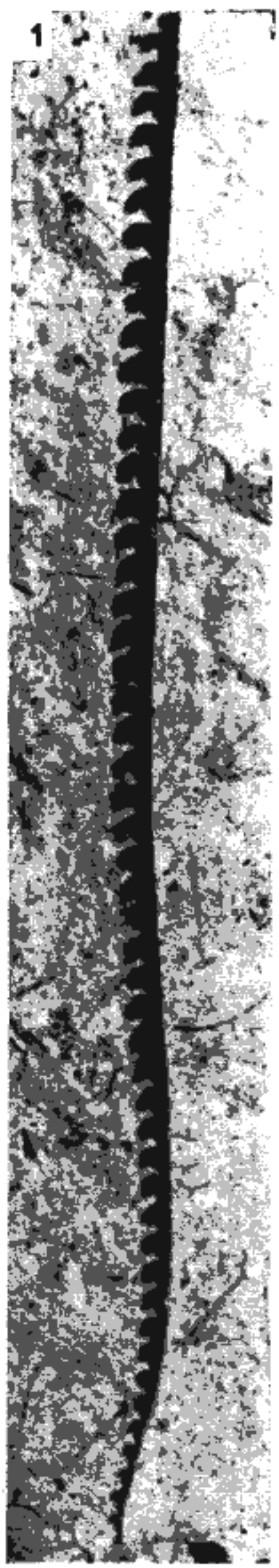


3a* • Paleontol. sv. 29 • 110-11'72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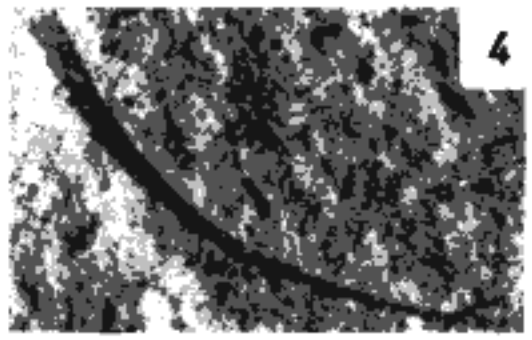
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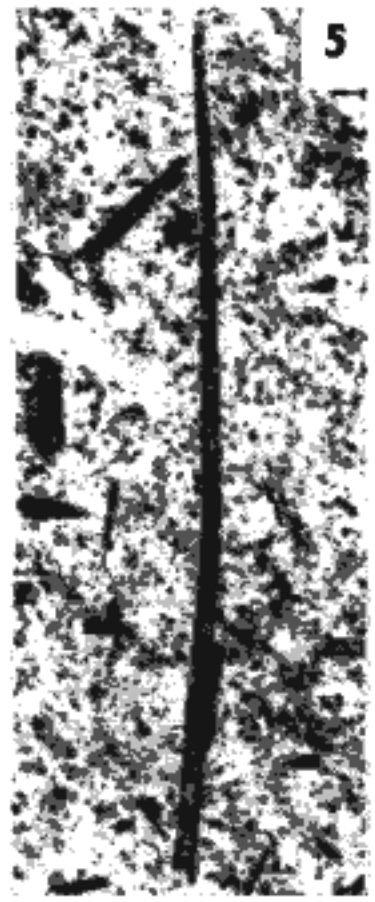
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