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NEW TRILOBITES FROM THE HØLONDA LIMESTONE (TRONDHEIM REGION, SOUTHERN NORWAY)

BY

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With 6 figures in the text.

Abstract. The trilobite fauna of the Hølonda Limestone comprises nine more or less imperfectly known species, listed on p. 83, the greater part of them of Scandinavian—Baltic affinity. The fauna indicates a stratigraphical horizon equivalent to some part of the Orthoceras Limestone Series of Sweden, not below the Asaphus Limestone zone (divisions 3cβ — 4a of the Oslo Region). Paleogeographical relations with broadly contemporaneous faunas in Scotland and Ireland and Newfoundland are claimed to exist.

In an area in the Trondheim Region between the Gauldal and Orkedal valleys practically unmetamorphic Ordovician rocks occur, which have yielded determinable fossils from various horizons. The stratigraphy of this area was put on a firm paleontological basis by the work of Kiær (1932) with the cooperation of several paleontologists. Recently the geology of a part of this area has been worked out and mapped in great detail by Professor Thorolf Vogt of Trondheim (Vogt 1945). The work of Professor Vogt also resulted in the discovery of some interesting specimens of fossils from earlier-known localities, as well as of a new fossil locality, situated north-east of the farm of Trotland, somewhat outside and to the west of the area mapped. Among the fossils from the new locality trilobites predominate, while this group forms only a small part of the faunas earlier collected from the same horizon. The stratigraphy of the deposits concerning us here can thus be summarized from Vogt's paper (from younger to older):

Hølonda Porphyrites.

Hølonda[1] Limestone, fine-grained bluish-grey limestone of variable

[1] In the papers of Kiær and coworkers (1932) this name was written Hølandet.

thickness. With great thickness a dark grey shale is frequently intercalated in the upper part of the limestone.

Fossils from this horizon have been described by Høeg (1932) (calcareous algae), Foerste (1932) (cephalopods), Reed (1932) (brachiopods) and Strand (1932) (trilobites, etc.).

Lists of the fossils are contained in Kiær 1932, p. 36, and in Vogt 1945, p. 477.

Hølonda Shales and Sandstones, occasionally with indeterminable traces of fossils.

Gaustadbakk Breccia.

Venna Conglomerate, forming the base of the Hovin Series.

Støren Greenstones (Bymark Group of Carstens), the wellknown volcanic division of Lower Ordovician (Skiddavian) age.

The horizon of the newly-found faunule seems to be in the dark grey shale intercalated in the Hølonda Limestone. If not, it is in the upper part of the Hølonda Shales and Sandstones, just below the Hølonda Limestone, but this is less probable (Vogt 1945, p. 476).

The fossils in the new collection of Professor Vogt were handed over to the writer, who also collected material at the new locality in the autumn of 1945. The material collected by Professor Vogt is in the geological collection of Norges Tekniske Høgskole, Trondheim; the material collected by the writer is deposited in the Paleontologisk Museum, Oslo.

The fauna of the Hølonda Limestone is of great interest as one of the few faunas known from the older Ordovician in the central parts of the Caledonian geosyncline in Scandinavia. It may be noted that the new finds confirm the views held by the late Professor Johan Kiær on the age and faunal relations of the Hølonda Limestone.

Trinodus? sp.

Fig. 3.

Material at hand. A piece of marlstone collected by Professor Vogt with a mould showing the anterior parts of the pygidium and one thoracic segment (indistinct). It can be studied on artificial casts only.

Description. Pygidium broadly rounded, nearly 3 mm wide anteriorly and probably about 2 mm long. Anterior outline curved backwards at the sides, where there is a distinct limb and furrow at the border. Rachis distinctly elevated above the surface of the shield with rounded trapezoidal outline, 1,2 mm wide anteriorly and 1,5 mm

long. It is divided into three lobes by distinct transverse furrows; the posterior and middle lobes are of about equal size, while the anterior lobe is distinctly smaller. The rachis has a median elevation or keel, the posterior end of which is at the posterior transverse furrow.

Remarks. In the absence of any knowledge of the cranidium, the systematic position of the present agnostid may be uncertain, Yet, the pygidium agrees perfectly with that of the genus *Trinodus* of the subfamily *Geragnostinae* (Kobayashi 1939). This genus is fairly widespread in the Ordovician with its oldest occurrence in the Ceratopyge beds in Sweden. We may note that the genus is represented in deposits of Chazyan age in Ireland, as well as in Newfoundland and eastern Appalachian areas of North America.

Horizon and locality. Shale intercalated in the Hølonda Limestone, at the winter-road at the Damtjernet pond near Ven, Hølonda.

Eoharpes sp.

Material at hand. A fragmentary brim collected by Prof. Vogt.

Description. The specimen is a part of the left half of the brim preserved to a length of 20 mm and 4 mm wide. A pitting of the brim is visible in a part of the specimen; there are 5 to 7 pits to one millimetre.

Remarks. The specimen is referred to *Eoharpes* rather than to *Harpes* in view of its stratigraphical occurrence. It may with fair confidence be determined as a trilobite of the Harpes type, but is too incomplete for a closer comparison with earlier described species.

Horizon and locality. Grey shale intercalated in Hølonda Limestone, north-east of Trotland, Hølonda.

Gonotelus? broeggeri Strand.

1932. *Gonotelus broeggeri*, Strand, p. 159, text-fig. 16, pl. 27 figs. 4–8.

Remarks. There is no new material of this species and nothing to add to its description, but its generic reference may be open to discussion. The reference to *Gonotelus* Ulrich (=*Goniurus* Raymond) rested on the authority of Dr. E. O. Ulrich (*vide* Strand 1932, p. 163), Comparison with figures of typical species of *Gonotelus* from the Beekmantown (Raymond 1913, p. 65, pl. 7 figs 10—12) does not bring out any striking similarity to the species here considered. The spined pygidium of *G.? broeggeri* is a feature common to many genera, and is thus not in itself of any great importance for a generic reference.

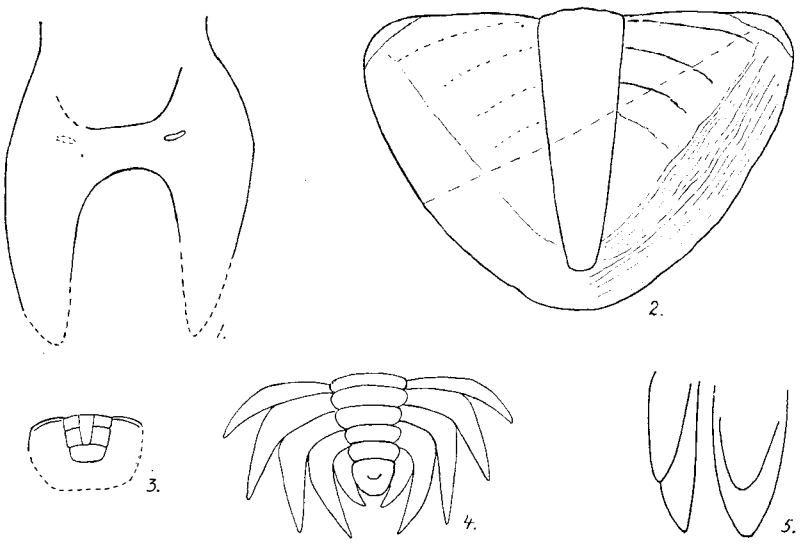

Fig. 1. *Pseudasaphus?* sp., hypostome, somewhat enlarged. No. 65630, Paleontologisk Museum, Oslo (P. M. O.)

Fig. 2. *Niobe?* sp., pygidium, ×1½. Only the parts behind the stippled line are preserved in the specimen. No. 65598, P. M. O.

Fig. 3. *Trinodus?* sp., pygidium, ×5. Drawn from an artificial cast, specimen collected by Prof. Vogt.

Fig. 4. *Pliomerops* sp., ×1½. Reconstruction sketch of pygidium, based on a specimen collected by Prof. Vogt and on specimen No. 65593, P. M. O.

Fig. 5. *Pliomerops?* sp., hypostome, nearly natural size. No. 65619, P. M. O.

All specimens depicted in figs 1—5 are from the Hølonda Limestone. *Trinodus?* sp. (fig. 3) was collected at the Damtjernet pond near Ven; the others are from the newly-discovered locality north-east of Trotland, Hølonda parish.

The pygidium of *G.? broeggeri*, the only part adequately known, has some general resemblance to that of *Bathyurus? congeneris* Walcott from the Pogonip of Nevada (Walcott 1884, p. 92, pl. 12, fig. 8). which species was referred to Matthew's genus *Holasaphus* in Bassler's Index. The genotype of *Holasaphus*, *H. centropyge*, as figured by Matthew (1895, p. 268, pl. 2, fig. 4) seems less similar to *G.? broeggeri* than is Walcott's species. In any case *G.? broeggeri* is evidently not related to any genus known from Scandinavian — Baltic faunas, and it is hoped that its relationships can be cleared up from the side of American paleontologists.

Horizon and locality. Hølonda Limestone, Skjærsjøhaugen and Vestre Katuglås, Hølonda.

Niobe vogti n. sp.
Fig. 6.

Derivation of name. In honour of Professor Thorolf Vogt, who discovered the faunule to which this species belongs.

Material at hand. A small number of mostly fragmentary pygidia, of which only one is tolerably well preserved, described below as the holotype.

Diagnosis. Pygidium with lateral and posterior outline subelliptical, proportion length to width about 0,7, probably with six lateral lobes, axis narrow and slowly tapering, pointed behind. Surface of test of pygidium with a sculpture of terrace lines parallel to the posterior and lateral outline.

Description. Holotype is a fragmentary pygidium with corresponding external mould, preserved in full relief and not sensibly distorted as to general form, but with some compression of the anterior lateral lobes. Length 23,5 mm, half the width 19 mm. Outline of lateral and posterior margin subelliptical. Near the anterior margin the specimen is broken, probably along the anterior border furrow, which sweeps strongly backwards at the sides. Shell with a moderate convexity with flatly depressed border. Axis narrow and as far as can be judged slowly tapering, with pointed end, separated by a short interspace (about 2 mm) from the posterior margin. A small part of the doublure is preserved in the posterior part, where a careful inspection reveals a thickening delimited by a straight line 7 mm from the posterior end. The terrace-lines on this small remnant of the doublure show disaccordance with terrace-lines meeting from the posterolateral part of the test. It is thus clear that the sculpture shown on the greater parts of the specimen belongs to the surface of the test and not to the doublure.

Further specimens are too badly preserved to add anything to the description, it may only be noted that the largest specimen in the collection indicates a length of 35 mm and a width of 50 mm of the pygidium.

Remarks. The generic reference of the present species rests on the general form of the pygidium with a depressed border and rounded lobes occurring in small numbers. Also the terrace-line sculpture on the test surface with a direction parallel to the margin is found in some other species of *Niobe*. In many other asaphid genera the course of the corresponding sculpture forms a small acute angle with the anterior margin.

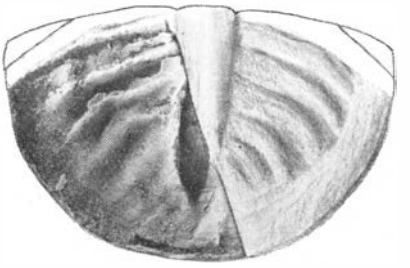

Fig. 6. *Niobe vogti* n. sp., pygidium, × 1½. To the left an unretouched photograph of the external mould; the right part is a drawing of the corresponding cast, anterior outline restored. Holotype, No. 65601—02, P. M. O. Hølonda Limestone, north-east of Trotland.

N. vogti is similar to *N. frontalis* (Brøgger 1882, p. 68, here determined as *N. emarginula*, cf. Brøgger 1886, p. 51). Both species have the same outline of the pygidium and the same type of surface sculpture, probably also with a corresponding number of lobes. The present species is distinguished by its narrower and less tapering axis with a pointed end. The *Niobe* pygidium described by Reed (1910, p. 272) from the Glensaul District of North-West Ireland seem to have a more subtriangular outline and may thus resemble the specimen described below as *Niobe* sp. Among the three species of *Niobe* described from Newfoundland by Raymond (1925) *N. morrissi* has some resemblance to the present species. Two species of *Niobe* described by Poulsen (1937) from East Greenland have a surface sculpture reminiscent of *N. vogti*, but are clearly distinguished by the extremely wide borders of the pygidium.

Horizon and locality. Grey shale intercalated in Hølonda Limestone, north-east of Trotland, Hølonda.

Niobe? sp.

Fig. 2.

Material at hand. A fragmentary pygidium without test, preserved in semi-relief.

Description. Length of pygidium to the ante-lateral facet, 25 mm, half the width 19 mm. Outline rounded triangular in lateral and posterior parts. The direction of the three anterior lobes indicate a forward curvature of the anterior margin. A clearly shown striated doublure occupies half the distance between margin and axis in the median part, and crosses the axis 8 mm from the posterior end.

Remarks. Possibly this specimen may represent a narrow form of *N. vogti* with a subtriangular outline, but the poor material does not permit us to decide whether this is so.

Horizon and locality. Grey shale intercalated in Hølonda Limestone, north-east of Trotland, Hølonda.

Nileus sp.

Material at hand. A number of fragments and an entire specimen, all very badly preserved.

Description. The entire specimen is 40 mm long and 25 mm wide. It shows the rounded outline of cephalon and pygidium, the latter with indication of a broad rounded axis. Thoracic segments with broad axis and narrow pleural parts without geniculation.

Remarks. The material present may be just sufficient to indicate the presence of *Nileus*, or of a trilobite genus of the same general form.

Horizon and locality. Grey shale intercalated in Hølonda Limestone, north-east of Trotland, Hølonda.

Pseudasaphus? sp. (hypostome).

Fig. 1.

Material at hand. An almost complete hypostome on a slab of bedded marlstone. The anterior part is not preserved in the main specimen, but the outline of it is shown on the counterpart.

Description. The length of the entire hypostome is about 40 mm, the maximum width, 30 mm, is a little in front of the inner corners of the posterior wings; from here the outline curves inwards posteriorly and still more so anteriorly. Between the anterior inner corners of the posterior wings there is a rather wide interspace with a feebly curved outline. The central body is indistinctly marked off and somewhat irregular, probably due to distortion. One of the maculae is shown as an elevation on the left side. The posterior wings are preserved in relief and the exterior moulds show the strong convexity of the upper side. The inner part of this mould of the left wing shows a sculpture of fine, raised lines, numbering 8 to one millimetre, which are parallel to the length direction in the median part but which take a curvature with a convexity directed backwards — outwards towards the inner side. This sculpture pattern recalls somewhat that of the human papillar lines.

Remarks. No doubt the present hypostome belongs to a large asaphid of the subfamily *Asaphinae*. Hypostomes of *Isotelus* (Brøgger 1886, p. 31, pl. 1 fig. 18, Størmer 1945, p. 409, text-fig. 5) have a similar outline. The central body is, however, feebly marked out and the maculae are situated rather far anteriorly, and are represented

by concave grooves, while they are convex tubercles in most other *Asaphinae*. In the situation and the shape of the maculae the present hypostome thus differs from that of *Isotelus*, at least so far as the representatives of this genus in the Upper Ordovician of Norway are concerned. The greatest resemblance of the described hypostome is with that of *Pseudasaphus*, as figured by Brøgger (1886, pl. 1 fig. 17); according to Schmidt (1904) this hypostome agrees completely with that of *Pseudaşaphus*.

Horizon and locality. Grey shale intercalated in Hølonda Limestone, north-east of Trotland, Hølonda.

Illænus sp.

Illænus sp. Strand 1932, p. 161, pl. 27 figs. 1—3.

Material at hand. In the new collection there is a small pygidium from Damtjernet near Ven and a badly preserved cranidium from the new locality north-east of Trotland.

Description. Small distorted pygidium from Damtjernet: Length 4 mm, width 5 to 6 mm with subtriangular outline. The axis occupies about half the length. Behind the axis there is a depressed furrow in the striated doublure. — The cranidium from the new locality seems to be of the same general type as the Illænus sp. earlier described from Hølonda.

Remarks. The specimens of *Illænus* described by Strand (1932) were compared to *I. esmarkii* from the Asaphus Limestone zone of Scandinavian — Baltic regions and were found to differ from this species in that they were shorter in proportion to their width. *I. weaveri*, described by Reed from the Tourmakeady Series and also cited from the Glensaul Limestone of Ireland (Reed 1909, 1910), was compared by its author to the Baltic species *I. dalmani* and *I. esmarkii*. A comparison of the *Illænus* from Hølonda with Reed's figures of *I. weaveri* does not bring out any close similarity, but evidently the Hølonda form belongs to the same group as the two Baltic and the Irish species.

The small pygidium from Damtjernet differs from the pygidium figured by Strand in its more triangular outline and recalls Holm's figures of *I. dalmani* (Holm 1886, pl. 1 figs. 11—12). One of the pygidia figured by Holm has a ridge behind the rachis in the same position as the furrow on the doublure in the present specimen.

Horizon and locality. Hølonda Limestone, Vestre Katuglås and Skjærsjøhaugen (specimens described by Strand 1932). Hølonda Limestone, upper part, on the south side of the dam at the outlet of Damtjernet near Ven (small pygidium collected by Prof. Vogt). An *Illænus* sp. also in grey shale intercalated in Hølonda Limestone, north-east of Trotland.

Pliomerops sp.

Figs. 4 and 5.

Pliomera sp. Strand 1932, p. 161, pl. 27 fig. 9.

Material at hand. In the older collections there was only a fragmentary thorax of pliomerid type. In the new collections there is a fragmentary external mould of a pygidium, showing the middle part, and a fragment which is the left part of the pygidium with the pleural spines. The reconstruction sketch fig. 4 has been worked out by combining the parts observed in the two specimens. There is also a hypostome in the collection, which is here tentatively referred to the same genus.

Description. The external mould shows the rachis with anterior half-ring, four rings and a rounded triangular terminal piece with a median groove. The hindmost pleural spines, though somewhat indistinct, are seen to curve inwards, touching the sides of the terminal piece. The second and third of the pleural spines, reckoned from behind, are also curved strongly backwards. Length of rachis 11 mm, anterior width 7 mm, width at the anterior margin of the terminal piece 4 mm. Width of the pygidium about 20 mm.

The other specimen has the lateral spine parts of three pleural ribs rather well preserved, probably corresponding to the three ribs behind the anterior half-rib in the first specimen. The two posterior ones of the spines are bent strongly backwards, the hindmost spine also distinctly inwards. The spines are also bent downwards at the sides. Cross-section of spines as a biconvex lens with curvature feeble at the upper side, strong at the lower side. Length of the pygidium with spines about 20 mm.

The hypostome (fig. 5) is of a simple type with a central body marked off by a furrow. It shows no surface markings or other structures. Length 20 mm, width 9 mm, the small width being due to a compression of the specimen from the sides.

Remarks. The genus *Pliomera* Angelin 1854 has *Amphion fischeri* Eichwald as its genotype. Raymond (1905) recognized that the genotype differed from other species referred to the genus in that it possessed an indentation in the front of the glabella and a denticulate border of the cranidium. He erected the new genus *Pliomerops* (genotype *Amphion canadensis* Billings). Kobayashi (1934) erected a new genus *Protopliomerops*, distinguished by a more primitive type of the cranidium, based on a species of Tremadoc age from South Chorea. In this genus he also included *Pliomera primigenia* Angelin from the Ceratopyge beds of Scandinavia. In these pliomerid genera the pygidium is of the same general type.

The present pygidium shows a general accordance with the pliomerid type. The greatest similarity is with *Protopl. primigenia* (Angelin 1854, p. 90, pl. 41 fig. 15), which not only has similar long backwards deflected spines, but also a triangular terminal piece of corresponding size. Other species, such as *Pl. mathesii* and *Pl. actinura* (Angelin 1854, pl. 32 figs. 1, 2) as well as the pygidium figured by Reed (1909, pl. 6 fig. 5) as *Pl.* aff. *barrandei* (Billings) resemble the present form in the long, deflected pleural spines, but have much smaller terminal pieces.

The hypostome described does not belong to a *Niobe* nor to any asaphid. In its simple type it may agree with the pliomerid hypostome, as the hypostome of *Pliomera fischeri* figured by Øpik (1937, text-fig. 32, p. 117). If this is the case, the *Pliomerops* of the present fauna must have been of a large size.

Horizon and locality. Hølonda Limestone, Vestre Katuglås (specimen described by Strand 1932). Grey shale intercalated in Hølonda Limestone, north-east of Trotland. Hølonda.

The trilobite fauna of the Hølonda Limestone, as now known, comprises the following forms:

Trinodus? sp.
Eoharpes sp.
Gonotelus? broeggeri Strand
Niobe vogti n. sp.
Niobe? sp.
Nileus sp.
Pseudasaphus? sp.
Illœnus sp.
Pliomerops sp.

Possibly more than one faunal horizon may be represented in the above assemblage, but the complicated tectonics of the area and the scarcity of determinable fossils makes a decision as to this point very difficult, if not impossible. In the discussions to follow the fauna is treated as a unit.

The fauna is too scanty and too badly preserved to allow of any precise age determination. It is clear, however, that it indicates a Lower Ordovician age, comprising genera like *Niobe* and *Pliomera* (*s. l.*), which in Scandinavia ranges from the Ceratopyge beds to the Asaphus Limestone (Asaphus expansus zone).[1] The two species of *Illœnus*, *esmarkii* and *dalmani*, evidently related to the *Illœnus* sp. in our fauna, occur in the divisions B_3 and C, respectively, in the East Baltic Region, which divisions have their equivalents in the Swedish Orthoceras Limestone Series from the Asaphus Limestone and upwards to the top. The hypostome here ascribed to a *Pseudasaphus?* sp. belongs in any case to a large-size member of the subfamily Asaphinae. This should indicate rather a high horizon in the Asaphus Limestone.

According to Scandinavian — Baltic conditions the genera *Pliomera* (*s. l.*) and *Niobe* should give the horizon of the Asaphus Limestona as an upper age limit for our fauna. We can not, however, be certain that the genera in question have the same range in our area. The Hølonda Limestone thus also contains a brachiopod identified with *Oxoplecia dorsata* (Hisinger) (Reed 1932, p. 134), which occurs in the lower part of the Chasmops Series in Sweden and the East Baltic Region. In the Glensaul Limestone in Ireland, which is discussed below, a species of *Niobe* has been found together with a phacopid pygidium, described as *Chasmops* aff. *odini* (Reed 1910), which should indicate a horizon not below the division C of the East Baltic Region. Nothing more definite can be said about the age relations, than that the horizon of our fauna is equivalent to some part of the Orthoceras Limestone Series of Sweden, and that a correlation also with a middle or upper part of this series is not excluded.

Within the area mapped by Prof. Vogt the Hølonda Limestone is indicated as somewhat younger than the Langeland Slate (Vogt 1945,

[1] Törnquist (1884, p. 83) cited *Niobe frontalis* from "Upper Red" Orthoceras Limestone at Skattungsbyn, Dalarne. Dr. Per Thorslund has kindly informed me that this is probably a red Asaphus Limestone, as no species of *Niobe* or *Pliomera* has been found above this horizon elsewhere in Sweden.

p. 500). The latter formation has yielded *Trinucleus forosi* (Størmer 1932), which is claimed to show relations to the Welsh species *T. murchisoni* and *T. etheridgei*, especially to the latter, which occurs in the Didymograptus bifidus zone (cf. Vogt 1945, p. 494). An approximate lower limit for the age of the Hølonda Limestone should thus be given, which agrees well with the results already arrived at. On the other hand the Hølonda Limestone is decidedly below the Tømme Black Shale and the Dicranograptus Shales of Gauldal, both of Caradocian age (Størmer 1932, Hadding 1932, cf. Vogt 1945, p. 489).

In the Otta Area in Gudbrandsdal, known to the writer from his own field work, a thick series of greenstones, no doubt equivalent to the Støren Greenstones, ends upwards in a thin conglomerate. This conglomerate is again overlain by the remarkable serpentine conglomerate, which has yielded a rich fauna of gastropods, brachiopods, trilobites *etc.*, comparatively well preserved and practically undeformed. Only the trilobites in the fauna have been more exactly determined hitherto (Hedström 1930); they indicate the horizon of the Asaphus Limestone. If the serpentine conglomerate is not separated from its substratum by a great hiatus, it should at least not be younger than the Hølonda Limestone; the latter, on the other hand, occurs higher above the greenstones. Nor does a comparison with the Otta Area contradict the conclusions already reached, therefore.

In the British Isles (Stubblefield 1939) the Glensaul Limestone and the Tourmakeady and Shangort Series (North-West Ireland), the limestones of Tramore (North-East Ireland) and the Stinchar Limestone of the Girvan Area in South Scotland contain faunas with among other genera *Pliomerops*, *Niobe* (Glensaul Limestone), *Nileus*, *Trinodus*, *Illænus,* which indicate a correlation in a broad way with the Hølonda Limestone in the Trondheim Region. The stratigraphical position of these deposits is in the Llanvirnian and Llandeillian of the British time-scale. Similar faunas in Newfoundland (Raymond 1925) have been referred to the Middle Chazyan of the American time-scale. The Chazy is considered equivalent to the Swedish Orthoceras Limestone from the Asaphus Limestone and upwards (correlation scheeme of Troedsson, 1929, p. 179). We can thus claim a broad contemporanity of the British and Newfoundland deposits mentioned, with the Hølonda Limestone, and the earlier dating of the latter as of Chazy age (Strand 1932) can be retained.

We have seen that the Hølonda Limestone fauna is of predominatingly Scandinavian-Baltic affinity, which is not surprising in view of the geographical position. But it is also distinguished by some foreign members. Among these *Gonotelus? brøggeri* is especially conspicuous. We may also mention the gastropod genus *Hormotoma* (Strand 1932), among the faunal elements present in America faunas from the early Ordovician, which did not reach Scandinavian — Baltic regions until Upper Ordovician time.

Considering the faunal elements apparently of Scandinavian-Baltic derivation we may also emphasize the disaccordance in time-value of some fossils both in the Trondheim Region and in the British regions mentioned above as compared with the Baltic area. This may point to a certain faunal independence of the geosynclinal areas in relation to the epicontinental Scandinavian-Baltic areas.

Possibly the two areas were isolated from each other during most of the time but were connected at certain epochs, when faunal intermingling could take place. We may thus assume that faunas from Scandinavian-Baltic epicontinental areas invaded the Caledonian geosyncline about Asaphus Limestone time. These faunas could easily migrate along the geosyncline and thus reached the Scots-Irish and eastern North American regions referred to above. On the American side there were similar invasions from the epicontinental areas on the other side of the geosyncline. The result was a mixed fauna, in which the Scandinavian-Baltic elements were especially dominating on the European side. Isolation under more or less different conditions may have been the cause of the different time range of some faunal elements in the two areas.

In Beekmantown (Skiddavian) time a limestone, probably being an extension of lithologically similar deposits at Durness and in Bear Island, is found intercalated in basic lavas, corresponding to the Støren Greenstones, in the island of Smøla at the west coast of Southern Norway, though the faunal evidence may be meagre (Strand 1931). Holtedahl (1920) postulated a land barrier that had prevented the Beekmantown *Piloceras* fauna from entering more eastern Scandinavian and Baltic regions. Conceptions like this of land barriers in geosynclines may invoke criticism. The matter is easier to understand, if one recognizes a geosynclinal area as a playground of orogenic forces even during the earlier depositional phases. Thus troughs and intervening ridges in the direction of the geosyncline may be

produced, *plis de fond* in the sense of Argand. The existence of a land barrier in Cambrian and Ordovician time is also indicated by the sediments in eastern Jämtland and central Southern Norway, which prove a supply of clastic material from the west.

In an attempt at a paleogeographical reconstruction the tectonical transport of the geosynclinal sediments here dealt with must also be taken into consideration. A paleogeographical map of a deformed area must be *palinspastic* (Kay 1937), as the areas of deposition were much wider than the present folded belts.

A fine example of faunal provinces certainly due to geographical isolation is given in the British Isles during the earlier parts of the Ordovician. When comparing the trilobite faunas in the Scots-Irish areas mentioned above with those in Anglo-Welsh areas, Stubblefield (1939, p. 58) states, that "there is probably no trilobite species in common until Upper Whitehouse times". The Scots-Irish faunas show relationship to broadly contemporaneous faunas in Scandinavian-Baltic regions as well as in Newfoundland. With the latter region genera like *Bathyurellus*, *Bronteopsis*, *Pliomerops* and *Telephus* are common. Of these *Bathyurellus* is certainly an American element, comparable to *Gonotelus? brøggeri* in the Hølonda fauna, while *Pliomerops* may be of Scandinavian-Baltic derivation, since a member of the family *Pliomeridae*, (*Pliomera primigenia* Ang.) occurs in the Ceratopyge deposits. Further there are many representatives of what might be called the Telephus fauna, ascribed by Ulrich (1930, p. 50) to a "Middle Atlantic realm", a group of genera especially prolific in the muddy facies, which is common to Scandinavia, the mentioned Scots-Irish regions and the eastern Appalachian regions of North America (including Newfoundland).

A continuation of the Caledonian geosyncline from Southern Norway, Scotland and Ireland to Newfoundland on the other side of the Atlantic Ocean, has been claimed by many earlier authors. The new information on the Lower Ordovician faunas in the Trondheim Region supports this view, which can now be said to be strongly born out by faunal evidence.

A discussion of the paleogeographical relations of the older Ordovician must also take into account the theory of continental displacement; a discussion from a paleontological standpoint was given by Öpik (1939). Wegmann (1944) has recently put forward a precision of the theory. It is noteworthy that both these authors

emphasize the need of testing the theory by geological and paleontological research. Perhaps also the faunas here described might yield indications in this respect, though they are not so well preserved as might be desired.

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