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ON SOME ORDOVICIAN GRAPTOLITE ASSEMBLAGES
OF BELGIUM,

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During a recent visit to the Institut royal des Sciences naturelles de Belgique, I had the privilege of examining collections of graptolites from various horizons in the Ordovician of Belgium. It appeared that some of the current determinations stood in need of revision, and the revised determinations provide some interesting evidence to be considered in connection with the palæogeography of the period. For this reason, it has been thought worth while to publish the revised lists in full.

Following the pioneer work of MALAISE, revised in a series of papers by MAILLIEUX, the graptolitic Ordovician of Belgium has been recognized as belonging to four main horizons identified (MAILLIEUX, 1926) as of Tremadocian, Upper Arenigian, Upper Llandeilian and Caradocian (Lower Hartfell) age.

1. Tremadocian.

Tremadocian beds carrying *Dictyonema flabelliforme* cf. var. *sociale* and asaphid trilobites have recently been identified in the Brabant massif (Dyle Valley). In recording this discovery, M. LECOMPTE (1948) has also furnished a revision of the *Dictyonema* material which was already known from various localities in the Stavelot massif, and there is nothing to add to the palæontological data given there.

2. Arenigian.

So-called Arenigian rocks, as yet unrecognized in the Brabant massif, have been recorded from several localities along the « Bande de Sambre-et-Meuse », principally from Huy and Sart-Bernard, the latter being the subject of a recent monograph by E. MAILLIEUX (1939). These constitute the « Assise de Huy » and carry a form originally identified by MALAISE as *Didymograptus murchisoni*, emended by MAILLIEUX to *Didymograptus bifidus*; and would thus belong to what it is customary in Britain to call Llanvirn. After examining the material in question, I formed the opinion that it was not referable to the true *D. bifidus*, but was either a very early form of that species or a late form of *D. protobifidus*; and the associated graptolite fauna would be consistent with a reference to the top of the *Didymograptus hirundo* zone or at most the very base of the *D. bifidus* zone. The term Arenigian, even in its restricted sense, would thus seem after all more correct than Llanvirnian. In addition to this, however, there is at Sart-Bernard a higher horizon (2a) of the same general series at which the true *D. bifidus* occurs associated with a trilobite fauna recalling the Llanvirn of Bohemia; and what appear to be the same arthropods are present, less abundantly, at the lower horizon. Since the series thus belongs wholly neither to the Arenigian *s. str.* nor the Llanvirnian, but bridges the two, it is perhaps desirable to retain the current term Arenigian, although at the risk of some ambiguity on account of the more restricted use of that term in Britain.

The revised graptolite lists from Huy and Sart-Bernard as follows :

« Pl. Huy n. 1. Huy-Statte, derrière le tank à eau près du tunnel. »

Didymograptus protobifidus ELLES (late form).

» *nicholsoni* var. *planus* ELLES & WOOD.

» cf. *gracilis* TÖRNQUIST.

» *callotheca* BULMAN (rare).

Tetragraptus serra (BRONGNIART).

Dichograptus octobrachiatus (HALL) hexad and pentad forms), and large dichograptid stipes.

Climacograptus scharenbergi LAPWORTH.
Glyptograptus dentatus (BRONGNIART).
Amplexograptus cf. *confertus* (LAPWORTH).
Glossograptus cf. *acanthus* ELLES & WOOD.

« Pl. Naninne n. 1. Sart-Bernard, tranchée chemin de fer au N-O de la gare. »

Didymograptus protobifidus ELLES (late form, or early
D. bifidus).
 » *nicholsoni* var. *planus* ELLES & WOOD.
 » cf. *prænuntius* TÖRNQUIST.
 » *callotheca* BULMAN.
 » cf. *climacograptoides* HOLM (BULMAN).
 » cf. *leptograptoides* MONSEN.

Dichograptus octobrachiatus (HALL) (hexad form), and large dichograptid stipes.

Phyllograptus glossograptoides EKSTRÖM.

Glyptograptus dentatus (BRONGNIART).

Amplexograptus cf. *confertus* (LAPWORTH).

Cryptograptus antennarius (HALL).

It is from the latter locality that MAILLIEUX has recently (1939) described and figured the graptolite fauna, and the following notes will explain certain discrepancies between his list and that given above :

- Pl. I, fig. 5 (non fig. 6) *D. bifidus* = late *protobifidus*.
 fig. 7 *D. acutidens* = *D. callotheca*.
 fig. 8 *D. stabilis* = possibly an early form of *bifidus*;
 the thecae are too close-set for *stabilis*.
 fig. 10 *P. angustifolius* = *P. glossograptoides*.
 fig. 9 *Cl. scharenbergi*; the figured specimen appears
 to be the septal view of a diplograptid split
 down the middle and is indeterminate. *Cl.*
scharenbergi occurs at Huy and may well be
 present at Sart-Bernard, but I did not see
 any material definitely referable to this
 species.
 fig. 3 *Cryptograptus tricornis* = *C. antennarius*.

The assemblages from Huy and Sart-Bernard are so nearly identical that they may surely be regarded as the same faunal horizon. Undoubtedly the most interesting feature of this fauna is its strong Scandinavian affinity. *Didymograptus callotheca* has not until now been recognized outside Sweden, where it occurs in the grå Vaginatumkalk (Lower Orthoceras Limestone) of Oeland (BULMAN, 1936) for which a *hirundo* zone age was argued. It there occurs associated *inter alia* with *Didymograptus cucullus*, *D. gracilis* TÖRNQUIST mut. Holm, *Climacograptus scharenbergi* and *Glyptograptus dentatus*. Now *D. cucullus* may eventually be shown to be identical with *D. climacograptoides*, which is only known from compressed shale examples; and *D. climacograptoides* occurs not only at Huy and Skåne (= *D. obscurus* of EKSTRÖM) but also the Lake District (Skiddaw Slates) and South America. In addition to these Vaginatumkalk species, the Huy fauna also includes *Didymograptus leptograptoides* (described from Norway and Sweden by MONSEN, 1937 and probably, as « *D. cf. euodus* », from Peru by BULMAN, 1933), *D. cf. prænuntius* (a characteristic Swedish form, known also from Norway and the Lake District), and *Phyllograptus glossograptoides* (described from Skåne by EKSTRÖM and possibly identical with « *Glossograptus* (?) sp. » of MONSEN).

Possibly this same horizon is again represented by a few specimens labelled « Pl. Naninne 3. Tranchée chemin creux 580 m E du château de Dave » which include ? *Glyptograptus dentatus* and *Phyllograptus cf. glossograptoides*.

The somewhat higher horizon mentioned above is more precisely localized as : « Pl. Naninne 2a. Sart-Bernard, tranchée Est station, 22 m ouest Km 73.1 au pied poteau télégraphique. Paroi sud ». Here occurs a much more restricted graptolite fauna consisting essentially of typical *Didymograptus bifidus*, associated with dichograptid stipes and some indeterminate fragments, with abundant arthropod remains identified by MAILLIEUX as *Cyclopyge prisca longicephala* KLOUCEK and *Lamprocaris micans* NOVAK. (These are also, more rarely, present at the Naninne 1 horizon). It seems probable that this higher horizon is also encountered at « Fosse 400. Puits creusé en 1913 dans le jardin Decoux, route de Ligny à Fosse » (yielding ? *D. bifidus* and *G. cf. teretiusculus* with ostracods and phyllocarids) and « Charbonnage d'Ormont. Sondage du Bois des Malagnes à Bouffioulx, profondeur 423-425 m » (yielding *D. bifidus* and *D. cf. nanus* associated with ostracods and phyllocarids).

3. Llandeilian.

The principal occurrence of this graptolite assemblage is « Pl. Tamines n. 8. Vitriyal (Bruyères) (Bande de Sambre-et-Meuse) » and the fauna comprises :

Leptograptus cf. *validus* LAPWORTH MS, ELLES & WOOD.

Leptograptus sp.

Dicellograptus cf. *divaricatus* (HALL).

Orthograptus truncatus intermedius ELLES & WOOD.

» *calcaratus vulgatus* ELLES & WOOD.

together with an Amplexograptid strongly reminiscent of and presumably a late development of the peculiar form described from the Lower Orthoceras Limestone of Oeland as *Amplexograptus* cf. *cœlatus* (BULMAN, 1936, pl. 3, figs. 30, 31). The horizon, as indicated by MAILLIEUX, is near that of the zone of *Climacograptus peltifer*; and the small collection from « Pl. Tamines 8, au pied S du tienne de la Bruyères, dans le ruisseau de Givaux » comprising :

Orthograptus truncatus intermedius ELLES & WOOD.

Glyptograptus terctiusculus euglyphus (LAPWORTH).

? *Climacograptus scharenbergi* LAPWORTH.

is comparable.

The use of the term « Llandeilian » for this horizon is unsatisfactory, and the reader is referred to the discussion in JONES [1933 (1935) pp. 7, 8] and the Shrewsbury Memoir (1938, pp. 79, 81). The actual Llandeilo Limestone horizon is unrepresented, at least in the graptolitic succession, in Belgium.

4. Caradocian.

The Schistes de Fauquez (Brabant massif) have been regarded by MAILLIEUX as belonging to the zone of *Pleurograptus linearis*, and while this is not absolutely certain, it is in all probability correct. The fauna from « Pl. Feluy. Au N de Monstreux » consists of :

Dicellograptus forchammeri (GEINITZ).

Climacograptus caudatus LAPWORTH.

» *styloideus* LAPWORTH (ELLES & WOOD).

Orthograptus truncatus intermedius ELLES & WOOD.
 » *calcaratus basilicus* LAPWORTH (ELLES & WOOD)
 together with a fragment referred with some reserve to *Pleurograptus linearis*.

The newly-discovered fauna from Lessines (also Brabant massif) is rather more uncertain, but I am inclined to refer it to the underlying zone of *Dicranograptus clingani*; it comprises the following forms :

- Dicellograptus morrisoni* HOPKINSON.
 » *forchammeri* (GEINITZ).
 » *johnstrupi* HADDING.
 » cf. *pumilus* LAPWORTH.
Climacograptus cf. *brevis* ELLES & WOOD.
 » *minimus* (CARRUTHERS).
 » cf. *supernus* ELLES & WOOD.
Orthograptus ? *truncatus* LAPWORTH.
 » *truncatus pauperatus* ELLES & WOOD.
 » *calcaratus vulgatus* ELLES & WOOD.
 » » *basilicus* LAPWORTH (ELLES & WOOD)
 » » aff. *robustus* HADDING.

On some bedding planes, the dicellograptids make up a tangled mat of stipes resembling *Pl. linearis*, but a very careful search has failed to provide any undoubted evidence of the presence of that species; and on balance, a reference of the fauna to the *D. clingani* zone seems preferable. Even this level is high for the occurrence of *Cl. brevis*, but ELLES and WOOD figure a specimen from the *linearis* zone and it is recorded by HADDING from the *clingani* and *styloideus* zones of Bornholm. The specimens identified as *calcaratus* aff. *robustus* possess too numerous thecae, but agree well in all other respects with HADDING's variety. Some connection with Scandinavia at this level again is suggested by the high form of *Cl. brevis*, the occurrence of *D. johnstrupi* and the variety of *calcaratus* resembling *robustus*.

CONCLUSIONS.

The general characters of the graptolite faunas of the Ordovician of Belgium have been indicated by MAILLIEUX (1926) and require only slight adjustments. The main « Arenigian »

fauna of Huy and Sart-Bernard is in all probability slightly earlier than the zone of *D. bifidus*, though the higher horizon 2a of Sart-Bernard is of undoubted *D. bifidus* zone age (i. e., Lower Llanvirn). The « Llandeilian » fauna is confirmed as referable to the zone of *Cl. peltifer*, which according to current practice in Britain would be assigned to the Lower Caradoc (or Upper Glenkiln). The higher Caradoc faunas are somewhat lacking in precision, but that of Lessines is probably *D. clingani* zone, while Monstreux (Schistes de Fauquez) may represent the *linearis* zone (the upper part of the Lower Hartfell).

In all of them, Scandinavian affinities are recognizable, particularly the Assise de Huy where there is much to suggest direct communication with South Scandinavia, the Lake District, and Bohemia. Reference may be made to TURNER's recently published views (1949) on the relations of the Lower Palaeozoic of the Lake District to Brabant and Scandinavia.

It is a pleasure to express my thanks to Professor V. VAN STRAELEN for his generous invitation to Brussels, and to Professor M. LECOMPTE and Dr. R. VAN TASSEL for their cordial assistance during my visit.

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