

The Lower Ordovician graptolites *Didymograptus balticus* Tullberg and *D. protobalticus* Mosen

JÖRG MALETZ

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The biostratigraphically important didymograptid graptolites *Didymograptus balticus* Tullberg and *Didymograptus protobalticus* Mosen are redescribed using type specimens, as well as newly discovered material from Scandinavia. It is concluded that *D. balticus* is a rare species. Its age is shown to be restricted to the early Bendigonian (Be 1–2). Its range overlaps considerably with that of the closely related but more long-ranging and common *D. protobalticus*.

Jörg Maletz, Ernst-Moritz-Arndt-Universität, Institut für Geologie und Paläontologie, Friedrich-Ludwig-Jahn-Str. 17a, D-17489 Greifswald, Germany.

Tullberg (1880) gave the name *Didymograptus balticus* to a robust didymograptid with proximally declined stipes. His material is from the Lower *Didymograptus* shale of Scania in southern Sweden. Later, the species became the name-giver of the *D. balticus* Zone of Scandinavia, introduced by Törnquist (1901). The zonal concept based on this species has been upheld since that time and is commonly used in the literature (e.g. Cooper & Lindholm 1990). Mosen (1937) differentiated a *Didymograptus validus* Zone below the *D. balticus* Zone. The faunas of both zones are largely identical. Lindholm (1991a) discussed the Scandinavian Hunneberg stage and described the *D. balticus* Zone as the uppermost biozone in her late Hunnebergian. She redefined the base of the *D. balticus* Zone as the level of first appearance of horizontal didymograptids of the *D. similis*/*D. constrictus* type, thus including the *D. validus* Zone of Mosen (1937). This level is slightly below the first appearance of *D. balticus* itself.

Maletz (1992a, p. 144) concluded that *D. balticus* is a rare species and that its usefulness for biostratigraphic purposes is not demonstrated. He favoured the replacement of the zone with the definition of the biozone using more common species, such as extensiform didymograptids. The same basic concept was followed by Lindholm (1991a), even though she retained the name for the biozone, but used expansograptids of the *D. similis*/*D. constrictus* group to define its base.

Lindholm (1991a) interpreted *D. balticus* and *D. protobalticus* as two stratigraphically succeeding subspecies with the transition from the older *D. b. protobalticus* seen in the lower part of the *D. balticus* Zone. The co-occurrence of both species at Mount Hunneberg in Västergötland indicates that they are largely contemporaneous. This and their morphological distinctiveness shows that they should be kept as separate species.

D. balticus and *D. protobalticus* appear in the Lower Bendigonian (Be 1), with *D. protobalticus* starting earlier.

The two species are among the oldest didymograptids known from the Lower Ordovician. The species are preceded, however, by other related species, united into a *D. balticus* group by Maletz et al. (1991). This group is established in the lower part of the *Tetragraptus phyllograptoides* Zone. The ancestors are not yet known, but may be found in the latest Tremadoc *Kiaerograptus*. Lindholm (1991b) suggested the origin of the *D. balticus* group and of *D. geometricus* from *Hunnegraptus* through the suppression of higher order stipes. The diversification of the didymograptids with its high number of species in the Bendigonian starts with *D. balticus* at a level around the Bendigonian 2, but *D. balticus* also reaches the Bendigonian 3 (Lindholm 1991a).

Systematic descriptions

Graptolite terminology as used in Cooper & Fortey (1982) and Maletz (1992b, 1994).

Repositories. – GPI: Institut und Museum für Geologie und Paläontologie der Universität Göttingen, Germany. LO: Lund type collection, Dept. of Geology, University of Lund, Sweden. PMO: Paleontologisk Museum Oslo, Norway. SGU: Sveriges Geologiska Undersökning, Uppsala, Sweden.

Family Dichograptidae Lapworth, 1873

Genus *Didymograptus* M'Coy in Sedgwick & M'Coy, 1851.

Type species. *Graptolithus murchisoni*, Beck in Murchison, 1839

Remarks. *Didymograptus* is a form genus including a variety of not necessarily phylogenetically related didy-

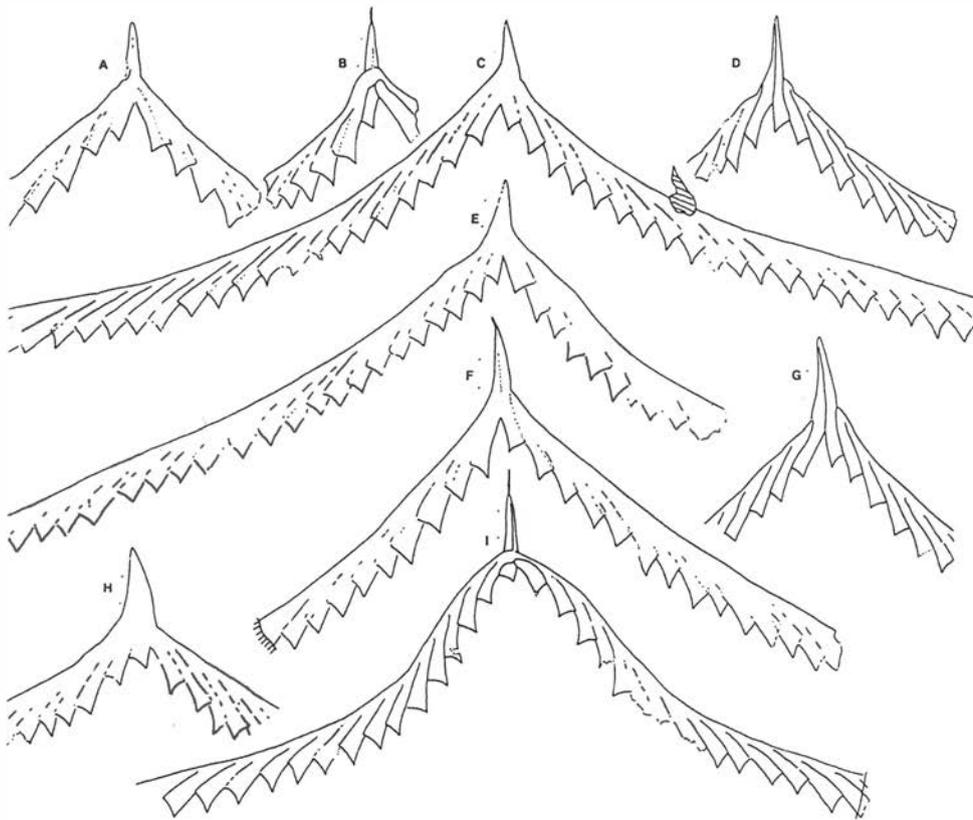


Fig. 1. *Didymograptus balticus* Tullberg and *Corymbograptus v-fractus tullbergi* (Monsen) A–H. *D. balticus*: A. LO 7130t, flattened specimen, Diabasbrottet, Hunneberg, 4.9–5.0 m. B. LO 7131t, relief in reverse view, Diabasbrottet, Hunneberg, 4.9–5.0 m. C. PMO K 495, Galgeberg, Oslo. D. PMO K 488 obverse view in relief, Galgeberg, Oslo. E. LO 342t lectotype, Kiviks–Esperöd, Scania, drawing from a latex cast. F. GPI 789-59-34A, flattened specimen, Diabasbrottet, Hunneberg. G. SGU 7960, proximal end of a large specimen, obverse view, Diabasbrottet, Hunneberg, 8.1–8.2 m, drawing from latex cast. H. PMO K 470, mature specimen with an unusually short free ventral wall of sicula, Galgeberg, Oslo; *C. v-fractus tullbergi*: I. PMO K 0484, holotype, Galgeberg, Oslo, drawing from a latex cast, reverse view. Magnification $\times 3.5$ for all specimens. The levels indicated for specimens from the Diabasbrottet and Mossebo sections in all Figs. refer to Maletz et al. (1995).

mograptids. A differentiation of the genus is beyond the scope of this article. Species not belonging to *Didymograptus* (*Didymograptus*) s. str. are called *Didymograptus* s.l. here. For preliminary information on the differentiation within the large group of *Didymograptus* s.l., see Maletz (1992a).

Didymograptus (s.l.) *balticus* Tullberg, 1880 Figs. 1A–H, 3A,D

1880 *Didymograptus balticus* n. sp. – Tullberg, pp. 41–42, pl. 2, figs. 2, 3 (non pl. 2, fig. 1 = *Corymbograptus v-fractus tullbergi*)

? 1901 *Didymograptus balticus* Tullberg–Törnquist, p. 19, pl. 2, figs. 21, 22–24 (Diabasbrottet, Hunneberg, *Didymograptus* cf. *balticus*)

non 1901 *Didymograptus balticus* Tullberg–Törnquist, p. 19, pl. 2, figs. 23, 25 (Flagabro, Scania, *Didymograptus* sp. indet)

1937 *Didymograptus balticus* Tullberg–Monsen, pp. 140–141, pl. 3, figs. 24, 27; pl. 10, figs. 2, 5

? 1939 *Didymograptus* aff. *balticus* Tullberg–Schmidt, p. 183, pl. 4, fig. 8

1992a *Cymatograptus balticus* (Tullberg) – Maletz, pp. 143–144, fig. 75

1993 *Didymograptus balticus* Tullberg–Toro, pp. 71–72, fig. 3:1; fig. 4:1–2

Type material. – Tullberg's (1880) description of *Didymograptus balticus* was accompanied by three figures. All his specimens are preserved in the type collection of the

Geological Department of the University of Lund and are referred to as syntypes here. The type numbers are LO 341–343t. A holotype was never selected from the type series. LO 342t is here selected to be the lectotype for *D. balticus* Tullberg. The specimen is flattened, showing no details of the proximal development (Fig. 1E). The outline of the specimen, however, is distinctive and is in accordance with the known species concept used by Scandinavian workers in the past. The specimen LO 341t (Tullberg 1880, pl. 2, Fig. 1) is excluded from the species and referred to as *Corymbograptus v-fractus tullbergi* (Monsen). This species, formerly called *Didymograptus v-fractus tullbergi*, was transferred to *Corymbograptus* and its proximal structure was discussed in detail by Maletz (1994). The holotype of *C. v-fractus tullbergi* is here refigured for comparison as Fig. 1I.

Further investigated material. – Monsen (1937) figured four specimens from the Tøyen shale of the Oslo Region, Norway (PMO K470, K486, K488, K495). All specimens came from the Galgeberg locality, collected by Otto Herrmann. Of these specimens, only one (PMO K488, Fig. 1D herein) is preserved in some relief, showing the obverse view in detail. All the others are flattened films of silvery, shining periderm material (Figs. 1C, H). One further specimen comes from Tøyen in Oslo (GPI T190) not shown here.

A few specimens were collected from Diabasbrottet, Hunneberg Mountain, Västergötland, Sweden. Here the specimens were found in the lower part of the Tøyen

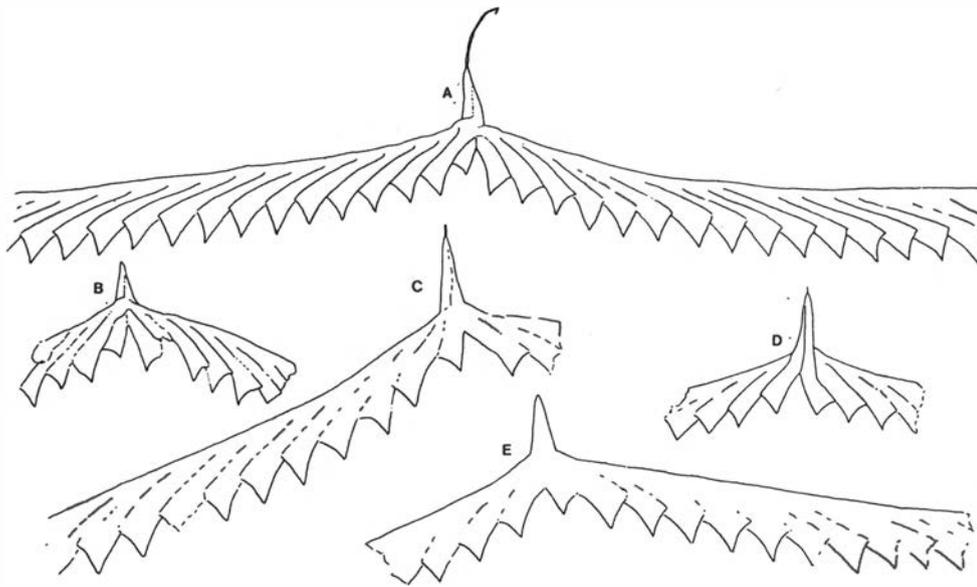


Fig. 2. *Didymograptus protobalticus* Mønst. A. SGU 7955, Diabasbrottet, Hunneberg, 4.1–4.2 m, showing the typical rhabdosome form. B. LO 7132t, Diabasbrottet, Hunneberg, 4.1–4.2 m. C–E. GPI 798-59-34A, three specimens associated with *D. balticus* (Fig. 1F). D is preserved as a mould in obverse view, drawing made from latex cast. All specimens come from Diabasbrottet, Hunneberg, Västergötland. Magnification A $\times 4$, B–E $\times 5$.

shale. Most specimens show few structural details, but some are preserved in full relief and reveal the proximal structures in obverse and reverse views. One specimen from Diabasbrottet (GPI 798-59-34A) occurs on a slab associated with *D. protobalticus* and *D. cf. demissus*. The exact horizon of this specimen is not known. The graptolite ranges in the Diabasbrottet section are given by Maletz et al. (1995).

Diagnosis. – A robust declined didymograptid with a characteristic very long and slender sicula and a comparatively deep indentation between the sicula and $th\ 1^1$. Crossing canals around the mid-length of the sicula are slender. The stipes are slender with a thecal overlap of about 50%.

Description. – The rhabdosome is declined with an initial angle of about 80–90°. Distally, it flexes outwards to include an angle of approximately 140–150°. The stipes have a uniform width of 1.7–1.9 mm. Their length reaches more than 40 mm. There are 8–10 thecae in 10 mm. The thecae are simple dichograptid without any elaborations. They show a low inclination of 16–20°, rarely up to 25°. Higher angles at thecal apertures are likely to be due to preservational aspects. The thecal apertures are straight, without any sign of a rutellum.

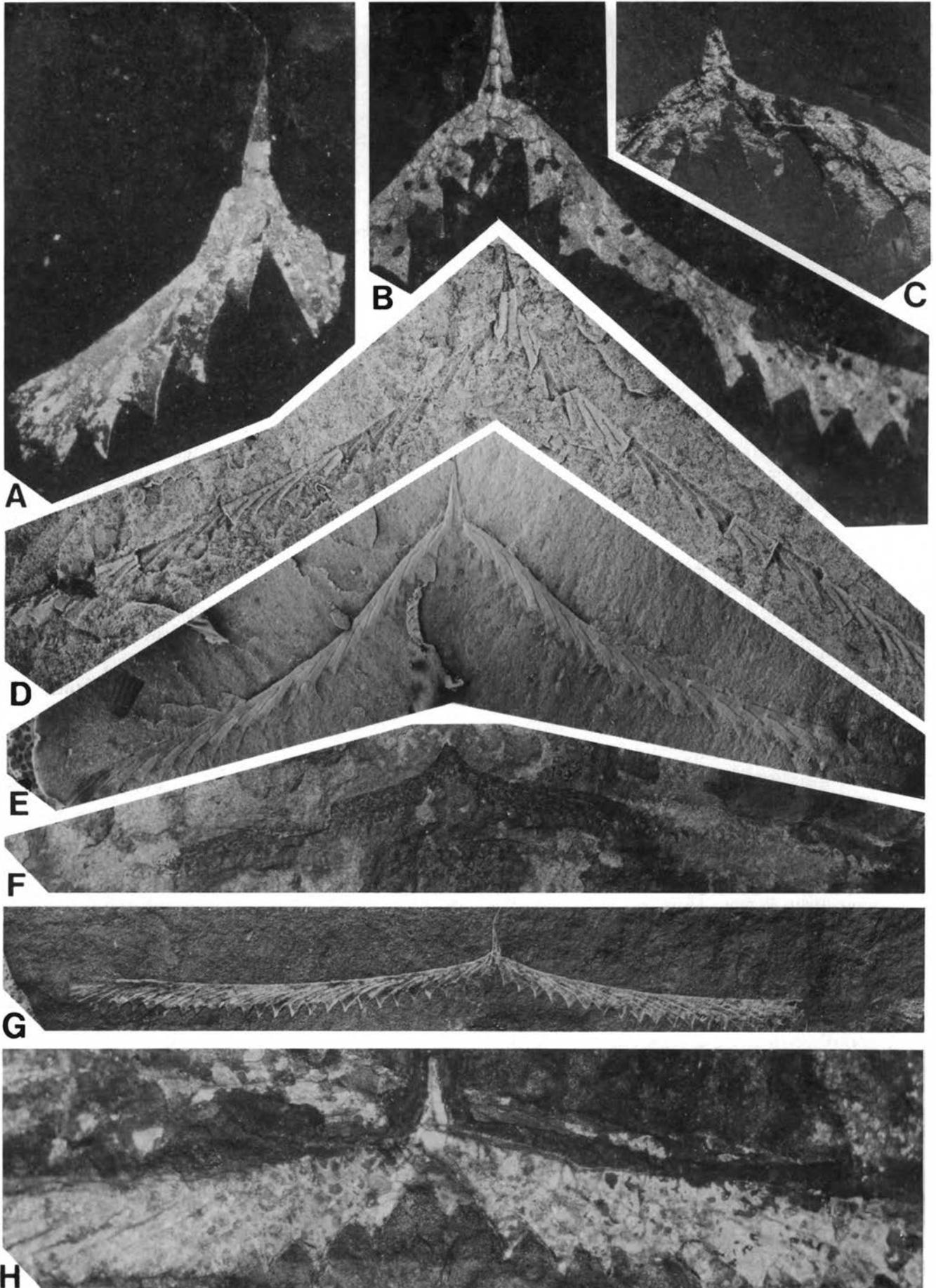
The proximal development is known in relief in reverse and obverse views (Figs. 1B, D, G, 3A, D). It is isograptid dextral. The reverse view of *D. balticus* (Fig. 1B, 3A) shows a fairly wide first crossing canal, growing obliquely downwards and following the dorsal side of the sicula. The second crossing canal is much more slender, reaching only about one third of the width of the other. A short isograptid suture, measuring up to 0.5 mm, is invariably found. The crossing canals grow obliquely downwards from their origins, building up an angular structure.

The sicula has a length of 4.3–4.8 mm, forming a long slender cone, only slowly widening towards the aperture.

A longer nema has not been found in any specimen, indicating that it may frequently be broken off (Fig. 1B, F). The stipes diverge from the sicula at about its mid-length. The origin of $th\ 1^1$ is high on the sicula, ca. 0.3–0.4 mm below its apex. It is not possible to decide whether it is in the pro- or metascula. The indentation between the sicula and $th\ 1^1$ is deep and narrow, showing the ventral free length of the sicula to be up to 1 mm long. This character gives a conspicuous appearance to the proximal part.

Associated graptolites. – *Baltograptus vacillans* (Tullberg) on PMO K 495. *D. protobalticus* Mønst., *D. cf. demissus* Törnquist on GPI 798-59-34A. *B. vacillans* (Tullberg), *Clonograptus multiplex* (Törnquist), *Paradelograptus? subtilis* (Törnquist), *Tetragraptus amii* Elles & Wood. Only species which are actually associated with *D. balticus* on the investigated slabs are cited.

Remarks. – Especially when poorly preserved, specimens of *D. balticus* can readily be confused with *C. v-fractus tullbergi* (Mønst. 1937), which has similar dimensions. *D. balticus* can be distinguished by a longer sicula and a more downwardly directed growth of the proximal thecae. The rhabdosomal form is distinctly declined, never truly deflexed. The dorsal side of the stipes of *C. v-fractus tullbergi* is concave–convex (Figs. 1I, 3E), but only concave in *D. balticus*. The free ventral part of the sicula is generally much longer in *D. balticus*, showing a deeper and narrower indentation between the sicula and $th\ 1^1$. In *C. v-fractus tullbergi*, $th\ 1^1$ diverges closer to the sicular aperture and bends more strongly outwards initially. The crossing canals in *C. v-fractus tullbergi* grow in a wide arch, forming a smoothly rounded structure. The stipes are more slender initially and widen considerably in *C. v-fractus tullbergi*. They reach their full width only below their deflection, reminiscent of the stipe growth in *Pendeograptus fruticosus*.



The specimens described by Törnquist (1901) from the Hunneberg Mountain are more slender, with a shorter sicula measuring 3 mm. They are here excluded from the species and called *D. cf. balticus*. The exact level from which the specimens come is not known. They differ from the common Hunneberg species *Corymbograptus* (?) *vicinatus* (Monsen 1937) through a distinctly declined rhabdosome and a long, free ventral side of the sicula. The main difference to *D. balticus* can be seen in the shorter sicula, being closer to that in *D. protobalticus*. *D. protobalticus*, however, has a more horizontal rhabdosome form.

C. (?) vicinatus shows strongly deflexed rhabdosome forms (Fig. 3B), with a sicula measuring about 3 mm. The indentation between sicula and th¹ is short, as is the ventral free wall of the sicula. The species may be closely related to *C. v-fractus tullbergi*.

Material described as *D. balticus* from Flagabro, Scania (Törnquist 1901, pl. 2 figs. 23, 25) shows a short sicula (ca. 2.5 mm) and a slightly declined rhabdosome. The proximal development is obscure. The specimens may not be related to the *D. balticus* group.

Distribution. – *D. balticus* first occurs in the Diabasbrottet section at 4.9–5.0 m (Maletz et al. 1995, Fig. 1), about 100–110 cm above the Upper *Planilimbata* Limestone band, comparable to the nodule layer indicated by Tjernvik (1956, Fig. 5) separating his intervals F and G. This limestone layer actually is a continuous limestone band (Tjernvik & Johansson 1980, p. 186). The youngest specimens of *D. balticus* are found at 8.1–8.2 m level in the uppermost shales, in which the graptolites are well enough preserved to be determined with certainty. The shales directly below the dolerite are heated and graptolites are too poorly preserved for specific identifications. As the shales are cut off by the dolerite at all Hunneberg localities, the top of the range of *D. balticus* may not have been reached.

D. balticus must be regarded as a rare species, discovered in a few localities only. It is known from Scania (Tullberg 1880; Tjernvik 1960; Lindholm 1981), the Hunneberg Mountain, Västergötland (Maletz 1992a) and Galgeberg, Oslo, Norway (Monsen 1937). In the Tøyen section in Oslo, only a single, incomplete specimen of *D. balticus* was discovered in the interval 10.04–10.25 m (Maletz 1992a, p. 143). The description of the *D. balticus* Zone from the Fågelsång boring (Hede 1951) is rejected by Lindholm (1991b), who claims the beds to be of latest Tremadoc to early Hunnebergian age, no younger than

the *Kiaerograptus supremus* Zone. *D. balticus* was not mentioned from the boring by Hede (1951), who described the *D. balticus* Zone from the core based on other graptolites. *D. balticus* is also distributed and used as a zonal index in parts of the Baltic countries (Kaljo 1974; Obut & Sennikov 1976). Specimens from this area have never been figured, however, and the identity is unclear. Modlinski (1973) lists 31 species from the *D. balticus* Zone of Poland, including *D. balticus*. Descriptions or figures of the material have never been published, however.

A specimen of *D. aff. balticus* (Schmidt 1939) from the Phycodes Quartzite of Thuringia is so poorly preserved that it cannot be included with this species with certainty. The specimen could be a fragment of a dichograptid species, as the sicula is not clearly seen.

A record from Argentina (Toro 1993) is the only indication that *D. balticus* may be more widespread. The species was found in the Acoite Formation of the Quebrada del Rio Cajas, Jujuy together with *Acrograptus filiformis*.

A record of *D. balticus* from the Chewtonian of Australia (Harris & Thomas 1938, fig. 35) seems to be based on a misidentification. Thomas (1960) quoted the specimen as *D. cf. balticus*. VandenBerg & Cooper (1992, p. 73) only noted that the species is not well documented in Australasia. In fact, no certain specimens of the *D. balticus* group have ever been found in the area.

D. balticus is restricted to strata comparable to the Bendigonian 1–3 or from the upper part of the range of *T. approximatus* to the lower *Pendeograptus fruticosus* interval. *D. balticus* is preceded by *D. protobalticus*, but the biostratigraphic range of both species overlaps considerably.

Didymograptus (s.l.) *protobalticus* Monsen, 1937 Figs. 2A–E, 3C, F–H

1933 *Didymograptus patulus* (J. Hall) – Elles, p. 100, fig. 9

1937 *Didymograptus protobalticus* n. sp. – Monsen, pp. 138–140, pl. 3, figs. 2, 3, 40; pl. 9, fig. 5

1979 *Didymograptus protobalticus* Monsen – Jackson, p. 28, fig. 4a–c

cf. 1988 *Didymograptus (Expansograptus) latus* T. S. Hall – Williams & Stevens, pp. 48–49, pl. 12, fig. 14; text figs. 34A–H.

1991 *Expansograptus protobalticus* (Monsen) – Palmer & Rickards, pl. 96 (no description)

1992a *Cymatograptus protobalticus* (Monsen) – Maletz, pp. 142–143, figs. 72/3; 74/1–12; 54/1

Fig. 3. A. *Didymograptus balticus* Tullberg, 1880, LO 7130t, reverse view, flattened, Diabasbrottet, 4.9–5.0 m, × 10. B. *Corymbograptus* (?) *vicinatus* (Törnquist 1901), LO 7133t, Diabasbrottet, Hunneberg, 4.2–4.3 m, obverse view, flattened, × 10. C. *Didymograptus protobalticus* Monsen, 1937, LO 7132t, Diabasbrottet, Hunneberg, 4.1–4.2 m, partial relief, reverse view, × 10. D. *Didymograptus balticus* Tullberg, 1880, SGU 7960, Diabasbrottet, 8.1–8.2 m, latex cast of a specimen in obverse view, preserved as a mould, × 5. E. *Corymbograptus v-fractus tullbergi* Monsen, 1937, PMO 59957, Ensjö teglverk, Oslo, Norway, coll. J. Kiaer, 1909 latex cast of a specimen preserved as a mould, obverse view, partial relief, × 5. F. *Didymograptus protobalticus* Monsen, 1937, SGU 7910, Mossebo, 9.7 m, flattened specimen with poorly preserved proximal end, showing more strongly deflexed proximal part of the rhabdosome, × 2.3. G. *Didymograptus protobalticus* Monsen, 1937, SGU 7955, Diabasbrottet, 4.1–4.2 m, flattened specimen, reverse view, × 3; H. *Didymograptus protobalticus* Monsen, 1937, LO 7134t, Diabasbrottet, 4.6–4.7 m, mould in reverse view, × 10.

Type material. – K0955 (holotype) Galgeberg, K0952, K0953, K0639 (paratypes). All specimens are from the Galgeberg locality in Oslo, Norway, where the species occurs in the *Tetragraptus approximatus* Zone (Monsen 1937).

Further investigated material. – Numerous specimens from Diabasbrottet and Mossebo, Hunneberg, Västergötland, where the species is common in many layers, occurring with a variety of associated species. Two specimens from the interval 8.39–8.41 m of the Tøyen section, Oslo (Erdtmann 1965; GPI T134–136). Several specimens from the basal Tøyen shale at Hovland Farm, Modum, Norway.

Diagnosis. – A robust subhorizontal to slightly declined didymograptid with a characteristic long and slender sicula and comparatively deep indentation between the sicula and th^1 . The crossing canals are placed around the mid-length of the sicula.

Description. – The slender sicula is about 3.0–3.3 mm long, rarely longer, slowly widening towards its aperture and bending slightly towards stipe two. A short nema is seen in many specimens. The sicular aperture is straight, not showing any indications of a rutellum. The supradorsal length of the sicula is between 1.4 and 1.6 mm. The origin of th^1 is high on the sicula, at about 0.3 mm below its apex, possibly in the lower part of the prosicula. The ventral free length of the sicula is up to 1.5 mm in mature specimens, but much shorter in juveniles, indicating growth even when the stipes are developed to a certain extent.

The proximal development is isograptid, dextral. The crossing canals are placed at about the mid-length of the sicula. Both crossing canals are initially directed downwards, with the second crossing canal somewhat more slender than the first one. A short isograptid suture can be seen below the isograptid arch, reaching 0.3–0.4 mm in length.

The thecae are slender, widening slowly towards their apertures. Only a slight indication of thecal rutelli is seen. The stipe width is 1.6–1.8 mm across the first theca on each side, and quickly reaches a maximum of 1.9–2.2 mm. The thecae number 9–10.5 in 10 mm. The thecal inclination measures 20–22° initially and reaches apertural values of 40–45°. The high apertural values may in parts be due to flattening of the thecae and can be less in true relief specimens. The growth of the stipes seems to be unrestricted, as fragments up to 80 mm long were found. The form of the rhabdosome varies considerably. Some specimens are almost horizontal, others are slightly deflexed near the proximal end (Fig. 3F). Within a certain population, however, the variation is less strong.

Associated graptolites. – *Didymograptus demissus* Törnquist, *Didymograptus balticus* Tullberg, *Baltograptus geometricus* (Törnquist), *B. vacillans* (Tullberg), *Expanso-*

graptus holmi (Törnquist), *Tetragraptus amii* (Brogniart), *Tetragraptus approximatus* Nicholson, *Clonograptus multplex* (Törnquist). Only species which are actually associated with *D. protobalticus* on the investigated slabs are cited.

Remarks. – *D. protobalticus* is widely distributed in Scandinavia, where it is often common. In the Diabasbrottet section it first appears at 4.0–4.1 m (Maletz et al. 1995), in the interval 10–20 cm above the Upper *Planilimbata* Limestone and reaches up to at least 5.0–5.1 m. In Norway this time interval seems to be poorly developed and only few specimens are found in the material from the Tøyen section. Therefore a clear range cannot be given. In the Hovland Farm section in Modum, Norway (Lindholm 1991a; Wandås 1982; Wöltje 1989), the species is restricted to the interval 0–56 cm at the base of the Tøyen shale, immediately followed by the *D. balticus* Zone (Lindholm, pers. comm.). This is also documented by Lindholm (1991a, Figs. 3, 4), who called the section Vikersund and indicated the *D. balticus* Zone to be 1.34 m thick. Lindholm (1992) documented the presence of the *D. balticus* Zone from the borings Gislövshammar-2 and Hällekis-1, even though specimens of *D. protobalticus* and *D. balticus* are rare and other species have been used for identification of the zone.

A few specimens of *D. protobalticus* were recorded from the Lower Ordovician of the Skiddaw Inlier of Britain (Jackson 1979) at the localities Burn Tod Gill and Frozenfell Gill. At Frozenfell Gill *Didymograptus rigoletto* was also discovered, a species which overlaps biostratigraphically with *D. protobalticus* in Scandinavia (Maletz et al. 1991). A very similar form that may be identical to *D. protobalticus* has recently been recognized in western Newfoundland, where it was identified with *D. latus* T. S. Hall by Williams & Stevens (1988). The specimens differ from *D. protobalticus* mainly in that they have a much higher thecal inclination. No differences are seen in the proximal structure and dimensions of the horizontal rhabdosomes of this form.

The relationship of *D. balticus* and *D. protobalticus*. – The proximal structures of both species are virtually identical. Differences can be seen in the length of the sicula and in the general form of the rhabdosome. Both species have a long and slender sicula with the crossing canals placed around the mid-point of the sicula. Sometimes the supradorsal part of the sicula is slightly shorter than the infradorsal part in both species (Fig. 2B: *D. protobalticus*). The thecae are long with high overlap and are inclined at angles of about 25°, with the apertures slightly pointed. *D. balticus* is distinguished from *D. protobalticus* by its longer sicula, measuring 4.3–4.8 mm, and a generally more strongly declined proximal part. The sicula in *D. protobalticus* is only 3.0–3.3 mm long, and the rhabdosome is subhorizontal to horizontal. Interestingly, the stipe width is identical in *D. protobalticus* and *D. balticus*. Therefore *D. balticus* shows a

different geometry of the proximal end with a conspicuously larger supradorsal part of the sicula. Intermediate forms have so far not been discovered and both species can easily be separated. Stipe fragments of the two species cannot be distinguished.

At the Hunneberg localities the two species overlap considerably in their biostratigraphic range with *D. protobalticus* appearing slightly earlier than *D. balticus* (Maletz et al. 1995). Both forms occur together in several horizons. It is preferred here to treat them as distinct species and not as two subspecies of *D. balticus* as done by Lindholm (1991a).

D. (E.) latus sensu Williams & Stevens (1988) is very similar to *D. protobalticus*. The main difference can be seen in the higher thecal inclination and, therefore, the wider stipes. Even though the proximal development is not well seen, indications show that it may be identical to that of *D. protobalticus*. *D. protobalticus* from Scandinavia, however, never displays the high thecal inclination seen in the Newfoundland material (compare Williams & Stevens, 1988 pl. 12, fig. 14). The form from western Newfoundland may be a subspecies of *D. protobalticus*. However, little is known about its palaeogeographic and biostratigraphic distribution. The species is found in two localities only, where it occurs in the lower part of the *Tetragraptus approximatus* Zone. This level is comparable to a low level in the biostratigraphic range of *D. protobalticus* or the upper *Tetragraptus phyllograptoides* Zone (Löfgren 1993, p. 227; Lindholm 1991a).

D. protobalticus was indicated to be restricted to the deep water biotope of the Atlantic faunal province by Cooper et al. (1991), as may be true of *D. balticus* and other related species. The presence of *D. balticus* and also other Atlantic faunal elements in Argentina (Toro 1993) may indicate that this species group can be expected to turn up in further localities around Gondwana and that it may be useful for biostratigraphic purposes when faunas from these areas have been studied in greater detail.

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