LUNDS UNIVERSITETS ÅRSSKRIFT. Band. 37. Afdeln. 2. N:r 5.
KONGL. FYSIOGRAFISKA SÄLLSKAPETS HANDLINGAR. Band. 12. N:r 5.

RESEARCHES

INTO THE

GRAPTOLITES OF THE LOWER ZONES OF THE SCANIAN

AND

VESTROGOTHIAN PHYLLO-TETRAGRAPTUS BEDS

BY

SV. LEONH. TÖRNQUIST.

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LUND, 1901.
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INTRODUCTION.

By the name *Phyllo-Tetragraptus Beds* I designate a well-defined series of shaly deposits, characterized by the presence of the genera *Phyllograptus* and *Tetragraptus*, which, together with other forms of *Dichograptidæ*, make up the main stock of the fauna of this formation. In such localities of Sweden as most clearly exhibit the relation between the *Phyllo-Tetragraptus* shales and the underlying rock, the lowest zone of the former rests conformably on the *Ceratopyge Limestone*. As regards the upper limit of the series, this can, in my opinion, most naturally be drawn at a horizon below which the two above-mentioned genera die out, and above which the *Dicellograptidæ* make their appearance. The division thus defined is to be correlated with the chief mass of the *Orthoceras Limestone* of those districts in which the *Ordovician* system shows a calcareous facies. In Skåne the shaly facies is unusually well-developed, and only the lowest zone is there poorly represented. This zone, again, is well shown in Westergötland, in which province, on the other hand, the highest zones are entirely wanting. The fact that the observations on the older *Ordovician* shales of these two provinces thus complete each other, has induced me, in the present paper, to deal with their graptolite faunas conjointly. But, as indicated by the title of this paper, the descriptions of the graptolites of the highest zone will be reserved for another communication.

LIFE-ZONES.

Led by the evidences as yet brought forth, I propose to divide the *Phyllo-Tetragraptus Beds* into five zones. They are, in ascending order, as follows:

a) *Zone of Tetragraptus phyllograptoides* Linrs. mscr. All the species restricted to this zone, with the exception of *Trochograptus diffusus* Holm, seem, up to now, not to have been described.

b) *Zone of Didymograptus balticus* Tullberg. *Tetragraptus serra* Brongn., *Dichograptus 8-brachiatus* Hall, and *Didymograptus constrictus* Hall, which make already their appearance in the underlying zone, range through all the strata of this member. As far as I know, the following are confined to this zone: *Didymograptus balticus* Tullb., *D. vacillans* Tullb., and *D. filiformis* Tullb.

c) *Zone of Phyllograptus densus* Törnq. The characteristic species occurs in the greatest profusion, while it seems to be altogether wanting in the preceding zone. There are, on the other hand, several species common to both these groups.

d) *Zone of Isograptus gibberulus* Nich. Restricted to this subdivision are further *Mæandrograptus Schmalenseei* Mbg, *Didymograptus patulus* Hall, and *Azygograptus suecicus* Mbg.

Even in the region where the shaly facies is most perfectly developed, the succession of shales is, above the last-named zone, interrupted by a calcareous deposit, representing some lower strata of the *Orthoceras Limestone*. There exists, consequently, in this part of the *Ordovician* system, a hiatus in our knowledge of the development of the graptolitic fauna, and the contrast between the fauna of the next zone and those of the foregoing ones, appears more striking than would have been the case if that blanc had been filled in.

e) *Zone of Phyllograptus* cf. *typus* Hall. Many forms of *Didymograptus* occur, and the *Diprionidian* group, faintly foreshaded in the zone d, is here represented by several species.

When working out the two oldest zones in the field, I was disposed to divide them into subzones, but, having had too little opportunity of controlling the validity of these minor divisions, I think it most advisable, for the present, to confine myself to the above arrangement.

LOCALITIES OF STRATIGRAPHICAL IMPORTANCE.

Westergötland.

The lower part of the *Phyllo-Tetragraptus Beds* is only visible at the foot of Mount Hunneberg. The best exposure lies above the quarries of Mossebo, not far from the Lilleskog railway-station. Along an extent of some two kilometers is seen a series of quarries, excavated horizontally in the alum shales which constitute the highest part of the *Cambrian* system. These shales are overlain by a few strata of *Ceratopyge Limestone*, lying almost horizontally, and forming the roof of all the quarries. Upon the limestone repose then graptolitiferous shales, measuring about 10 m. in thickness. These are, again, surmounted by the great mass of *diabase* which forms the plateau of the whole mountain. As the quarries are scooped out close to one another, only leaving between them partitions necessary to support the overlying mass of rock, and, moreover, as the mountain above the entrances of the quarries forms a nearly perpendicular cliff, the graptolite-bearing shales, though clearly visible from below all along, are only accessible at very few points. They are of a black or brownish colour, and abound in fossils, which in the lower portion indicate the *zone of Tetragraptus phyllograptoides*, and, in the upper half, the *zone of Didymograptus balticus*. The same

sequence is seen above the quarries of Storeklef, the rock being, however, at that place more coarse-grained, and rather poor in fossils.

Higher zones may be studied at the Kinnekulle mountain. At the base of Martorps-klef the lower red *Orthoceras Limestone* is immediately underlain by greenish shales, interbanded with thin seams of black colour, and including graptolites characteristic of the *zone of Phyllograptus densus.* The *zone of Didymograptus gibberulus* is, accordingly, either wanting, or replaced by a portion of the *Orthoceras Limestone.* On the other hand, as the *zone of Phyllograptus densus* occupies the same geological position in Westergötland as the *Glauconite Limestone* of the Siljan district, I have, a long time ago [1]), adduced reasons for regarding these two layers as representing the same age. — Shales probably belonging to other zones are cropping out at several points of this mountain, but I regret having had very little opportunity of examining these localities.

Skåne.

The majority of exposures of *Phyllo-Tetragraptus Shales* are to be found in the south-western part of the province, where they occur as isolated patches, scattered over an area nearly coinciding with that mapped out on the sheet »Simrishamn» of the Geological Survey of Sweden. The little river Jerrestads-å has along its course cut several sections through *Cambrian, Ordovician,* and *Silurian* beds, some of which have been long known as being of paramount interest. At Flagabro, about 2 km north of Smedstorp railway-station, a succession of strata is visible in the banks and in the very bottom of the stream. Alum shales with *Dictyonema flabelliforme* Eichw. appear near the water-mill, but as we follow the course of the river, we soon find them replaced by argillaceous shales. The lowest portion of these shales are of a light greenish colour and almost devoid of fossils, but in some darker seams a few graptolite species have been found, belonging to the *zone of Tetragraptus phyllograptoides.* Upon them follow black shales including a rich fauna of graptolites. The species indicate the *zone of Didymograptus balticus*, being, for the most part, identical with those seen in the corresponding zone of Hunneberg. This zone is succeded by strata of similar shales literally crowded with specimens of *Phyllograptus densus* Törnq. They dip some few degrees to the S.S.W., so as to subside below the *Orthoceras Limestone*, which crops out a short distance fourther down the stream. The whole length of the exposure from the base of the argillaceous shales to the top of the *zone of Phyllograptus densus,* scarcely exceeds 50 metres. Immediately beneath the *Orthoceras Limestone* a band of grey or greenish shales may be observed. From their position one might suppose them to represent the *zone of Isograptus gibberulus*, but, having found only fragments of graptolites in them, I am unable, at present, to determine their systematic place. — Near the

[1]) Törnquist, S. L., Några komparativt-geologiska anteckningar från en resa i Vestergötlands silurområde sommaren 1883; Geol. Föreп:s i Stockh. Förhandl. Bd. VI, 1883; p. 682—684.

quarries of Komstad, 1,5 km east of this locality, the said zone is well shown. In a ditch dug from one of the quarries, the limestone is seen reposing on grey or greenish shales with *Didymograptus patulus* HALL, *Mæandrograptus Schmalenseei* MBG, and other species characterizing the *zone of Isograptus gibberulus*. Easier of access is, however, an exposure between Killeröd and Gårdlösa, described by MOBERG several years ago, and in the following designated as Killeröd.

Passing down the same stream from the Neckebo Mill, 0,7 km to the south of Jerrestad railway-station, small and disconnected outcrops of *Phyllo-Tetragraptus shales* are observed in the southern slope of the river-valley, other parts of the *Ordovician* and *Cambrian* systems being also exhibited in the same slope. I have here seen all the zones lying below the *Orthoceras Limestone*, with the exception of the oldest one, but, owing to small landslips, the exposures change their appearance from time to time.

The lowest zone of the group has been found in a small exposure south of the promontory called Gislöfshammar.

The *zone of Phyllograptus* cf. *typus* is only known in sitû at one locality, viz. at Fågelsång, 8 km east of Lund. In the old quarry this zone rests immediately upon sheets of *Orthoceras Limestone*, while, at another point close by, it is seen surmounted by the lowest portion of the *Dicellograptus Beds*.

HISTORICAL SUMMARY.

There can be no doubt that the earlier Swedish geologists, HISINGER, WAHLENBERG, and DALMAN, have seen rocks belonging to the *Phyllo-Tetragraptus Shales*, but they seem to have always considered the graptolite-bearing shales as constituting an indivisible whole. From ANGELIN's public lectures, delivered in Lund nearly fourty years ago, I know that it has not escaped this keen observer that these beds contain different graptolite faunas, but in his writings no suggestion to that effect is given.

In 1865 the present writer [1]) gave a rough description of the section along the brook between Sularp, 7 km east of Lund, and Södra Sandby. The main mass of shales there visible were considered as younger than the *Orthoceras Limestone* quarried at Fågelsång, but no attempt at a more detailed palæontological classification could, at that time, be made, though it was suggested that such a classification might possibly be effected at some future time. Some graptolites were described, one of which, determined as *Phyllograptus typus* HALL, was stated to occur in the shaly bed immediately reposing on the *Orthoceras Limestone* of Fågelsång.

1866. J. G. O. LINNARSSON [2]) mentioned a stratum of marly shales observed at Kinnekulle, placed between the *Ceratopyge Limestone* and the *Orthoceras*

[1]) Geologiska iakttagelser öfver Fågelsångstraktens undersiluriska lager, I; Lunds Univ. Årsskrift, Tom. I.

[2]) Om de siluriska bildningarne i mellersta Westergötland, p. 7.

Limestone. On account of its stratigraphical place, he compared it with *the Lower Graptolite Shales* of Norway, and with the English *Skiddaw Slates.*

1869. Linnarsson [1]), in his important paper on the Cambrian and Silurian formations of Westergötland, gave a more detailed account of the beds in question, to which he now assigned the title »*undre graptolitskiffer*» *(Lower Graptolite Shales).* They were stated to occur in Hunneberg, too.

1875. Linnarsson [2]) expressed his opinion that the shales of Fågelsång containing *Phyllograptus* cf. *typus* could not be younger than the *Orthoceras Limestone* of that locality, but must be united with his *Lower Graptolite Shales.* Strata of such shales were recorded from a new Scanian locality, now known under the name of Neckebo.

1875. The author of this paper [3]) again proved that the shales with *Phyllograptus* cf. *typus* certainly repose *upon the Orthoceras Limestone* in the quarry of Fågelsång, but admitted that a similar bed at a neighbouring point seemed to lie *below* the limestone. For all the beds above the *Ceratopyge Limestone*, as far up as the genus *Phyllograptus* ranges, I proposed the term »*Phyllograptusskiffer*» *(Phyllograptus Shales).* I further pointed out the necessity of separating the calcareous and the slaty deposits of Sweden into two parallel series, the members of which ought to be placed side by side of one another, and not intermingled in one and the same continous series, as the practice had been till then. *Phyllograptus Shales* were, for the first time, mentioned as occurring at Flagabro.

1876. In ignorance of my denomination, Linnarsson [4]) likewise proposed the name »*Phyllograptusskiffer*» for all the shales between the *Ceratopyge Limestone* and the *Orthoceras Limestone*, still supposing that the beds with *Phyllograptus* cf. *typus* were older than the latter.

1878. After a revision of the sections in the vicinity of Fågelsång, Linnarsson [5]) agreed to my statement as to the place of the zone with *Ph.* cf. *typus* in the quarry, but advanced the opinion that the same zone also at the other point rests *upon* the *Orthoceras Limestone.* In consequence of his altered views, he now proposed provisionally to designate the shales *below* the *Orthoceras Limestone*, as far down as the *Ceratopyge Limestone*, by the earlier term »*undre graptolitskiffer*», and to unite the stratum including *Phyllograptus* cf. *typus* with the overlying graptolitiferous rock under the name of »*mel-*

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[1]) Om Vestergötlands cambriska och siluriska aflagringar; K. Vet.-Ak. Handl., Bd. 8; p. 15, 30, 57.

[2]) Anteckningar från en resa i Skånes silurtrakter år 1874; Geol. Fören. i Stockh. Förhandl. Bd. II; p. 264—266, 274—276.

[3]) Berättelse om en geologisk resa genom Skånes och Östergötlands palæozoiska trakter sommaren 1875; Öfvers, K. Vet.-Ak. Förhandl. 1875; p. 46, 52, 57.

[4]) On the vertical range of the graptolite types of Sweden; Geol. Mag., Dec. II, Vol. III.

[5]) Iakttagelser öfver de graptolitförande skiffrarne i Skåne; Geol. Fören. i Stockh. Förhandl., Bd. IV; p. 228, 234—238.

lersta graptolitskiffer» (Middle Graptolite Shales). The locality near Gislöfshammar was recorded.

From this time the two terms »*Phyllograptusskiffer*» and »*undre graptolitskiffer*» are often met with in our geological literature, but, to avoid misunderstanding, it must be borne in mind that they are not used indiscriminately, the former comprising all the five zones enumerated in the above, whereas the latter is only applied to the four zones *below the Orthoceras Limestone.*

1880. S. A. Tullberg [1]) described *Didymograptus balticus* n. sp., *D. vacillans* n. sp., *D. pusillus* n. sp., *D. filiformis* n. sp., and *D. suecicus* n. sp., all found in loose slabs near Kiviks-Esperöd.

1881. G. Holm [2]) described *Hologràptus expansus* n. sp. from Mossebo.

1882. Tullberg [3]) divided the »*Undersiluriska serien*» (the *Ordovician* system) into three stages, the lowest of which, called »*understa etagen*» *(lower stage)*, embraces the following zones enumerated in descending order: a) *Zonen med Phyllograptus* cf. *typus* Hall, b) *Orthocerkalk,* c) *Zonen med Tetragraptus*, and d) *Ceratopygekalk?*

1883. In a short review Tullberg [4]) maintained the same classification. He further noted the presence of a *Dichograptus (Clonograptus)* allied to *Clonograptus flexilis* Hall in the upper part of the *Dictyonema Bed.*

1885. A. G. Nathorst [5]) mentioned the discovery of *Phyllograptus* cf. *typus* Hall in a bore-hole at Stabbarp, at a depth of 90 m.

1887. G. de Geer [6]), in describing the geology of Fågelsång, followed chiefly the classification advanced by Tullberg, but placed the stratum with *Clonograptus* cfr. *flexilis* immediately below the *Orthoceras Limestone,* accordingly attributing it to the *Ordovician* system.

1892. J. C. Moberg [7]) described the wing of an insect by him named *Protocimex siluricus.* It was discovered at Killeröd in the greenish shales, referred in this paper to the *zone of Isograptus gibberulus.*

1892. Moberg [8]) gave a detailed account of a section through the last-named bed at Killeröd, and described *Azygograptus suecicus* n. sp., *Mæandrograptus Schmalenseei* n. sp., and *Isograptus gibberulus* Nich.

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[1]) Några graptolitarter i undre graptolitskiffern vid Kiviks-Esperöd; Geol. Fören. i Stockh. Förhandl., Bd. V.

[2]) Tvenne nya slägten af familjen Dichograptidæ; Öfvers. af K. Vet.-Ak. Förhandl., 1881; p. 46.

[3]) Skånes Graptoliter, I; Sveriges Geol. Undersökn., ser. C, N:o 50; p. 21, 22.

[4]) Ueber die Schichtenfolge des Silurs in Schonen nebst einem Vergleiche mit anderen gleichaltrigen Bildungen; Zeitschr. d. Deutsch. Geol. Gesellschaft, Bd. 35; p. 245—247.

[5]) Beskrifning till kartbladet Trolleholm; Sveriges Geol. Unders., Ser. Aa, N:o 97; p. 16.

[6]) Beskrifning till kartbladet Lund; Sveriges Geol. Unders., Ser. Aa, N:o 92; p. 13—15.

[7]) Om en Hemipter från Sveriges undre graptolitskiffer; Geol. Fören. i Stockh. Förhandl., Bd. XIV; p. 121.

[8]) Om några nya graptoliter från Skånes undre graptolitskiffer; Geol. Fören. i Stockh. Förhandl., Bd. XIV; p. 339.

1892. MOBERG [1]) proved that a limestone band with *Trinucleus coscinorrhinus* ANG., in TULLBERG'S scheme placed *above* the *zone of Dicranograptus Clingani* CARR., has its true geological position *below* this zone, and above the *Orthoceras Limestone*. This band is sometimes regarded as approximately corresponding to the *zone of Phyllograptus* cf. *typus*.

1892. MOBERG [2]) communicated a report on the *Phyllo-Tetragraptus Shales (»undre graptolitskiffer»)* observed in the Simrishamn district; localities, as Flagabro, Killeröd, Neckebo, Gislöfshammar, were mentioned, together with descriptions of some fossils.

1896. MOBERG [3]) sketched the results obtained up to that date by the geological investigations in the vicinity of Fågelsång, partly made by members of the Geological Field Club of Lund. Following the example given by DE GEER, he placed the strata containing *Clonograptus* cf. *flexilis* HALL and *Dictyonema norvegicum* KJERULF, though with a sign of doubt, *above* the *Ceratopyge Limestone*. In the same scheme the *zone of Phyllograptus* cf. *typus*, the *Orthoceras Limestone*, and *the zone of Didymograptus geminus* HIS. were united into one main division, rudely paralleled with the *Orthoceras Limestone* of Öland.

1900. A. NILSSON and A. TELLANDER [4]) proved the bed with *Clonograptus* cf. *flexilis* to have its place *below* the *Ceratopyge Limestone*.

1900. A. HENNIG [5]) published a review of all the results gained by the geological researches hitherto made in Skåne. In the description of the *Ordovician* system he accepted the classification proposed by MOBERG.

NOTES ON THE TERM PHYLLO-TETRAGRAPTUS SHALES.

As may be inferred from the historical summary, different opinions have been advocated concerning the limitation and the denomination of the group here dealt with. Already the fact that the main divisions of our (Upper) Silurian Graptolite Shales have been named after characteristic genera, makes it desirable that also the Ordovician chief members of similar facies be denominated in accordance with the same principle. The term *Lower Graptolite Shales*, though once convenient, can no more be regarded as an appropriate one, for below the division thus named there exists even a lower graptolitiferous group, viz. that characterized by *Clonograptus*

[1]) Om den af Trinucleus coscinorrhinus Ang. karakteriserade kalkens geologiska ålder; Geol. Fören. i Stockh. Förhandl., Bd. XIV; p. 379.

[2]) N. O. HOLST, Beskrifning till kartbladet Simrishamn; Sveriges Geol. Unders., Ser. Aa, N:o 109; p. 21—25. The statements concerning the Ordovician System here referred to were communicated by J. C. MOBERG.

[3]) Geologisk vägvisare inom Fågelsångstrakten; p. 35.

[4]) Geologiska åldern af skiffern med Clonograptus cf. flexilis HALL vid Fågelsång; Geol. Fören. i Stockh. Förhandl., Bd. XXII; p. 421.

[5]) Geologischer Führer durch Schonen; p. 33—36.

tenellus LINRS. and some species of *Bryograptus;* and the use of that term has, again, led to the employment of another term, the *Middle Graptolite Shales*, for beds which by no means deserve this title. Such a denomination has, moreover, involved a difficulty concerning the whole classification. The *zone of Phyllograptus* cf. *typus* has been cut off from its natural connexion with the lower graptolite-bearing zones, and it has, at the same time, when united with the *Orthoceras Limestone*, been removed from the series of graptolite zones into a suit of strata belonging to a different facies. The full consequence of the reasons adduced in favour of this method of proceding would be to drop all the divisions founded on the succession of graptolite faunas, since each of them certainly has, somewhere or other, its calcareous representative.

In this paper I have slightly modified the name previously proposed by me, so as to express more exactly the characteristic of the formation to which it has been assigned. The genus *Phyllograptus* has not as yet been found in the lowest portion of the group, whereas *Tetragrapti* are there in abundance.

Still maintaining the classification of the Swedish graptolite shales which I advanced in 1889 [1]), I avail myself of the opportunity of introducing the same here. The members are in descending order:

Colonus Shales.

Cyrtograptus Shales { *Upper, Flemingii Shales.* / *Lower, Retiolites Shales.*

Rastrites Shales.

[*Brachiopod Shales* = D, zones a—c, TULLBERG.]

Dicellograptus Shales { *Upper* = *Trinucleus Shales* = D, zones d—h, TULLBERG. / *Middle* = D, zones i—k; E, zones a—g, TULLBERG. / *Lower* = E, zones h—o, TULLBERG.

Phyllo-Tetragraptus Shales.

To these members should be added the graptolite-bearing shales which occur below the *Ceratopyge Limestone*, viz., Shales with *Bryograptus* and *Dictyonema.*

MOBERG [2]) has recently proposed to draw the divisional line between the *Cambrian* and *Ordovician* systems just beneath the *Dictyonema Shales.* This proposition seems to be worthy of all consideration as concerns Scandinavia, and will, possibly, prove practicable in foreign countries, too [3]).

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[1]) Några anmärkningar om vestra Europas kambriska och siluriska korologi; Geol. Fören. i Stockh. Förhandl., Bd. XI; p. 312.

[2]) Nya bidrag till utredning af frågan om gränsen mellan undersilur och kambrium; Geol. Fören. i Stockh. Förhandl., Bd. XXII, 1880; p. 523.

[3]) Compare also BRÖGGER, Die Silurischen Etagen 2 und 3 im Kristianiagebiet; p. 156.

DESCRIPTIONS ON THE SPECIES.

Preliminary remarks.

Though I have, as a rule, followed the terminology accepted by the majority of graptolithologists, a few expressions used in the sequel may require some explanatory notes.

By the name »primordial stipe» I designate that branch which issues on the same side of the sicula as the first theca, the other being called the »complemental stipe».

As regards the expression »the first theca» I employ it, for the sake of brevity, in the same sense as it has been used by Miss G. Elles [1]). In some cases it will, however, be necessary to distinguish between different parts of this theca; the earliest part of it from its origin as far as the point where the stipes separate, is then called the »initial portion»; this continues in the middle or »ramifying portion», and terminates in the »apertural portion», or the true theca.

With regard to the employment of the term »connecting canal» there exists some confusion, which has probably arisen from a typographical error in a brief review [2]) of my paper entitled »Observations on the structure of some Diprionidæ» [3]). The term was originally assigned to the tube-shaped canal which in a diprionidian graptolite connects the cavity of the sicula with the cavity from which the earliest thecæ are seen to bud. Thus defined it only corresponds with the initial portion of the first theca of a *Didymograptus*, the ramifying portion of the same organ being homologous with the last-named cavity. It then follows that the term »connecting canal» cannot be applied to that part of the complemental stipe which crosses the sicula. In this paper that part will be designated »the cross-canal».

For reasons adduced by me in 1890 [4]), I delineate the species of *Didymograptus* in such a position that the apex of the sicula is directed downwards, though I, by no means, underrate the motives which may have prevailed upon some authors to figure these fossils in a different position. It is evident that expressions such as »upwards», »downwards», and the like, must be understood in accordance with the position in which the rhabdosome has been represented.

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[1]) The Graptolite-Fauna of the Skiddaw Slates; Quart. Journ. Geol. Soc., Vol. LIV, 1898.

[2]) Geol. Fören. i Stockh. Förhandl., Bd. XV, 1893; p. 166. In the only revise read by me, the sentence referred to in the text run thus: »Hos samtliga arterna» — af Diprionidæ — »visar sig sikula som en nedtill öppen kon, hvilken därjämte genom en öppning å ena sidan står i förbindelse med en mot rhabdosomets bas riktad kanal — »the connecting canal».» (In all the species — of Diprionidæ examined — the sicula appears as a cone open downwards, which by means of a foramen at the one side communicates with a canal directed towards the base of the rhabdosome — »the connecting canal».) I then appointed the dash (—) to be changed into a comma (,), but in the printed paper it was replaced by a misleading sign of plus (+).

[3]) Lunds Universitets Årsskrift, Tom. XXIX, 2; 1893.

[4]) Undersökningar öfver Siljansområdets Graptoliter; Lunds Univ. Årsskrift, Tom. XXVI, 2; p. 4, 5.

Family **Dichograptidæ.**

Notes on the genera Didymograptus, Isograptus and Mæandrograptus.

The two genera *Isograptus* and *Mæandrograptus*, established by MOBERG in 1892 [1]), agree in their structure with the general type of *Didymograptus*, but they exhibit such modifications of this type, that, in my opinion, they may properly be separated from *Didymograptus sensu latiori*. Whether they ought to be regarded as subgenera of that genus, or as distinct genera, I shall leave undecided. They may be distinguished as follows:

Didymograptus (sensu strictiori): The cavity of the ramifying portion of the first theca passes gradually into the common canal of the primordial stipe as well as into the apertural part of the theca.

Isograptus: The cavity of the ramifying portion of the first theca passes gradually into its apertural part, but into the common canal of the primordial stipe by means of a very constricted foramen placed near the prolific side of the sicula.

Mæandrograptus: The cavity of the ramifying portion of the first theca is in direct communication with two or three thecæ of the primordial stipe.

Only one species of either of the two last-named genera being known, a full generic diagnosis of them cannot, as yet, be given, but some peculiarities pointed out in the descriptions of the species may probably prove of generic value.

Genus **Didymograptus.**

Didymograptus undulatus n. sp.

Plate I, figures 1—7.

A feature common to the majority of the earliest *Didymograpti*, is their small size. Their narrow stipes contrast in a strange manner with the broad branches of the *Tetragrapti* with which they occur associated. In this respect *Didymograptus undulatus* agrees with the majority. The stipes of my most complete specimen reach a length of 12 mm with a nearly uniform width not exceeding 1 mm. Sometimes they are straight, but often they show a slight bending, and diverge at an angle of about 180°. The sicula, being 2,5 mm long, continues in a delicate virgula, which may attain a length of at least 9 or 10 mm. The first theca originates apparently at the very apex of the sicula, and its free distal portion makes with the sicula an average angle of 45° — scarcely ever exceeding 50°. In the space of 10 mm 12 or 13 thecæ are counted. These are faintly curved, a little widening towards the apertures, and inclined at an angle of from 30° to 35°. Their apertural angle varies between 105° and 115°. Near the sicula each theca does not extend

[1]) See foot-note 8 p. 6.

beyond the inner orifice of the next theca, but distally the thecæ cover 1,5 such orifices, the length of their walls being 2 mm. A very characteristic feature is afforded by the dorsal margin of the stipes, which, owing to successive constrictions between the inner edges of the interthecal walls, exhibits the form of a waving line. In the reverse aspect of some specimens this undulation is seen running across the sicula and the first theca (figs. 4 and 5). Towards the distal extremities of the stipes the undulation becomes less conspicuous. All my specimens, with the exception of that represented in fig. 3, are strongly compressed, and permit no closer examination into the inner structure of the initial parts.

From all its congeners the species is, at the first glance, distinguished by the peculiar shape of the dorsal outline.

Horizon and locality. This little species occurs by no means rarely in the *zone of Tetragraptus phyllograptoides* at Mossebo, and at Flagabro.

Didymograptus demissus n. sp.

Plate I, figures 8—11.

The straight stipes have a lenght of at least 20 mm, and maintain a width of about 1 mm throughout. They diverge at an angle oscillating between 135° and 155°. The sicula measures from 2,5 to 3 mm in length, and sends forth a thread-like virgula of unknown extent. It forms together with the first theca a very pointed »radicle». This theca originates near the apex of the sicula, and makes distally an angle of from 55° to 70° with the apertural part of the same. The thecæ number 12 in 10 mm, and are inclined 30° to 35°, having an apertural angle of about 100°. Their proximal walls are 2 mm long, rectilinear or imperceptibly curved, and free for about half their lenght, or — in the distal parts of the stipes — a little less. The common canal seems to have a width of 0,15 mm.

All my examples of this species are compressed, the periderm being reduced to a very thin, glossy, white film.

The species is closely allied to *Didymograptus geometricus* n. sp., in the description of which the differences will be pointed out.

Horizon and locality. Not rare in the *zone of Tetragraptus phyllograptoides* at Mossebo.

Didymograptus geometricus n. sp.

Plate I, figures 12—14.

From an initial widht of 0,5 mm the stipes gradually increase until, at a distance of 20 mm from their origin, a breadth of 0,8 mm is attained. They are straight and rigid, and, as far as I have observed, do not much exceed 20 mm in length. Most commonly they diverge at an angle of from 135° to 140°; but in one specimen probably belonging to this species, the angle of divergence approaches 180°. The sicula is 1,5 or, at most, 2 mm long, and emits the first theca from

near its apex. The apertural portion of this theca makes an angle of about 70° with the corresponding part of the sicula. There are 11 or 12 thecæ in 10 mm; these are inclined at an angle varying between 25° and 35°, and free for the half of their length. In the distal parts of the stipes each theca does not extend beyond the inner orifice of the next theca.

Most of my specimens are strongly compressed, some few, however, being preserved as faint impressions.

The above description is drawn up from examples collected at Mossebo. There occur at Flagabro specimens perfectly agreeing with these, but other specimens have been found mixed with them, which differ from them in having the stipes less rigid, and somewhat wider towards the extremities. My collection of this latter form is too incomplete for me to decide whether they belong to the species in question, or not.

From *Didymograptus demissus* n. sp. this graptolite may be distinguished by the following characters: the sicula is shorter, the stipes are at their origin only half as wide, and the thecæ do not exceed 1 mm in length, whereas those of *D. demissus* are 2 mm long.

It bears, moreover, a superficial resemblance to some other species. Of these *Didymograptus Nicholsoni* Lapw. [1]) has broader stipes, a lower angle of divergence, and the interthecal walls much shorter with respect to the length of the inner orifices. The thecæ of *Didymograptus affinis* Nich. [2]) are inclined at a more acute angle, and are stated to be free for much more than half their length.

Horizon and localities. Common in the *zone of Didymograptus balticus* at Mossebo and Flagabro.

Didymograptus Holmi n. sp.

Plate I, figures 15—18.

Commencing with a breadth of 1 mm, the stipes expand slowly until a diameter of 1,4 mm is attained at a distance of 20 mm from the sicula. Probably they have never been much longer, for broken fragments are rare. They usually diverge at an angle of 180°, and are sometimes proximally bent a little backwards. The sicula is about 2 mm long, pointed, and provided with a delicate virgula of unknown lenght, which is, however, not preserved in the majority of specimens. On the ventral side of the rhabdosome, the free portion of the sicula is rather short, its parietal margin being not longer than the apertural edge. The first theca arises at a distance of 0,5 mm from the apex of the sicula, and is evenly curved.

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[1]) J. Hopkinson and Ch. Lapworth, Descriptions of the Graptolites of the Arenig and Llandeilo Rocks of St. David's; Quart. Journ. Geol. Soc., Vol. XXXI, 1875; p. 644, Pl. XXXIII, figs. 5. — Compare: G. Elles, The Graptolite-Fauna of the Skiddaw Slates; Quart. Journ. Geol. Soc., Vol. LIV, 1898; p. 502, f. 21.

[2]) H. A. Nicholson, On some new species of Graptolites; Ann. Mag. Nat. Hist., Ser. 4, Vol. IV, 1863; p. 240, pl. XI, fig. 20. — Compare: G. Elles, Op. cit., p. 503.

The thecæ number 12 in 10 mm; when fully developed they are 2,5 mm long, slightly curved, free for $^2/_5$ to $^1/_3$ of their length, and each of them extends as far as the middle of the second inner orifice succeeding. In the proximal portion of the stipes their angle of inclination is 45°, but distally it is only 40°. In compressed specimens the thecæ appear to dilate from a width of 0,5 mm to a width of 0,8 mm, but, in reality, their expansion must be regarded as somewhat less. The common canal is 0,2 mm wide.

Though the typical forms of this species and of *Didymograptus constrictus* HALL are easily distinguished, examples of the former are met with which, in their general habit, approximate to the latter; but, as far as I have observed, they never show the rapid proximal dilatation of the stipes which is so characteristic of *D. constrictus*. The prolongation of the virgula in *D. Holmi* would also offer a feature of specific value, if this appendage were not so often broken off. From *Didymograptus suecicus* TULLB. the species differs in the form of the sicula, the low angle between the apertural portion of the sicula and the first theca, and in the even curvature of the two earliest thecæ.

Horizon and locality. Occurs in the *zone of Tetragraptus phyllograptoides* at Mossebo.

Didymograptus suecicus TULLBERG.

Plate I, figures 19—24.

1880. *Didymograptus suecicus* TULLBERG, Några Didymograptusarter i undre graptolitsk. vid Kiviks-Esperöd; Geol. Fören. i Stockh. Förhandl., Bd. V; p. 43, Tafl. 2, fig. 15, 16.

A multitude of examples of this species lie before me, many of which are preserved in full relief; others occurring as impressions of such specimens. The stipes diverge at an angle of 180°, being seldom directed slightly backwards. They increase in width from 1 mm at their origin up to a maximum of about 1,5 mm, which is acquired at a distance of 30 mm from the sicula. Judging from the great number of broken fragments met with, the stipes may have attained a considerable length. The sicula has a lenght of from 1,6 to 2 mm, and projects beyond the cross-canal in form of a short isosceles triangle with slightly concave outlines, the sides included between the proximal portions of the two earlies thècæ being, likewise, somewhat concave. No virgular prolongation has been observed, and probably there was none. The first theca begins at a distance of 0,3 mm from the apex of the sicula, and its distal portion is bent abruptly outwards, making a right, or even obtuse angle with the free sicular wall. A similar shape is presented by the first theca of the complemental stipe (th. 1^2). So sharp is the bending of these two thecæ, that a line drawn between their outer corners will nearly touch the apertural extremity of the sicula. The thecæ number 9 or 10 in 10 mm; they are slightly curved, inclined at an angle of from 25° to 30°; and free for $^1/_3$ or $^1/_4$ of their length. In flattened specimens they widen perceptibly towards the apertures, but, when pre-

served with their full relief, this expansion is hardly observable. Each theca projects as far as the middle of the second inner orifice succeeding.

Well preserved specimens are easily distinguished from other *Didymograpti* by the structure of their initial elements, but, in compressed specimens, these details are more or less obscured. The short apertural portion of the sicula, and the abrupt outward turn of the two earliest thecæ will, however, in most cases, serve as sufficiant characteristics of the species.

TULLBERG regards *Didymograptus suecicus* as nearly akin to *D. nitidus* HALL. Indeed, fig. 8, Pl. I of »Graptolites of the Quebec group» bears an unmistakable resemblance to *D. suecicus;* but from all other figures of *D. nitidus* given in that work the last-named species differs in general habit as well as in the form of the thecæ. Moreover, the figur referred to deviates so essentially from all other specimens of *D. nitidus* illustrated by HALL, that it seems questionable whether it really belongs to the same species. Neither does our species agree with the description of *Didymograptus nitidus* given by Miss ELLES [1]).

Horizon and localities. Occurs abundantly in the *zone of Phyllograptus densus* at Flagabro, more sparingly in the *zone of Didymograptus balticus* at the same locality. TULLBERG's type specimens were found in loos slabs along the shore near Kiviks-Esperöd.

Didymograptus extensus HALL.

Plate I, figures 25—30.

1858. *Graptolithus extensus* HALL, Geol. Survey of Canada, Rep. 1857; p. 152.
1865. » » » Graptolites of the Quebec Group; Geol. Survey of Canada, Dec. 2; p. 80, Pl. II, f. 11—16.
1870. *Didymograpsus* » NICHOLSON, British species of Didymograpsus; Ann. Mag. Nat. Hist. 1870; p. 341, Pl. VII, f. 2, 2 a.
1875. *Didymograptus* » LAPWORTH and HOPKINSON, Graptol. of the Arenig and Llandeilo Rocks of St. Davids; Quart. Journ. Geol. Soc., Vol. XXXI; p. 642, Pl. XXXIII, f. 1 a—1 d.
1890. ? » » G. ELLES, The Graptolite-Fauna of the Skiddaw Slates; Quart. Journ. Geol. Soc., Vol. LIV; p. 504.

Of this graptolite I possess a collection of fairly well preserved specimens, agreeing in every detail with the description and the illustrations given by HALL. Most of them appear in the form of impressions of examples in relief. The stipes diverge at an angle of 180°, their dorsal margins usually forming one straight line only interrupted by the »radicle»; in some specimens they are directed slightly backwards, exactly as shown in HALL's fig. 11. Stipes preserved in full relief widen from a diameter of 0,5 mm near the sicula to a maximum width of 2 mm; across the twentieth theca, on each side, they measure 1,5 mm in bredth, and from this

[1]) Op. cit., p. 499, fig. 19, 20.

point they enlarge very slowly. Compressed examples are always a little broader. As I have seen no complete specimens, I am unable to state the whole length reached by the stipes, but they have certainly attained several centimeters in extent. The sicula has a length of 1 mm, and projects very little on the ventral side of the rhabdosome, its free wall being always shorter than the concave apertural margin. The first theca arises — as it appears — near the apical extremity of the sicula, and curves gently upwards and outwards, distally making a right angle with the apertural portion of the sicula. There are 11 thecæ in the space of 10 mm. These are very slightly curved, and inclined at an angle of from 37° to 40°; their apertural angle varies between 120° and 130°. In the proximal portion of the stipes each theca covers one inner orifice, being free for about half its length; the fully developed thecæ are free for two fifths of their lenght, and extend a little beyond the next inner orifice.

At Flagabro I have come across some specimens which, in their state of preservation, remind us very much of the form represented by HALL on Pl. II, f. 15 and 16 (Graptol. of the Quebec Group). Such a specimens is delineated in fig. 30. This aspect will appear if the pressure has worked so as to show the distal boundary line of one theca in alignement of one of the edges of the prismatic theca next in advance, and at the same time with the exterior margin of the second theca succeeding. The specimen figured by HALL has been preserved with its full relief, whereas the original of my illustration is an imprint of an example in half relief.

There can be no doubt that the species described in the above is identical with *Didymograptus extensus* HALL. It likewise agrees in all particulars with the description given by LAPWORTH in the paper I have cited; but, from the accompanying figure, it differs slightly inasmuch as this exhibits a small upward curvature in the most proximal part of the rhabdosome. More doubt might be entertained about the identity between our species and that referred to *D. extensus* HALL by Miss ELLES, the stipes of this form being stated to diverge at an angle of only 150°, while, in all Scanian specimens known to me, this angle is never less than 180°. As all other structural details of the Skiddaw form agree with those of HALL's species, I have introduced it among the synonyms, though with a sign of uncertainty.

Horizon and localities. The species has been found at Killeröd and Komstad, being, as far as hitherto known, restricted to the *zone of Isograptus gibberulus*.

Didymograptus patulus HALL.

Plate II, figures 1—6.

1858. *Graptolithus patulus* HALL, Geol. Survey of Canada, Rep. 1857; p. 131.

1863. ? *Didymograpsus hirundo* SALTER, (On the Skiddaw Slate Series by R. HARKNESS with) Notes on the Graptolites by J. W. SALTER; Quart. Journ. Geol. Soc., Vol. XIX; p. 137, f. 13 f.

1865. *Graptolithus patulus* HALL, Graptol. of the Quebec Group; Geol. Survey of Canada, Dec. 2; p. 71, Pl. I, f. 10—15.

1870. *Didymograpsus* » NICHOLSON, On the Species of Didymograpsus; Ann. Mag. Nat. Hist., Ser. 4, Vol. 5; p. 340, Pl. VII, f. 1, 1 a (non fig. 1 pag. 340).

1875. *Didymograptus* » LAPWORTH and HOPKINSON, Graptol. of the Arenig and Llandeilo Rocks of St. David's; Quart. Journ. Geol. Soc., Vol. XXXI; p. 644, pl. XXXIII, f. 4 a—4 e.

1898. » » G. ELLES, The Graptolite Fauna of the Skiddaw Slates; Quart. Journ. Geol. Soc., Vol. LIV; p. 504, f. 22, 23.

The stipes, which diverge 180°, have reached a considerable length, and widen gradually from an initial width of 2 mm to a maximum diameter of about 3 mm. The sicula is 3 mm long; its concave apertural margin is of the same length as the free wall of the apertural portion. In one specimen I have seen a filiform appendice projecting from the corner of the aperture, in every respect resembling the virgella of the *Diplograpti* and *Monograpti*. The first theca arises near the apex of the sicula, and exhibits distally a markedly concave outline, forming a low angle of only about 40° with the apertural part of the sicula. In the space of 10 mm the thecæ constantly number 10; these are gently curved, widening towards the apertures, and inclined at an angle decreasing from 45° near the sicula to 40° distally. Each theca covers 1,5 inner orifices in the proximal portion of the rhabdosome, and 2 such orifices where fully developed. Their apertural margins are roughly S-shaped, inclined 120° to the general direction of the stipes, and form pointed denticles with the free walls. A fine transverse striation parallel to the apertural margins is usually observable. The common canal occupies about $^1/_5$ of the breadth of the stipes. For further particulars the careful description given by Miss ELLES may be refered to.

I have only to add a few words concerning the structure of the initial parts. From Pl. II, f. 4, representing an impression of the reverse aspect of the proximal portion, it may be inferred that the sicula of this species, as well as the earliest thecæ and the cross-canal, agree, in every respect, with the same elements of all true *Didymograpti*. The two lines seen along the left half of the »radicle» may easily be explained by a comparison with fig. 9 on the same plate, illustrative of a nearly allied form. From this it appears that the boundary line between the sicula and the first theca is shorter in the reverse aspect than in the opposite view, the end of this line being also visible in the impression of the broken-off apex of the sicula. If this specimen had been compressed, the two lines marking the edges of the partition between the sicula and the first theca would have appeared in the same impression as two parallel lines of unequal length. Such is the case with the specimen delineated in fig. 4. The two lines there visible should be compared with the double lines so often marking the interthecal partitions. Fig. 3 in Miss ELLES paper agrees in all essentials with my fig. 4, only with the differences due

to the fact that the former represents the obverse aspect of the graptolite. It should here be noticed, that a structure of the sicula similar to that shown in fig. 9 has been observed in several other species of *Didymograptus*, too.

This and the following species stand fairly isolated amongst those of its congeners which agree with them in respect of the direction of their stipes. The inward curvature of the earliest thecæ, and the conformation of the thecæ in general are very distinctive characters.

Horizon and locality. At Killeröd and Komstad examples of the species are common in the *zone of Isograptus gibberulus*. Some specimens presented to me by Baron Cl. Kurck were collected by him in the same zone at Jerrestad in the year 1880.

Didymograptus prænuntius n. sp.

Plate II, figures 7—12.

I have hesitated very much whether I should regard this form as a variety of *Didymograptus patulus* Hall, or as a distinct species. Reasons might be adduced in favour of the one view as well as of the other; but having, in spite of their close relationship, seen no connecting link between the two forms, I provisionally assigne the above specific name to the older one. Although it presents the same appearance in the initial parts as *Didymograptus patulus*, it differs in the following points, viz., the stipes are narrower, scarcely ever exceeding 2 mm in width; the thecæ number 8 or 9 in the space of 10 mm; they widen more rapidly towards their apertures, and are usually more curved; the indentations between the thecæ, which in *D. patulus* occupy, at most, one third of the diameter of the stipes, are perceptibly deeper with regard to the same diameter. A transverse striation is visible across the thecæ, though not so conspicuous as in the foregoing species. Broken stipes have been found measuring 130 mm in length.

Horizon and locality. The species is abundant in the *zone of Phyllograptus densus* at Flagabro.

Didymograptus constrictus Hall.

Plate II, figures 13—17.

1865. *Graptolithus constrictus* Hall, Graptol. of the Quebec Group; Geol. Survey of Canada, Dec. II; p. 76, Pl. I, f. 23—27.

The stipes are immediately near the sicula bent more or less backwards, and then continue so as to lie, on both sides, along the same straight line. Between the forms represented in figs. 13 and 14 every gradation has been found. From an original widt of about 1 mm they suddenly expand to a breadth of 1,5 or even 2 mm, which width is obtained at a point varying between the second and sixth theca. In my most complete specimen the stipes have a length of 50 mm, and judging from the small number of fragments occurring, they have not been very much longer. The sicula has a length of from 2 to 2,2 mm; its free apertural

wall is not longer than the aperture itself. The first theca begins near the apical extremity of the sicula, and curves evenly upwards. There are 10 or 11 thecæ in 10 mm; these are inclined at an angle of 35°, their apertural angle oscillating between 115° and 120°. Each of them reaches as far as the middle of the second inner succeeding orifice. HALL describes the thecæ of this species in the following terms: »The cellules, in their lower part, and for two thirds of their length, are straight, and scarcely wider throughout than at their origin: at this point, just before becoming free, they are abruptly expanded on the posterior side, and this margin of the free extremity makes a larger angle with the direction of the axis. This expansion of the cellule is perhaps as properly a sudden constriction just below the orifice, or at the base of the cell-denticle.» Quite the same characteristic might be applied to the thecæ of my specimens when compressed, with the single exception that the proximal parts of the thecæ are sometimes slightly curved. But the constriction below the outer third of the thecæ is only apparent, and due to another peculiarity of this species. In examples preserved in full relief, the thecæ show a slight uninterrupted curvature, which, in the outer third, is more perceptible than proximally, but without any constriction altogether. A transverse section of a stipe will show that this widens so considerably towards the ventral margin, that the width of a theca, measured between the lateral walls near the aperture, is three or four times as great as the space between the interthecal walls at the same level. In more flattened specimens the adnate portion of the broad proximal wall of one theca is folded so as to form one or two longitudinal ridges, which are concealed in the cavity of the theca next below, whereas the free portion of the same wall is pressed out and fully visible. A strong pressure would then bring about just the appearance seen on Pl. II, fig. 16 of this paper, and in HALL's representation on Pl. I, fig. 17.

Horizon and localities. The species ranges from the *zone of Tetragraptus phyllograptoides* to the top of the *zone of Didymograptus balticus*, being most common in the latter zone. It has been found at Mossebo and Flagabro.

Didymograptus validus n. sp.

Plate II, figures 18—20.

The short stipes diverge at an angle of little more than 180°, being accordingly directed very slightly backwards. Beginning with a breadth of 1,7 mm, they already measure 2 mm in width across the second theca of each stipe (th. 2^1 and th. 2^2), and acquire a maximum diameter of 2,2 mm. They seem not to have exceeded 12 mm in extent, and are, near the extremities, abruptly rounded off. The sicula has a length of 2,5 mm, its greater part bordering upon the bases of the stipes. It forms, together with the initial part of the first theca, a very short and blunt »radicle», and the free parietal margin of its apertural portion is shorter than the apertural edge itself. The ventral outline of the whole rhabdosome forms a gently curved line, almost imperceptibly interrupted by a shallow notch above

the sicula. Owing to a strong compression, the structure of the initial parts are, in all my specimens, rather obscured, and I have been unable to make out the details of the oldest thecæ. There are 10 or 11 thecæ in 10 mm, making an angle of from 30° to 35° with the dorsal margin of the stipe. They are rectilinear or faintly curved, free for $^2/_7$ or $^1/_4$ of their length, and extend beyond the second inner orifice succeeding. When fully developed, they attain a length of from 3,5 to 4 mm.

This species bears some resemblance to the preceding one, but may readily be distinguished from that, as well as from other known *Didymograpti,* by the general form and size of the rhabdosome, the short and broad »radicle», and the long thecæ.

Horizon and locality. Occurs abundantly in a band running through the lower part of the *zone of Didymograptus balticus* at Mossebo.

Didymograptus balticus Tullberg.

Plate II, figures 21—25.

1880. *Didymograptus balticus* Tullberg, Några Didymograptusarter i undre graptolitsk. vid Kiviks-Esperöd; Geol. Fören. i Stockh. Förhandl., Bd. V; p. 41, Tafl. 2, f. 1—3.

The stipes diverge at an initial angle oscillating between 70° and 100°, but as they proceed for some distance in an even dorsal curvature and then tend distally to become straight, this angle increases steadily up to a maximum of about 150°. In my most perfect specimen they have a length of 60 mm, and a nearly uniform width of 1,5 mm. The sicula is 2,5 mm long, and apically protracted into a short virgula, which, however, is not present in the majority of specimens I have examined. Its apertural portion is much longer than the concave aperture, and forms an angle of only 40° with the first theca. The thecæ number 10 or 11 in the space of 10 mm; they are curved, inclined at an angle of from 30° to 35°, and their free exterior walls form pointed denticles with the apertural margins. Tullberg's statement that the thecæ are free for half their length only holds good of the proximal part of the stipes, the distal thecæ being free for scarcely one third of their extent. Near the sicula, each theca extends as far as the middle of the second inner orifice next in advance, but, distally, as far as the base of the third orifice.

This species can hardly be confounded with any other *Didymograptus;* its nearest ally may be the following species.

Horizon and localities. Tullberg's type specimens were collected in detached slabs along the shore near Kiviks-Esperöd. Examples of the species occur not too sparingly at Mossebo and Flagabro, characterizing the zone to which its name has been assigned.

Didymograptus vacillans Tullberg.

Plate II, figures 26—29.

1880. *Didymograptus vacillans* Tullberg, Några Didymograptusarter i undre graptolitsk. vid Kiviks-Esperöd; Geol. Fören. i Stockh. Förhandl., Bd. V; p. 42, Tafl. 2, f. 4—7.

In complete specimens the stipes have an average length of 15 mm, and a width of about 1 mm. The primordial stipe exhibits a double curve, the dorsal margin being proximally convex, and in its distal half concave; the complemental stipe shows a tendancy to proceed in a straight line. Tullberg states that their angle of divergence varies at first between 120° and 90° (»240° and 270°»), and distally between 105° and 60° (»255° and 300°»). My specimens display a similar variation in the direction of the stipes. A series of measurements of the angle enclosed by two lines drawn on either side of the sicula from its apical extremity to a point of the stipes situated at a distance of 8 mm from the apex, has given the following numbers of degree: 80°, 82°, 84°, 88°, 94°, 96°, 97°, 107°, 110°, 116°, 124°. All these specimens thus examined were seen on the same slab. The sicula has a length of 1,5 mm, and projects very little on the ventral side of the rhabdosome, its concave apertural margin being longer than its free wall. The thecæ number 12 or 13 in 10 mm; they are straight or slightly curved, inclined at an angle of 35° (or according to Tullberg 30°), and free for about half their length, or more. Each theca covers the inner orifice of the theca next in advance. The greater number of my specimens appear as hollow casts of rhabdosomes preserved in full relief; but the apertural portions of the thecæ are generally flattened out, or even effaced.

From *Didymograptus balticus* Tullb. this species differs in its general appearance, smaller size, shorter thecæ, and the short apertural portion of the sicula. As Miss Elles has remarked [1]), it is nearly related to *Didymograptus V-fractus* Salt.; but distinguishes by the uniform width of the stipes; the proximal walls of the thecæ are, moreover, as far as I am aware, never convex at any point of the stipes.

Horizon and localities. *Didymograptus vacillans* was for the first time found by Tullberg at Kiviks-Esperöd, where it occurred in association with *D. balticus*. At Mossebo it occurs in great multitude on a horizon belonging to the lower part of the *zone of Didymograptus balticus*.

Didymograptus Kurcki n. sp.

Plate III, figures 1—5.

The stipes, which show a slight dorsal curvature, diverge at an angle of about 90°. In my most complete specimens they have a length of 25 mm, and increase in width from 0,4 mm up to a maximum of 1 mm. They are, however, distally

[1]) Op. cit., p. 508.

broken off. The sicula seems to have a length of 1,5 mm, and emits the first theca at a short distance from its apex. There are 12 thecæ in 10 mm. The two earliest thecæ (th. 1^1 and th. 1^2) are curved, narrow at their bases, and widening considerably towards the apertures; the second theca of each stipe (th. 2^1, th. 2^2) is less curved, and all the following ones are almost straight, of uniform width, and inclined at an angle of 20°. Their apertures make an angle of 115° with the dorsal margin. Each theca, being free for half its length, extends as far as the base of the second inner orifice succeeding.

In its most proximal parts *Didymograptus Kurcki* reminds us very much of *D. V-fractus* Salt., but disregarding this resemblance, the differences between the two forms seem to be sufficient for regarding them as distinct species.

Horizon and locality. I have been presented with some specimens of this species by Baron Cl. Kurck, who collected them at Jerrestad in the year 1880. There is some uncertainty about the horizon of their occurrance, but I am most inclined to refer the species to the *zone of Isograptus gibberulus.*

Didymograptus filiformis Tullberg.

Plate III, figures 6—9.

1880. *Didymograptus filiformis* Tullberg, Några Didymograptusarter i undre graptolitsk. vid Kiviks-Esperöd; Geol. Fören. i Stockh. Förhandl., Bd. V; p. 42, Tafl. 2, f. 8—11.

One of the smallest species of this genus. Its stipes, which enclose an angle of about 70°, have a width not exceeding 0,2 or 0,3 mm, and attain a length of at least 15 mm. The sicula, measuring 1 mm in length, has an almost uniform width, but contracts abruptly at the apical extremity, from which an exceedingly delicate virgula is, in some specimens, seen to proceed. As the apertural portion of the sicula is almost straight, and not perceptibly bent towards the side of the complemental stipe, and as, moreover, the free wall of this portion is, at least, twice as long as the apertural edge, the stipes spring out at markedly different levels. The thecæ number generally 6 in 10 mm, but sometimes 7 or 8 in the same space. They are narrow, several times as long as wide, and make an angle of 10° with the direction of the stipes. Tullberg's statement that their angle of inclination is 30° depends evidently on a typographical error, as may be induced from his figures. Each theca covers about the half of the next inner orifice. According to Tullberg, the apertural angle is 90°, and in compressed specimens I have also found this to be the case, but in examples converted into pyrites this angle seems to be as low as 50°. The thecæ then terminate in acute denticles directed towards the extremity of the stipes.

The species is closely related to *Didymograptus gracilis* Törnq. [1]), but differs

[1]) Undersökningar öfver Siljansområdets Graptoliter; Lunds Univ. Årsskr., Tom. XXVI, 2; p. 17, Tafl. I, figs. 9—12.

from it in the direction of the stipes and in having clearly-marked interthecal walls. As was formerly suggested by me, it is not impossible that *D. gracilis* may have had such walls, though, owing to the state of preservation, they were obliterated in the specimens from which my description was drawn; but, on the other hand, all traces of interthecal partitions are wanting in a *Didymograptus* delineated in HOLM's paper »Om Didymograptus, Tetragraptus och Phyllograptus» [1]), and quoted by him as *Didymograptus gracilis* TÖRNQ. mut.

Horizon and localities. Found by TULLBERG in boulders at Kiviks-Esperöd. At Mossebo examples of the species are seen associated with *Didymograptus vacillans* TULLB. in the *zone of Didymograptus balticus.*

Didymograptus flagellifer TULLBERG mscr.

Plate III, figures 10 and 11.

The following description is founded on three imperfect specimens, all seen on the same slab, the most complete of which is delineated in fig. 10. In spite of the scantiness of the material, the species deserves, in my opinion, to be described, especially on account of the peculiar feature afforded by its proximal parts.

It belongs to the tuning-fork *Didymograpti;* the stipes, which seem distally to have been quite parallel, reach a length of, at least, 35 mm, and increase in width from 1 mm to 2 mm. The sicula passes insensibly into a virgula so stout and coarse that it is almost impossible to decide where the one ends, and the other begins. Judging from the point from which the first theca springs, the sicula may be said to have a length of 2,5 mm, in which case the virgula is nearly 20 mm long. Above the cross-canal the free wall of the sicula is not bent to the side of the complemental stipe. There are 10 theca in 10 mm. The first two thecæ formed (th. 1^1 and th. 1^2) are long and curved inwards; the following ones become successively less curved, but are not quite straight even in the distal part of the stipes. They are inclined at an angle of 35^0, and free for about one third of their length. The apertural angle of the distal thecæ is 130^0. Each theca covers one inner orifice near the sicula, but reaches, in the distal part of the stipes, as far as the base of the third inner orifice in advance.

Horizon and locality. The slab spoken of in the above was found by TULLBERG at Gislöfshammar in 1882, and given to Baron CL. KURCK, who, in turn, has presented it to me. They were labelled by TULLBERG as *D. flagellifer.* The horizon of the fossil is not known, it is even not certain that its zone is situated below the *Orthoceras Limestone.*

Note. In all the zones dealt with in this paper there occur several tuning-fork *Didymograpti*, but my collection of them is too poor for me to venture, at present, on attempting to disentangle these closely allied forms.

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[1]) p. 334, Tafl. II, figs. 7, 8.

Didymograptus Mobergi n. sp.

Plate III, figures 12—15.

Of this pretty little species I possess only some few and imperfect imprints, the best of which are figured on Pl. III. The stipes are faintly arcuate and directed somewhat backwards, increasing in width from 0,6 mm to a maximum diameter of 1 mm. Their extent is unknown. Owing to consecutive retirements of their dorsal margin between the inner edges of the interthecal walls, this margin presents a wavy aspect. The sicula is about 2 mm long, and apically provided with a short delicate virgula. Its prolific side is straight throughout. The first theca originates near its apex, and distally turns so abruptly outwards that its free margin makes an angle of 85° with the free portion of the sicula. There are 9 or 10 thecæ in 10 mm. These are in the proximal part of the rhabdosome free for nearly half their length, but distally for two fifths. Their form is very characteristic: the adnate portion of a proximal wall is slightly concave, making an angle of 20° with the direction of the stipe; immediately beyond the aperture of the theca next behind, the free margin projects a little outwards, and then, again, continues in a slightly concave curvature, terminating in a short spine, which lies in the same line as the apertural edge. This free part of the theca is inclined at an angle of 15°, the apertural angle being as much as 120°.

At the first glance, this species may be recognized by its general appearance and expression, which deviates from that of the majority of *Didymograpti.*

Horizon and locality. Sparingly found in the *zone of Isograptus gibberulus* at Flagabro.

Genus **Isograptus** Moberg.

Isograptus gibberulus Moberg.

Plate III, figures 16—19.

1853. *Diplograpsus caduceus* Salter, ex p. Bigsby, On the Geology of Quebec and its environs; Quart. Journ. Geol. Soc., Vol. IX; p. 87, f. 1 right figure.

1863. » » Salter, ex p. Note on the Skiddaw Slate Fossils; Quart. Journ. Geol. Soc., Vol. XIX; p. 138, f. 13 a.

1875. *Didymograptus gibberulus* Nicholson, On a new Genus and some new Species of Graptol. from the Skiddaw Slates; Ann. Mag. Nat. Hist., Ser. 4, Vol. XVI; p. 271, Pl. VII, f. 3—6.

1891. » » Moberg, Om ett par synonymier; Geol. Fören. i Stockh. Förhandl., Bd. 13; p. 221.

1892. » » Moberg, Nya graptoliter från Skånes undre graptolitskiffer; Geol. Fören. i Stockh. Förhandl., Bd. 14; p. 346, Tafl. 8, f. 3—7.

1898. *Didymograptus gibberulus* G. ELLES, The Graptolite-Fauna of the Skiddaw Slates; Quart. Journ. Geol. Soc., Vol. LIV; p. 496, f. 17 (p. 498) and f. 18 (p. 499).

In the papers of NICHOLSON, MOBERG, and G. ELLES this species has been so fully described and characterized that a new description here would be superfluous. I have only to add some observations on the initial structure of the fossil.

The conical sicula has a length of 4,5 mm, and is apically provided with a virgula, the extent of which may be 20 mm, or more. For the further interpretation of the proximal parts it will be necessary to examine either aspect separately. In the obverse view (fig. 17) the first theca is seen to originate near the very apex of the sicula, and it assumes so precisely the same size and form as this that, except its place, it would be difficult not to mistake it for a sicula. The apertural portions of this two elements seem to be connected by a thin peridermal film, the true nature of which I am unable satisfactorily to explain. The two stipes appear to spring out symmetrically from below these parts. The reverse aspect (fig. 18) displays the same parts; but at the level at which the stipes arise, and very near the prolific side of the sicula, the first theca communicates only by means of a narrow foramen with the stipes; accordingly, on the one side with the second theca of the primordial stipe (th. 2^1) and with the common canal of the same, and on the other side with the first theca of the complemental stipe (th. 1^2) and the common canal of that side (compare fig. 19). These two thecæ as well as the two common canals are symmetrically arranged on the sides of the prolific wall of the sicula. Thus, the one stipe crosses the sicula, and the other stipe the first theca.

Horizon and localities. The species is common in the *zone of Isograptus gibberulus* at Killeröd and Komstad. Some smaller specimens have been found at Neckebo, probably in a passage bed between the said zone and the underlying one.

Genus **Mæandrograptus** MOBERG.

Mæandrograptus Schmalenseei MOBERG.

Plate III, figures 20—25.

1892. *Mæandrograptus Schmalenseei* MOBERG, Nya graptoliter från Skånes undre graptolitskiffer; Geol. Fören. i Stockh. Förhandl., Bd. 14; p. 344, Tafl. 8, f. 8—10.

The stipes are, at first, directed somewhat backwards, diverging at an angle oscillating between 260° and 240°, or, according to MOBERG's statement, between still wider limits. Commencing with a breadth of little less than 1 mm, they gradually expand until a width of 2 mm is obtained, and, judging from my most complete specimens, they have attained a length of, at least, 18 mm.

The sicula, which measures 2,5 mm in length and has a nearly uniform width of 0,2 or 0,3 mm, terminates in a pointed apex, from which a short, delicate virgula

proceeds. It is insensibly curved, and its apertural portion is, in some specimens, not entirely adnate to the first theca of the complemental stipe. The periderm is exceedingly thin, and lines from both the aspects are often traceable in the same impression. Though there are still several obscure points, due to the state of preservation of the fossil, about the structure of the proximal parts, I hope, however, that the following description will clear up some features peculiar to this strange graptolite. The first theca originates near the apex of the sicula. In the impression of the obverse aspect (fig. 21) the following details can be observed. The proximal half of the first theca, instead of flanking the sicula, is folded longitudinally over it; its free apertural part is bent outwards and a little backwards, and at the aperture provided with a short spine. The second and third thecæ of the primordial stipe (th. 2^1 and th. 3^1) apparently arise from the middle portion of the first theca. While giving off these two thecæ, the common canal may have turned down towards the apex of the sicula, being thus entirely incorporated with the adjoining part of the first theca. Only from the base of the fourth theca (th. 4^1) it takes the direction of the free stipe. Other details of this aspect will be understood from what follows. Corresponding deviations from the general *Didymograptus* type are seen in the reverse aspect (figs. 22—25). The cross-canal, before traversing the sicula, makes so broad a curvature towards the base of the primordial stipe that it wholly covers the bases of the three earliest thecæ of that stipe (th. 1^1, th. 2^1, th. 3^1). At the same time it widens markedly, and seems at once to emit three thecæ (or more rarely only two) before passing into the complemental stipe. This structure must, of course, be explained in the same way as the similar structure of the proximal part of the primordial stipe.

If this interpretation be right, the genus makes an obvious approximation to the mono-diprionidian and diprionidian graptolites.

The thecæ number 9 or 10 in the space of 10 mm. They display quaint modifications in shape and size along the stipes. Their varying forms will be more readily understood from the figures than from the most minute description. The first theca of each stipe has a moderate length, but the following ones increase successively until a length of 7 mm is attained by the tenth or eleventh theca. A line dropped perpendicularly from the aperture of the third theca cuts three succeeding thecæ, but such a line drawn from the tenth thecal aperture cuts five following thecæ. The free margin of the earliest five or six thecæ of either stipe show the form of a faintly bent S; it makes an outward curve before the aperture of the theca next behind, continues then in a shallow concave outline, and terminates in a short spine, projecting in the direction of the apertural edge. Between the thecal partitions, their proximal portions are flexuous, making one, two, or three undulations, according to their distance from the sicula. Beyond the fifth theca the interthecal walls become gradually more straight, and the thecæ themselves assume more and more the appearance of the typical *Didymograptus* thecæ. They

are, however, constantly twice as broad at the apertures as between the interthecal walls. The common canal is very narrow, and, owing to pressure normal to the direction of the stipes, often invisible. In this case, the dorsal margin exhibits a row of small notches reaching the inner edges of the thecal partitions.

Horizon and localities. The species seems to be confined to the *zone of Isograptus gibberulus*, and has been found at Killeröd and Komstad.

(Printed October 16, 1901.)

Explanation of Plate I.

Didymograptus undulatus n. sp.; page 10.
Mossebo; *zone of Tetragraptus phyllograptoides.*

Fig. 1. Compressed specimen; natural size.
» 2. Compressed specimen; natural size.
» 3. Proximal part of a specimen preserved in relief; obverse aspect; distal portion of the sicula and some of the thecæ incomplete; magn. $^{6}/_{1}$.
» 4. Compressed specimen, proximal portion; reverse aspect; magn. $^{5}/_{1}$.
» 5. Compressed specimen, proximal portion; the shadowed part represents the obverse aspect, and the white portion, the impression of the reverse aspect; magn. $^{11}/_{2}$.
» 6. Portion of the same specimen more enlarged, showing the sicula with a virgula.
» 7. Proximal portion of a strongly compressed specimen; obverse aspect; some thecæ of the primordial stipe are incomplete; a line running across the sicula is seen through from the opposite aspect; magn. $^{5}/_{1}$.

Didymograptus demissus n. sp.; page 11.
Mossebo; *zone of Tetragraptus phyllograptoides.*

Fig. 8. Compressed specimen; natural size.
» 9. Proximal portion of a compressed specimen; obverse aspect; magn. $^{5}/_{1}$.
» 10. Compressed specimen, proximal portion; reverse aspect; magn. $^{6}/_{1}$.
» 11. Portion of a stipe; magn. $^{6}/_{1}$.

Didymograptus geometricus n. sp.; page 11.
Mossebo; *zone of Didymograptus balticus.*

Fig. 12. Compressed specimen; natural size.
» 13. Proximal portion of a compressed specimen; reverse aspect; magn. $^{11}/_{2}$.
» 14. Portion of a compressed stipe; magn. $^{9}/_{2}$.

Didymograptus Holmi n. sp.; page 12.
Mossebo; *zone of Tetragraptus phyllograptoides.*

Fig. 15. Impression of a specimen preserved in relief; reverse aspect; natural size.
» 16. Impression of a compressed specimen, proximal part; obverse aspect; magn. $^{5}/_{1}$.
» 17. Impression of a specimen partly compressed, partly preserved in relief; proximal portion; obverse aspect; magn. $^{5}/_{1}$.
» 18. Impression of a fragment of a stipe preserved in relief; magn. $^{5}/_{1}$.

Didymograptus suecicus Tullberg; page 13.
Flagabro figs. 19, 20, 22, 23; *zone of Phyllograptus densus.*
Mossebo fig. 21; *zone of Didymograptus balticus.*

Fig. 19. Impression of a specimen in flattened relief; obverse aspect; natural size.
» 20. Impression of a specimen in flattened relief, proximal portion; obverse aspect; magn. $^{11}/_{2}$.

Fig. 21. Young specimen in half relief; reverse aspect; magn. $^{9}/_{2}$.
» 22. Longitudinal section through the proximal part of a specimen converted into pyrites; apex of the sicula and the apertures of the thecæ are ground away; magn. $^{4}/_{1}$.
» 23. Portion of a stipe, the most part of which is preserved in relief; magn. $^{7}/_{2}$.
» 24. Portion of a stipe in half relief.

Didymograptus extensus HALL; page 14.
Killeröd; *zone of Isograptus gibberulus.*

Fig. 25. Impression of a specimen in faint relief; obverse aspect; natural size.
» 26. Impression of a specimen in faint relief, proximal portion; obverse aspect; magn. $^{9}/_{2}$.
» 27. Impression of a specimen in faint relief, proximal portion; reverse aspect; the apex of the sicula is broken off; magn. $^{9}/_{2}$.
» 28. Impression of a specimen in faint relief, distal fragment; magn. $^{4}/_{1}$.
» 29. Portion of a stipe in half relief; magn. $^{7}/_{2}$.
» 30. Portion of a stipe in half relief; magn. $^{9}/_{2}$.

Explanation of Plate II.

Didymograptus patulus HALL; page 15.
Killeröd; *zone of Isograptus gibberulus.*

Fig. 1. Impression of a flattened specimen; obverse aspect; natural size.
» 2. Impression of a flattened specimen, proximal portion; obverse aspect; magn. $^{9}/_{2}$.
» 3. Impression of a flattened specimen, proximal portion; obverse aspect; magn. $^{4}/_{1}$.
» 4. Impression of a specimen in half relief, proximal portion; reverse aspect; magn. $^{9}/_{2}$.
» 5. Impression of a portion of compressed stipe; magn. $^{7}/_{2}$.
» 6. Impression of a fragment of a strongly compressed stipe; magn. $^{4}/_{1}$.

Didymograptus prænuntius n. sp.; page 17.
Flagabro; *zone of Phyllograptus densus.*

Fig. 7. Compressed specimen; natural size.
» 8. Impression of a specimen in relief, proximal portion; obverse aspect; magn. $^{9}/_{2}$.
» 9. Proximal portion of a specimen in relief; reverse aspect; the primordial stipe and the sicula are shown as impression; magn. $^{5}/_{1}$.
» 10. Impression of a specimen in faint relief, proximal portion; reverse aspect; magn. $^{9}/_{2}$.
» 11. Impression of a portion of a stipe; magn. $^{5}/_{1}$.
» 12. Impression of a fragment of a compressed stipe; magn. $^{4}/_{1}$.

Didymograptus constrictus HALL; page 17.
Mossebo figs. 13, 16, 17; Flagabro figs. 14, 15; *zone of Didymograptus balticus.*

Fig. 13. Compressed specimen; reverse aspect; natural size.
» 14. Impression of a compressed specimen; obverse aspect; natural size.
» 15. Proximal portion of a specimen preserved in relief; obverse aspect; apex of the sicula broken off, distal portions of the thecæ flattened out; magn. $^{9}/_{2}$.
» 16. Portion of a compressed stipe; magn. $^{4}/_{1}$.
» 17. Impression of a portion of a stipe, the dorsal half of which is preserved in relief, the ventral half flattened out; magn. $^{7}/_{2}$.

Didymograptus validus n. sp.; page 18.
Mossebo; *zone of Didymograptus balticus.*

Fig. 18. Compressed specimen; reverse aspect; natural size.
» 19. Compressed specimen; natural size.
» 20. Proximal portion of a compressed specimen; obverse aspect; magn. $^{3}/_{1}$.

Didymograptus balticus TULLBERG; page 19.
Mossebo figs. 21, 22, 24; Flagabro figs. 23, 25; *zone of Didymograptus balticus.*

Fig. 21. Compressed specimen, partly seen as impression; natural size.
» 22. Compressed specimen; reverse aspect; natural size.

Fig. 23. Compressed specimen; obverse aspect; aperture of the sicula obscure; magn. $^4/_1$.
» 24. Impression of a specimen in faint relief, proximal portion; reverse aspect; magn. $^4/_1$.
» 25. Impression of a portion of a stipe preserved in relief; magn. $^4/_1$.

Didymograptus vacillans TULLBERG; page 20.
Mossebo; *zone of Didymograptus balticus.*

Fig. 26. Specimen in faint relief; reverse aspect; natural size.
» 27. Impression of a specimen in relief, proximal portion; obverse aspect; magn. $^4/_1$.
» 28. Impression of a specimen in relief, proximal portion; reverse aspect; magn. $^5/_1$.
» 29. Distal fragment; dorsal side shown as hollow cast, the apertural portions of the thecæ strongly compressed, and visible only in favourable light; magn. $^9/_2$.

Explanation of Plate III.

Didymograptus Kurcki n. sp.; page 20.
Jerrestad; *zone uncertain.*

Fig. 1. Impression of a specimen preserved in faint relief; natural size.
» 2. Impression of a specimen in faint relief, proximal portion; reverse aspect; apex of the sicula broken off; magn. $^{5}/_{1}$.
» 3. Impression of a specimen in faint relief, proximal portion; reverse aspect; magn. $^{9}/_{2}$.
» 4. Specimen in half relief; the first theca shown as impression; magn. $^{5}/_{1}$.
» 5. Impression of a portion of a stipe preserved in faint relief; magn. $^{11}/_{2}$.

Didymograptus filiformis Tullberg; page 21.
Mossebo; *zone of Didymograptus balticus.*

Fig. 6. Impression of a specimen preserved in relief; natural size.
» 7. Impression of a specimen in relief, proximal portion; obverse aspect; magn. $^{11}/_{2}$.
» 8. Impression of a specimen in relief, proximal portion; reverse aspect; magn. $^{7}/_{2}$.
» 9. Impression of a fragment of a stipe; magn. $^{9}/_{2}$.

Didymograptus flagellifer Tullberg mscr.; page 22.
Gislöf; *zone uncertain.*

Fig. 10. Impression of a slightly flattened specimen; natural size.
» 11. Longitudinal section through the proximal portion of a specimen converted into pyrites; the dark parts show the surface untouched by the honey; magn. $^{6}/_{1}$.

Didymograptus Mobergi n. sp.; page 23.
Killeröd; *zone of Isograptus gibberulus.*

Fig. 12. Impression of a flattened specimen, proximal part; reverse aspect; natural size.
» 13. Impression of a fragment of a flattened stipe; natural size.
» 14. Impression of a flattened specimen, proximal portion; reverse aspect; magn. $^{6}/_{1}$.
» 15. Impression of a flattened distal fragment; magn. $^{9}/_{2}$.

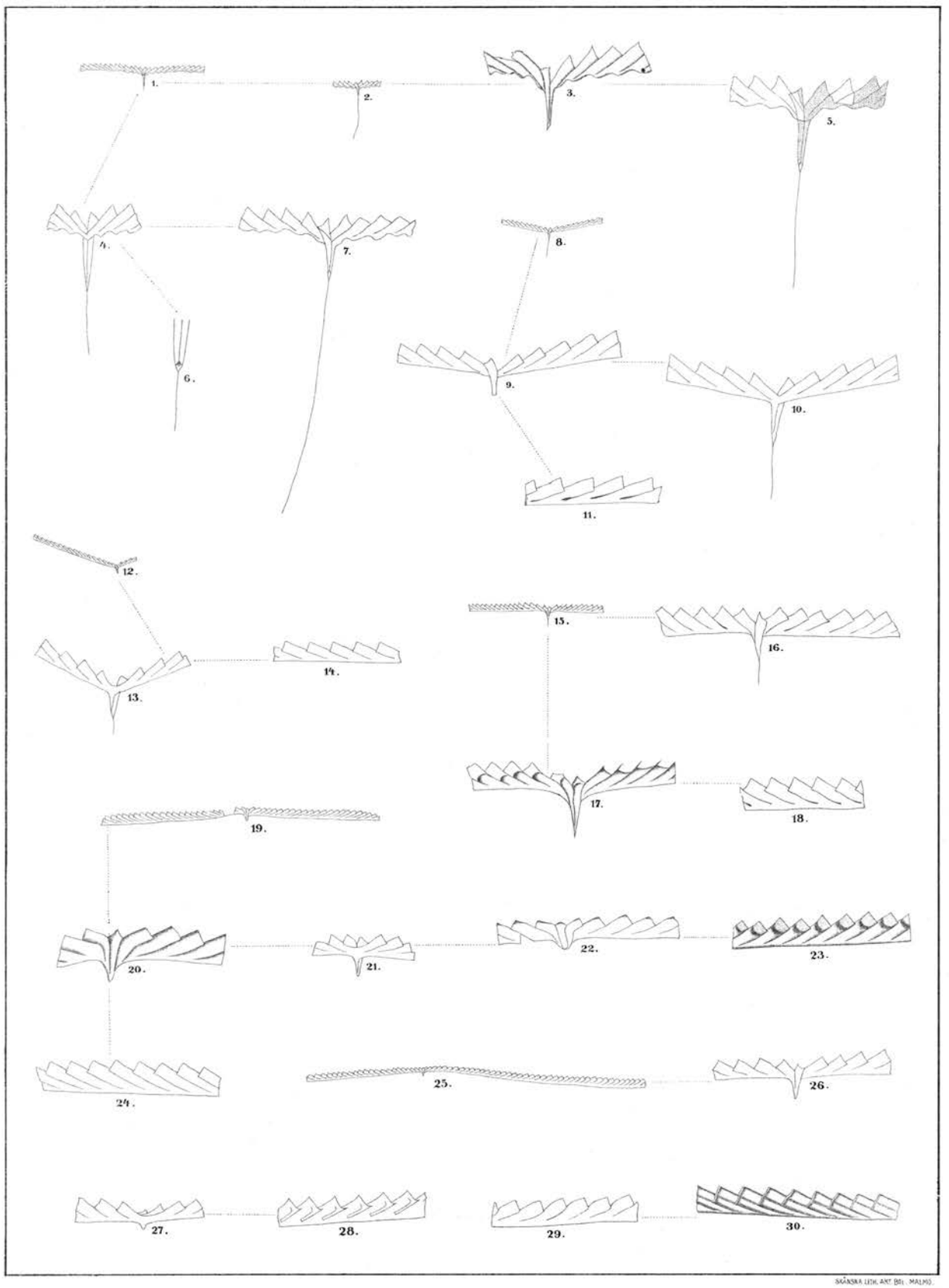
Isograptus gibberulus Nicholson; page 23.
Killeröd; *zone of Isograptus gibberulus.*

Fig. 16. Impression of a flattened specimen; reverse aspect; natural size.
» 17. Impression of a specimen in flattened relief, proximal portion; obverse aspect; magn. $^{9}/_{2}$.
» 18. Impression of a flattened specimen, proximal portion; reverse aspect; the sides of the sicula and of the first theca are seen through from the obverse aspect; magn. $^{4}/_{1}$.
» 19. Young specimen preserved in flattened relief; reverse aspect; magn. $^{4}/_{1}$.

Mæandrograptus Schmalenseei MOBERG; page 24.

Killeröd; *zone of Isograptus gibberulus.*

Fig. 20. Impression of a flattened specimen; natural size.
» 21. Impression of a specimen in faint relief, proximal portion; obverse aspect; magn. $^{9}/_{2}$.
» 22. Impression of a specimen in faint relief, proximal portion; reverse aspect; magn. $^{5}/_{1}$.
» 23. Impression of a flattened specimen, proximal portion; reverse aspect; magn. $^{5}/_{1}$.
» 24. Impression of a flattened specimen, proximal portion; reverse aspect; magn. $^{9}/_{2}$.
» 25. Impression of a flattened specimen, proximal portion; reverse aspect; sicula visible through from the obverse aspect; magn. $^{9}/_{2}$.



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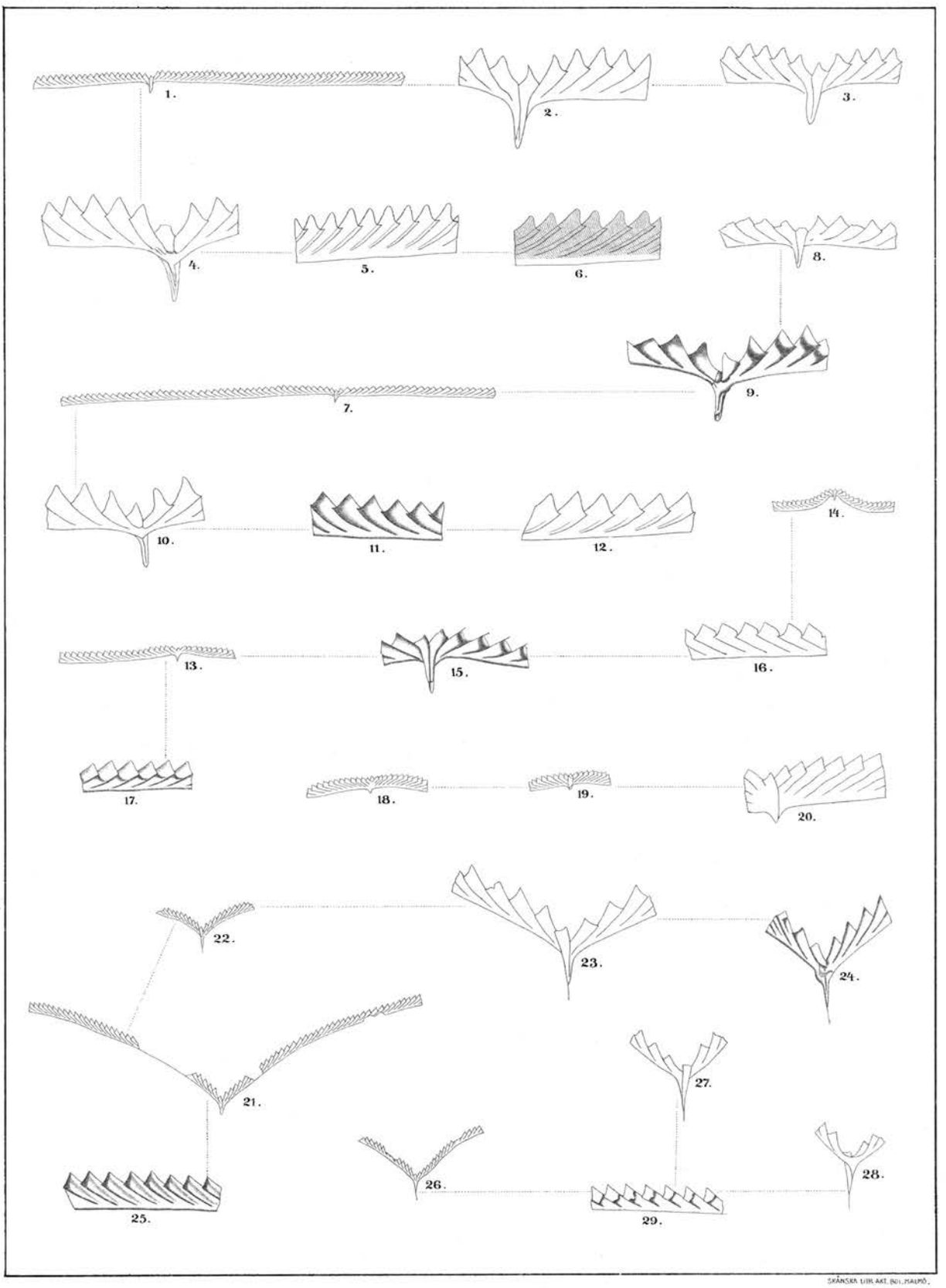

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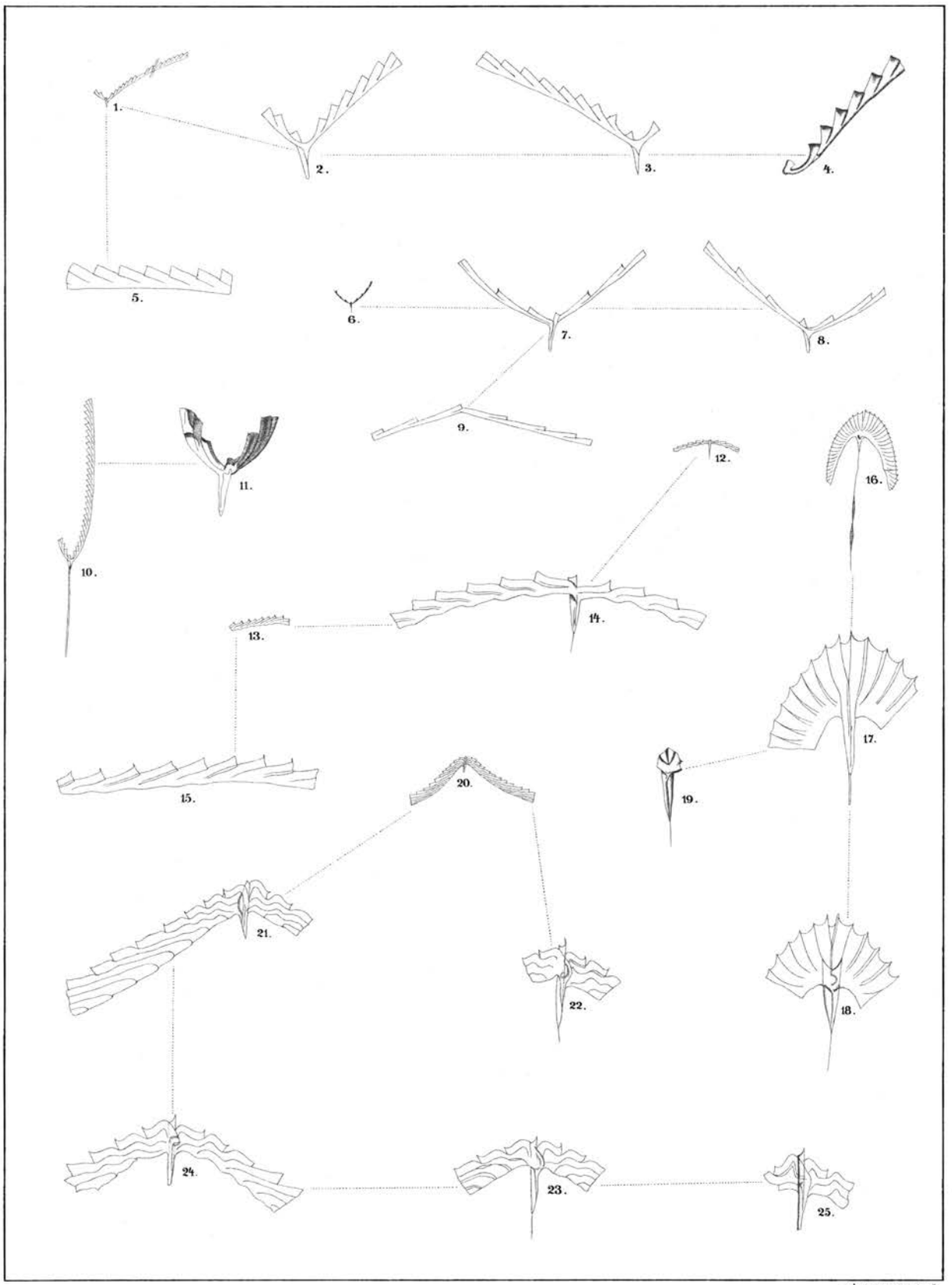

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