

EARLY MIDDLE CAMBRIAN FAUNA FROM ROGALAND, SW NORWAY

(*Paradoxides oelandicus* stage = 1c α)

BY

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Abstract. Cambrian fossils have, for the first time, been found on the west coast of Norway. They were found by cand. real. Bjørn Andersen in 1949 at Ritland, Hjelmeland district, Rogaland County. The fossils occur in autochthonous dark shale, and belong to the *Paradoxides oelandicus* stage (Early Middle Cambrian). Trilobites (including *Ptychoparia anderseni* sp. n.), brachiopods, hyolithids, sponge needles, and problematica (including archaeocyathids?) have been collected. The absence of this stage in the autochthonous series in the Oslo region, as well as in the Swedish areas Västergötland and Scania, suggests a land mass in these areas in *P. oelandicus* time, bordered to the north by the Caledonian geosyncline, and to the east by a shallow sea.

Introduction.

While geologically mapping in the northern part of Rogaland County (SW Norway) in the summer 1949, cand. real. Bjørn Andersen found a piece of shale containing the impression of a trilobite (*Paradoxides pinus*, pl. 1, figs. 3—4), and thus discovered a locality for Cambrian fossils farther west than any other known locality in Norway. More fossils were collected later. They were all found in situ

or in loose blocks in a few collecting grounds near to each other on a steep mountainside less than 1 km west of the houses of the property Ritland in Hjelmeland district at Jøsentfjord, c. 50 km NW of Stavanger.

The locality is inside the area of Caledonian overthrusts, but the fossiliferous shale is autochthonous (or parautochthonous). The nearest locality with Cambrian fossils within the Caledonian mountain chain area is Usteberget at Ustaøset (Uppermost Lower Cambrian, cf. Størmer, 1925), some 160 km to the NE. The nearest occurrence of Cambro-Silurian outside the Caledonian mountain chain is in the Skien-Langesund area in the Oslo region, some 180 km to the east. The only other known locality for prequaternary fossils in Rogaland is Skudenes, on the island Karmøy, some 65 km west of Ritland. According to Strand (in Broch a. o., 1940), the fossiliferous beds are most probably of Upper Ordovician age.

After finding the first fossil, cand. real. Bjørn Andersen soon found more, and on that and later occasions collected fragments of *Paradoxides* (one identified as *P. oelandicus*), inarticulate brachiopods, hyolithids, sponge needles, and problematic fossils. Cand. real. Nils Spjeldnæs, together with Bjørn Andersen, collected more of the same fossils in the summer 1950, as well as some additional forms; *Peronopsis fallax* and articulate brachiopods. Curator Holger Holgersen also visited this locality in 1950 and collected inarticulate brachiopods, hyolithids, *Paradoxides* remains and an almost complete dorsal shield of *Ptychoparia anderseni* sp. n. The counterpiece of this trilobite was later found by Mr. Tor Ritland.

The fossils collected by Curator H. Holgersen belong to Stavanger Museum, whereas all the others belong to Paleontologisk Museum in Oslo. The writer expresses his grateful thanks to Professor A. Heintz, (Paleontologisk Museum, Oslo) and Curator H. Holgersen (Stavanger Museum), who placed the fossils at his disposal.

The fossils are preserved in a dark, grey-streaked shale, comparatively little altered considering that it occurs in the Caledonian mountain chain area. There are at present too few data to permit a safe determination of the vertical distribution of the fauna; probably it is between 30 and 60 m.

The manuscript has kindly been revised by Miss Jill Murray.

THE FOSSILS

TRILOBITÆ

Superfamily **Agnostacea** Salter, 1864.

Family **Agnostidae** (Corda, 1847) M'Coy, 1849.¹

Subfamily **Peronopsinae** Westergård, 1936.

Genus *Peronopsis* Corda, 1847 (type species: *Battus integer* Beyrich, 1845).

Peronopsis fallax (Linnarsson, 1869) — Pl. 2, fig. 5.

1936. *Peronopsis fallax* (Linnarsson) — Westergård, Parad. øland. Beds of Öland, p. 28, pl. 1, figs. 9—15. (List of synonymy, remarks on species.)
1946. *Peronopsis fallax* (Linnarsson). — Westergård, Agnostidea, p. 37, pl. 2, figs. 18—24. (Remarks on species.)

Remarks: — Only one cephalon and one pygidium have been found, lying close together and probably from one individual. They are only impressions, and the preservation is not too good. However, the long pygidial axis, reaching the posterior rim, and other characters agree with the form of *Peronopsis fallax* occurring in the *Paradoxides pinus* beds in Sweden, so that the Rogaland shields can be safely assigned to this species.

Superfamily **Redlichiacea** Richter, 1932.

Family **Paradoxididae** Emmrich, 1839.

Subfamily **Paradoxidinae** Emmrich, 1839 (subf.: Howell, 1933).

Genus *Paradoxides* Brongniart (type species: *Entomostracites paradoxissimus* Wahlenberg, 1821).

¹ M'Coy, 1849 has usually been credited for this family. The first to erect agnostid families was, however, Corda, 1847, who erected the families Battoides and Phalacromides. (*Battus* Dalman, 1827 is a synonym for *Agnostus* Brongniart, 1822.) Agnostidae is then only a new name for Battoides.

Paradoxides pinus Westergård, 1936.¹ — Pl. 1, figs. 3—4.

- cf. 1929. *Paradoxides* cf. *pinus* Holm in museo — Strand, Cambr. Beds Mjøsen, p. 350. (Recorded from the Hadeland district.)
1936. *Paradoxides pinus* Holm ms. — Westergård, Parad. øland. Beds Öland, p. 38, pls. IV—VI. (Description, also of larval stages.)
- cf. 1948. *Paradoxides* cf. *pinus* Holm — Strand, Middle Cambr. Hadeland, p. 92 (Mentions the find which was briefly described in 1929.)

Remarks: — The first fossil found at Ritland, a damaged dorsal shield of *Paradoxides* (and its counterpart), belongs to this species. The pygidium is not well preserved, but the posterior pleurae show clearly the characteristic feature of this species; the pleural spines in the most posterior segments being about equal in breadth to the part of the pleurae inside the fulcrum, and not expanded. Probably a number of other fragments of *Paradoxides* also belong to this species, as well as to the next species.

Occurrence: — Norway (Rogaland, Hadeland?), Sweden.

Paradoxides oelandicus Sjögren, 1872 — Pl. 1, fig. 1.

1872. *Paradoxides Oelandicus* n. sp. — Sjögren, Ölands Kambr. lager. p. 72, pl. 5, fig. 1. (Description.)
1877. *Paradoxides ölandicus* Sjögren — Linnarsson, Lagren med Parad. öland., p. 3 (345), pl. I (14), figs. 1—6. (Description.)
1882. *Paradoxides ölandicus* Sjögren — Brøgger, Parad. Öland. nivået ved Ringsaker, p. 146. (Recorded from Ringsaker in the Mjøsa district.)
1929. *Paradoxides ölandicus* Sjögren — Strand, Cambr. Beds Mjøsen, p. 350. (Recorded from the Mjøsa and Hadeland districts.)
- ? 1929. *Paradoxides* n. sp. — Strand, *idem*, p. 350. (Short description of pygidium from the Mjøsa district.)
- ? 1934. *Paradoxides* cf. *oelandicus* Sjögren — Cobbold, Cambr. area of Rushton, p. 348, p. 42, figs. 4—6. (Records fragments possibly belonging to the *oelandicus* group.)
- ? 1935. *Paradoxides ölandicus*? Sjögren — Lake, Brit. Cambr. trilob., p. 224. (Mentions Cobbold's material, which is stated to be quite insufficient to determine the species.)
1936. *Paradoxides oelandicus* Sjögren — Westergård, Parad. øland. Beds Öland, p. 33, pl. II, figs. 1—11, pl. III, figs. 1—6. (Supplementary description.)
1948. *Paradoxides* cranidia of *oelandicus* type. — Strand, Middle Cambr. Hadeland, p. 92. (Records the find mentioned in 1929.)

¹ According to article 25 of the "rules", Westergård is the author of the species.

Remarks: — A *Paradoxides* fragment consisting of the posterior part of the thorax and the pygidium is of the *oelandicus* type. The pygidium is of the *oelandicus* rather than the *quadrimucronatus* form, being only slightly longer than wide. The specimen may be assigned to *P. oelandicus*.

The pygidium referred to by Strand (1929) as *Paradoxides* n. sp. is very large (3 cm long), indicating a length of the dorsal shield of over 20 cm. The pygidium is of the *oelandicus* type, but has two pairs of smaller spines between the outer pair of spines, instead of only one pair, and is granulated. It recalls a pygidium figured by Westergård (1936, pl. III, fig. 10) as a “variety of *P. oelandicus*?”, but Strand’s specimen has a shorter axis. It is possible that it represents a variety of *oelandicus*, as is also suggested for *quadrimucronatus* by Westergård (1936, p. 36).

Occurrence: — Norway (Rogaland, Hadeland, Ringsaker), Sweden, Great Britain?

Superfamily **Conocoryphacea** Swinnerton, 1915.

Family **Conocoryphidae** Angelin, 1854.

Subfamily **Ptychopariinae** Matthew, 1887.

Genus *Ptychoparia* Corda, 1847 (type species: *Conocephalites striatus* Emmrich, 1839).

Ptychoparia anderseni sp. n. — Pl. 2, figs. 1—2.

Name: — The name is given in honour of cand. real. Bjørn Andersen, who discovered the *Oelandicus* beds in Rogaland.

Holotype: — PMO. 66300, a cephalon and 12 thoracic segments, preserved as an external mould. The fossil itself (SM. 1951/53) has also been found, but is less well preserved.

Other material: — SM. 1951/54, an external mould showing parts of the occipital region and 13 thoracic segments.

Diagnosis: — *Ptychoparia anderseni* sp. n. is like the type species, but differs in having the fulcrum much nearer the axis, a coarser granulation of the test, and more rapidly narrowing glabella.

Description: — Entire trilobite probably sub-oval in outline (pygidium not known). Axial lobe strongly convex; inner parts of pleural lobes flattened, outer parts bent down.

Cephalon sub-semicircular in outline with genal angles drawn out to spines, marginal border raised in front, and with deep marginal, axial, and occipital furrows around the convex cheeks and glabella. Glabella (including occipital ring) narrowing forwards, rounded at front. Surface not well preserved, but at least two pairs of short oblique glabellar furrows can be discerned. Width of glabella about three-quarters its length. Sagittal length of occipital ring about one-quarter the length of entire glabella. Eyes situated midway between anterior and posterior margins, but closer to glabella than to lateral margin. Ocular ridges oblique, fairly strong. Anterior branches of facial sutures not well preserved, but apparently cutting anterior margin nearly in front of the eyes. Posterior branches bend out and back to cut posterior margin at a distance from the axial furrows slightly less than transverse width of occipital ring. Intra-ocular parts of fixed cheeks (width between one-half and two-thirds that of glabella between eyes) slope down towards glabella, whereas post-ocular parts ("posterior limbs"), free cheeks, and the pre-glabellar field bend down outwards. Free cheeks about as wide as glabella, with genal angles prolonged into strong, but not very long spines continuing curve formed by outer margin.

Hypostome and doublures unknown.

Thorax. Number of segments not known. The holotype shows 12 segments preserved, whereas the other specimen (SM. 1951/54) has 13, which may possibly be the total number of thoracic segments, as in the type species. Axial lobe somewhat more than one-quarter the width of thorax. Axial rings strongly raised. Inner parts of pleurae flattened, rising slightly to the fulcrum, situated less than halfway out from axial lobe at a distance from it considerably less than width of axial lobe. Outer parts of pleurae bending down and ending in short posterolaterally directed points. Pleural grooves deep and wide, deepest at the fulcrum. Ridges in front of and behind grooves very prominent, especially posterior ridge at the fulcrum.

Pygidium unknown.

Ornament sporadically preserved. Fixed cheeks and possibly glabella covered by fairly large tubercles, the distance between their centers being about 0.5 mm. The interspace seems to be densely covered by very fine tubercles. Free cheeks and pre-glabellar field ornamented with branching and anastomosing ridges. Thorax covered with coarse and possibly also fine tubercles, as are the free cheeks.

Pleural ridges each bearing one row of coarse tubercles, whereas axial rings appear to bear at least three rows. No occipital or axial spines seem to be present.

Dimensions: — The holotype is of maximum width 2.4 cm at the posterior margin of the cephalon. Length unknown, but may be estimated to have been at least 3 cm. Length of head 1.1 cm, genal spines excluded. Length of thorax preserved (12 segments) 1.6 cm. Length of thorax in the other specimen (SM. 1951/54) with 13 segments, c. 1.7 cm.

Affinities: — *Ptychoparia striata*, the type species, resembles rather much *P. anderseni* sp. n. (cf. diagnosis, p. 17). *P. striata* has some of its characters more accentuated; in agreeance with this *P. anderseni* sp. n. probably is an earlier species than *P. striata*. *P. anderseni* sp. n. also reminds one of North American genera like *Clappaspis* Deiss, 1939 and *Elrathia* Walcott, 1924, which are probably fairly closely related to *Ptychoparia*, but seem to have more thoracic segments (cf. figs. in Resser, 1939).

Occurrence: — Norway (Rogaland).

BRACHIOPODA

Order **Protremata** Beecher, 1891.

Superfamily **Orthacea** Walcott, 1908.

Orthoid brachiopod. — Pl. 2, fig. 6.

A few defective valves of an orthoid brachiopod have been found. The best preserved specimen is figured. An orthoid brachiopod is recorded by Westergård (1936, p. 25) from the Oelandicus Beds in Sweden.

Order **Atremata** Beecher, 1891.

Superfamily **Obolacea** Schuchert, 1896.

Family **Obolidae** King, 1846.

Genus *Lingulella* Salter, 1866 (type species: *Lingula davisi* M'Coy, 1846).

Lingulella sp. — Pl. 2, fig. 4.

A single ventral valve (external impression) of a *Lingulella* sp. has been collected. The preservation is not too good, and the anterior part is split off to a lower plane than that of the edge of the valve,

probably making the anterior part appear more acute (and slightly shorter) than it was. The preserved part is 12 mm long. An 8 mm long *Lingulella?* sp. is recorded by Westergård (1936, p. 23) from the Oelandicus Beds in Sweden.

Order **Neotremata** Beecher, 1891.

Superfamily **Acrotretacea** Schuchert, 1896.

Family **Acrotretidae** Schuchert, 1893.

Genus *Acrothele* Linnarsson, 1876.

Subgenus *Redlichella* Walcott, 1908 (type species: *Acrothele granulata* Linnarsson, 1876).

Acrothele (Redlichella) granulata Linnarsson, 1876 — Pl. 2, fig. 3.

1876. *Acrothele granulata* n. sp. — Linnarsson, Brach. of the Parad. Beds, p. 24, pl. IV, figs. 51–52. (Description, figs. of both valves.)

1877. *Acrothele granulata* Linrs. — Linnarsson, Lagren med Parad. oeland., p. 22, pl. 2, fig. 12. (Revised description of ventral valve.)

1912. *Acrothele (Redlichella) granulata* (Linnarsson) — Walcott, Cambr. Brach., p. 663, pl. LVI, figs. , 2 a—n. (Description, figs. of both valves.)

1923. *Acrothele (Redlichella) granulata* (Linnarsson) — Hedström, Remarks on some fossils from . . Visby, p. 10, pl. I, figs. 14 a—c. (Figs. of dorsal valve.)

1929. *Acrothele (Redlichella) granulata* (Lnrs.) — Strand, Cambr. Beds Mjøsen, p. 341. (Listed, with a few notes.)

1934. *Acrothele (Redlichella) granulata* (Linnarsson) — Cobbold, Cambr. area Rushton, p. 330. (Recorded from the Rushton area.)

1936. *Acrothele (Redlichella) granulata* (Linnarsson) — Westergård, Parad. øland. Beds Öland, p. 24. (Recorded. Notes on vertical and geographical distribution.)

1942. *Acrothele (Redlichella) granulata* Linnarsson — Poulsen, Nogle hidtil ukendte Fossiler fra Bornholms Exsulanskalk, p. 216, pl. p. 235, figs. 7–11. (Figs. of fragments of ventral valve.)

Remarks: — A number of more or less fragmentary preserved valves have been collected. They agree well with the Swedish form.

Occurrence: — Norway (Rogaland, Ringsaker), Sweden, Denmark (Bornholm), Great Britain.

Genus *Acrotreta* Kutorga, 1848 (type species: *A. subconica* Kutorga, 1848).

Acrotreta socialis v. Seebach, 1865.

- 1865. *Acrotreta socialis* — v. Seebach, Geol. d. Insel Bornholm, p. 341. (Figs. of both valves.)
- ? 1867. *Acrotreta socialis* v. Seebach — Linnarsson, Brach. of the Parad. Beds, p. 16, pl. III, figs. 32—35. (Description, figs. of both valves. By Walcott, 1912, referred to *A. schmalenseei*.)
- ? 1902. *Acrotreta schmalenseei* n. sp. — Walcott, Cambr. Brach., p. 597. (Linnarsson's "*Acrotreta socialis*" described as a new species.)
- ? 1912. *Acrotreta schmalenseei* Walcott — Walcott, Cambr. Brach., p. 709, pl. LXX, figs. 1, 1 a—s. (Description, figs. of both valves.)
- 1912. *Acrotreta socialis* von Seebach — Walcott, Cambr. Brach., p. 711. (Description, figs. of both valves.)
- ? 1921. *Acrotreta socialis* Seebach(?) — Cobbold, Cambr. horizons of Comley, p. 347, pl. XXII, fig. 35. (Description, figs. of both valves.)
- ? 1929. *Acrotreta schmalenseei* Walc. — Strand, Cambr. Beds Mjøsen, p. 341. (Listed from the Mjøsa district after Walcott.)
- ? 1934. *Acrotreta socialis* von Seebach — Cobbold, Cambr. Beds Rushton, p. 331. (Lists same form as at Comley.)
- ? 1936. *Acrotreta schmalenseei* Walcott — Westergård, Parad. øland, p. 24. (Suggests that this species may not be distinct from *A. socialis*.)
- 1936. *Acrotreta socialis* v. Seebach — Westergård, *idem.*, p. 25.

Remarks: — In some slabs the bedding planes are covered by valves of *Acrotreta*, which are more or less distorted. Some of the better preserved specimens agree very well with the description of *A. socialis*. This species differs, according to Walcott (1902, 1912), from *A. schmalenseei* in having a rather strong and broad median groove of the false area, whereas it is absent or faint and shallow in *A. schmalenseei*. The latter form is also present in the Rogaland material. There appear to be intermediate forms as well, as in Westergård's material, and it is probable that *A. schmalenseei* should be regarded as a synonym for *A. socialis*, as suspected by Westergård (1936).

Occurrence: — Norway (Rogaland, Ringsaker), Sweden, Denmark (Bornholm), Great Britain?

HYOLITHA

Since the hyolithids most probably should not be assigned to the Pteropoda (cf. Wenz, 1938, p. 39), they are here assigned to a separate group.

Family **Hyalithidae** Nicholson.

A large number of hyolithids have been collected, but the preservation is not good. The specimens are more or less compressed, and rarely show any ornament. Two species have been fairly safely determined, but others are probably also present.

Genus *Hyalithes* Eichwald, 1840 (type species *H. acutus* Eichwald, 1840).

Hyalithes obesus Holm, 1893.

1893. *Hyalithus obesus* nov. sp. — Holm, Hyolithidae och Conularidae, p. 75, pl. 5, figs. 34—39. (Description, figs. of shells and cross sections.)

Remarks: — Only compressed specimens are known. The Rogaland material agrees well with Holm's description of compressed specimens in Sweden, having an angle of divergence of about 30°. One individual shows the convex dorsal lip. Little is seen of the ornament. One specimen has an angle of divergence of 23°, thus approaching the angle (13°) of the species *H. ölandicus* Holm, 1893, which is rather similar to *H. obesus* in other respects.

Occurrence: — Norway (Rogaland), Sweden.

Genus *Orthotheca* Novak, 1886 (type species: *O. intermedia* Novak, 1886).

Orthotheca teretiuscula (Linnarsson, 1877).

1877. *Hyalithus teretiusculus* n. sp. — Linnarsson, Om faunaen i lagren med Parad. öland., p. 22 (373), pl. 2 (15), fig. 11. (Description, figs. of shell, cross section, and ornament.)

1893. *Hyalithus (Orthotheca) teretiusculus* Linnarsson — Holm, Hyolithidae och Conularidae, p. 51, pl. 1, figs. 21—24. (Description, figs. of shell and cross sections.)

Remarks: — Among the numerous, more or less badly preserved hyolithids, some show a striation like that characteristic of this species. The angle of divergence is about 10°, which is somewhat more than in the Swedish material (6°—7°).

Occurrence: — Norway (Rogaland), Sweden.

PORIFERA

Order **Hexactinellida** O. Schmidt (Triaxonia F. E. Schultze).

Family **Protospongiidae** Hinde.

Genus *Protospongia* Salter, 1864 (type species: *P. fenestrata* Salter, 1864).

Protospongia? sp. — Pl. 2, fig. 8.

Remarks: — The skeleton is not preserved, but great masses of spicules occur. The rays are slender, extending out at right angles to each other to form a cross in the bedding plane. There is also a central axis. In specimens with counterpiece both a downward-pointing and an upward-pointing ray may be seen. The spicules vary in size. The largest spicules have up to 8 mm long rays, but they are only 0.1 mm wide. The spicules seem to be round in cross section and do not appear swollen at their bases. They resemble those of *Protospongia fenestrata*, but differ in being hexactinellid.

Family **Chancelloridae** Walcott, 1920.

Genus *Chancelloria* Walcott, 1920 (type species: *C. eros* Walcott, 1920).

Chancelloria sp. — Pl. 2, fig. 9.

Remarks: — Only scattered spicules are known. They consist of a central disc with 4, 6 or 7 "horizontal" rays, and possibly a vertical ray. The "horizontal" rays slope down like frames of an umbrella. A six-rayed spicule, c. 1.7 mm in diameter from the tips of the rays, has the following proportions; body of spicule 0.5 mm, central disc or node 0.25 mm, length of ray from where it joins the body, 0.6 mm. The shape of their spicules and their varying number of rays agree well with *Chancelloria*, as described by Walcott (1920, p. 372) from the Middle Cambrian of North America. Some spicules even appear to have a round cavity at the base of each transverse ray, as described in *C. drusila* Walcott (1920, p. 331). *Chancelloria* has been described from Spain (R. & E. Richter, 1940) in the *Sauki-anda* Beds (probably uppermost Lower Cambrian, cf. Henningsmoen, 1951), and may probably occur in the Middle Cambrian of Manchuria (cf. R. & E. Richter, 1940, p. 53).

Chancelloria sp. has not been found on the same bedding surfaces as *Protospongia?* sp.

PROBLEMATICA

Different types of problematica are present in the Rogaland Rogaland material. Some are flat, filled with an earthy substance showing no structures. These fossils usually have the outline of twigs, worms and sausages.

Another type of problematica (Pl. 2, fig. 7) is represented by a few specimens. They are ovate in outline, the longest diameter varying from 0.7 to 4 cm. A number (c. 6) of cracks or ridges radiate from the center. Some fine radiating ridges may represent an original structure, but rather similar, not radiating structures appear to be of a secondary origin. Quite similar problematica have been found in Middle Cambrian shale from Krekling in SE Norway. Here they show a transition over to forms with no radiating cracks. The latter forms appear to be better preserved, and though the general outline is ovate, it has four rather shallow indentations, dividing the outline into four lobes. A not too well preserved specimen (not showing the natural outline) has been figured by Brøgger (1878, p. IV, fig. 18). These problematica remind one somewhat of an archaeocyathid described by Bornemann (1886, p. 57, pl. 11, figs. 8 d, 8 e) as *Archaeocyathus bilobus* from the Lower Cambrian of Sardinia. However, the true nature of the problematica is questionary.

DISCUSSION OF FAUNA

The fossils are from several collecting grounds, and although these are quite near together, they do not all belong to the same level. Most of the forms occur associated, two or more together. However, *Perenopsis fallax*, the articulate brachiopod, *Protospongia?* sp., and the round problematica have only been found isolated.

The following species are common to Rogaland and the type area (Öland, Sweden) of the *Paradoxides oelandicus* fauna: *Paradoxides oelandicus*, *P. pinus*, *Peronopsis fallax*, *Hyolithes obesus*, *Orthotheca teretiuscula*, *Acrothele (Redlichella) granulata*, and *Acrotreta socialis*. Only *Perenopsis fallax* and the two brachiopods are also known to occur in beds younger than the *Paradoxides oelandicus* stage. None of them have been found in older beds. The Rogaland fauna is thus a typical *oelandicus* fauna. The *Paradoxides oelandicus* stage has been divided into two zones (Westergård, 1936); a lower

zone with *Paradoxides insularis*, and an upper zone with *P. pinus*. The find of *P. pinus* shows that the upper zone is present in Rogaland. The other fossils found are either known to occur in both zones, or are not recorded previously from the *P. oelandicus* stage. As *P. insularis* has not been found in Rogaland, it is doubtful whether also the lower zone is present.

Paradoxides oelandicus faunas were earlier known in Norway only from Ringsaker in the Mjøsa district (Brøgger, 1882; Strand, 1929) and Hadeland (Strand, 1929, 1948). The localities at Ringsaker are in the allochthonous series of the area of Caledonian overthrusts (Skjeseth, 1952), and so is that of Hadeland, where the beds are interpreted as belonging to a nappe (Strand, 1948). The occurrence in Rogaland is thus the only one known in autochthonous beds in Norway. The *Paradoxides oelandicus* beds (Ic α) are not known from the parautochthonous beds in the Mjøsa district, or in Hadeland (cf. Strand, 1948), or farther south in the Oslo region. Probably these beds were never deposited in the areas with parautochthonous and autochthonous beds in the Oslo region. In these areas the basal Cambrian appears to be of *Paradoxides paradoxissimus* age (Ic γ) or later. Cores from diamond drillings in the Skien-Langesund district reveal that the upper part of the basal sandstone intercalates with alum shale containing fossils of the *P. paradoxissimus* stage. The sandstone as a whole may probably belong to this stage.

The *Paradoxides oelandicus* stage is known from many localities in Sweden (cf. Westergård, 1936). No true *P. oelandicus* faunas have been found outside Scandinavia. As stated by Lake (1935, p. 224), the British specimens which were suspected by Cobbold (1934) to belong to *P. oelandicus* or *P. pinus* are quite insufficient to determine the species. Faunas probably contemporaneous with the *P. oelandicus* fauna have been tabulated by Cobbold & Pocock (1934, pl. 39).

When the known occurrences of the *P. oelandicus* fauna are plotted on a map of Scandinavia (text fig. 1), it is seen that the fauna has been found partly in the Caledonian mountain chain area, and partly in an area stretching from Närke to Öland in Sweden. In an area from Mjøsa (parautochthonous series) across Oslo to Scania and Bornholm the *P. oelandicus* beds are missing in the known sections where they might be expected, probably indicating a land area at the *P. oelandicus* time. This is rather interesting, as this Oslo-Scania area later in the Cambrian, and at times in the Ordovician

appears to have been deeper below sea-level than other areas in southern Scandinavia outside the Caledonian geosyncline. The Oslo-Scania land area was probably bordered to the east by a shallow sea, to the north by the Caledonian geosyncline, and to the west probably united with another land area. This area (covering parts of present southern Norway) may have been present south of the Caledonian geosyncline during parts or the whole of the Cambro-Silurian time.

List of fossils from the <i>Paradoxides oelandicus</i> stage (1ca) in Norway ¹		Rogaland	Hadeland	Ringsaker
<i>Trilobitae</i>				
<i>Paradoxides oelandicus</i> Sjögren		+	cf.	+
» <i>pinus</i> Westergård		+	cf.	
» <i>torelli</i> Westergård				+
» sp.			+	
<i>Ptychoparia anderseni</i> sp. n.		+		
<i>Solenopleura cristata</i> Linnarsson				+
<i>Bailiella emarginata</i> (Linnarsson) ²				+
<i>Ptychagnostus</i> (<i>Triplagnostus</i>) <i>praeurrens</i> (Westergård) ..				+
<i>Brachiopoda</i>				
<i>Orthoid</i> brachiopod		+		
<i>Lingulella</i> sp.		+		
<i>Lingulella ferruginea</i> Salter				+
<i>Acrothele</i> (<i>Redlichella</i>) <i>granulata</i> (Linnarsson)		+		+
<i>Acrotreta socialis</i> v. Seebach		+		+
<i>Hyolitha</i>				
<i>Hyolithes obesus</i> Holm		+		
<i>Orthotheca teretiuscula</i> (Linnarsson)		+		
<i>Porifera</i>				
<i>Protospongia</i> sp.		+		
<i>Chancelloria</i> sp.		+		
<i>Problematica</i>				
		+		

¹ Corresponding list for Sweden: Westergård, 1936 (pp. 52—63).

² Not previously recorded from Norway.

Fig. 1. *Paradoxides oelandicus* stage in Scandinavia. — 1 Rogaland, 2—7 Oslo region: 2 Skien-Langesund district, 3 Oslo district, 4—5 Hadeland, 6—7 Mjøsa district (6 Ringsaker), 8—9 S. Jämtland, 10—11 N. Jämtland and Ångermanland, 12 Lappland, 13 Närke, 14 Östergötland, 15 Väster-götland, 16 Gotland, 17 Öland, 18 Scania, 19 Bornholm.

■ Allochthonous.

● Autochthonous and parautochthonous.

○ Missing in the autochthonous and parautochthonous series.

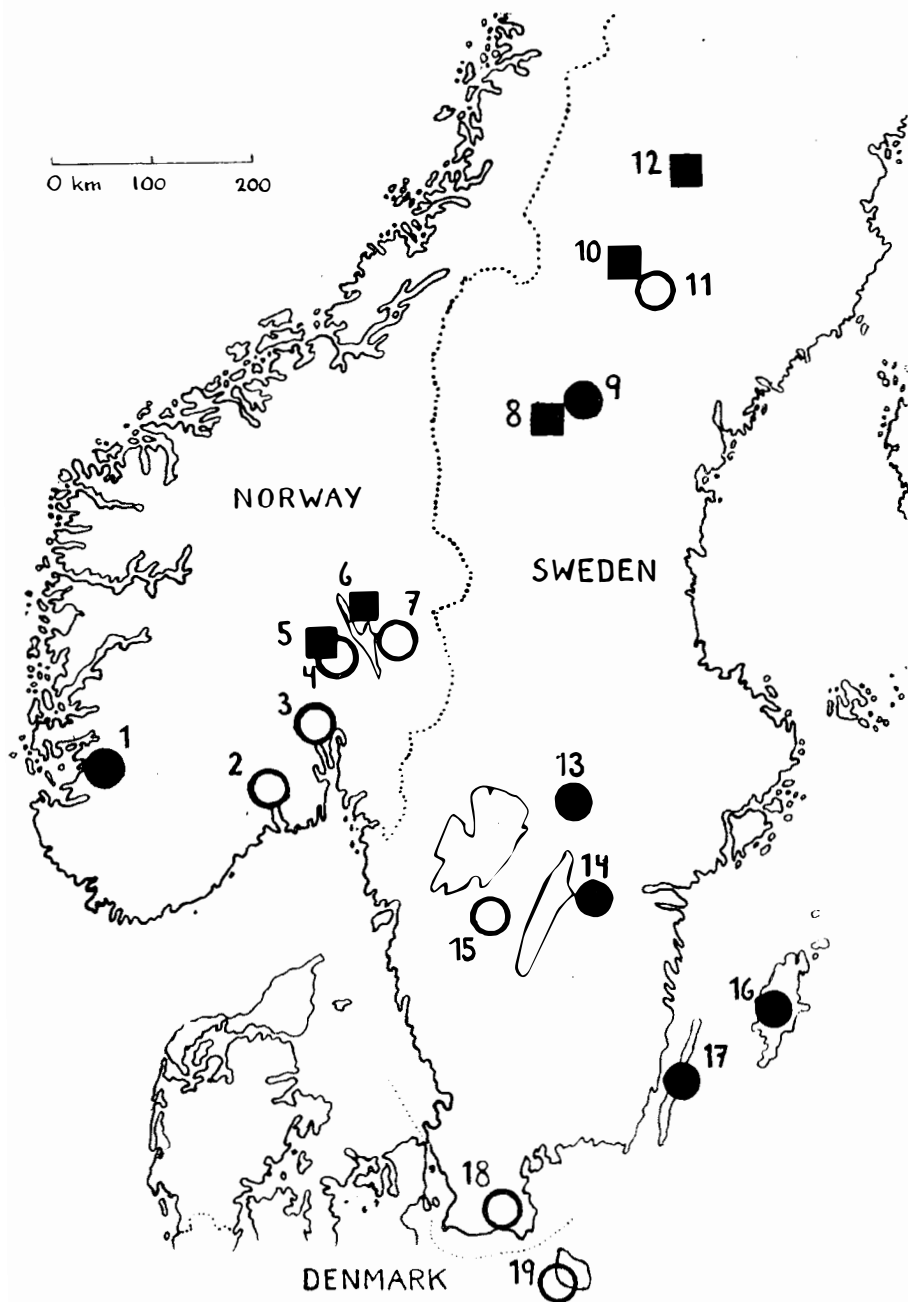


Fig. 1.

KAMBRISKE FOSSILER FRA ROGALAND

Under geologisk kartlegningsarbeide i Rogaland sommeren 1949 fant cand. real. Bjørn Andersen en forstening, trilobitten *Paradoxides pinus*, og etter hvert flere andre fossiler. Det er første gang fossiler fra kambrium-tiden er funnet på vestkysten av Norge. Foruten Bjørn Andersen har også konservator Holger Holgersen (Stavanger Museum), herr Tor Ritland og cand. real. Nils Spjeldnæs (Paleontologisk Institutt, Oslo) samlet inn fossiler samme sted.

Fossilene fins i mørk, grå-streket (alunskifer-lignende) skifer i en fjellvegg og i uren under, mindre enn 1 km vest for gården Ritland i Hjelmeland herred ved Jøsenfjorden. Det er funnet forstenede trilobitter, brachiopoder, hyolithider, svampe-nåler og usikre forsteninger (se fossil-liste s. 26). En hittil ukjent trilobitt-art, *Ptychoparia anderseni* sp. n., er blitt kalt opp etter finneren av fossil-finnestedet.

Fossilene viser at lagene de ligger i, ble avsatt i havet i tidlig mellom-kambrisk tid. I Norge var disse lagene (*Paradoxides oelandicus*-lagene = $lc\alpha$) tidligere bare kjent fra Hadeland og Ringsaker. Lagene ble avsatt på bunnen av et stort innsynknings-område (den kaledonske geosynklinal) som bl. a. strakte seg fra Skottland over Skandinavia til Svalbard. I de geologiske tidene nærmest etter kambrium dannet det seg en fjellkjede (den kaledonske fjellkjede) i det samme området, med overskjøvne og foldede fjellmasser. På Hadeland og Ringsaker er $lc\alpha$ -lagene bare kjent fra slikt overskjøvet (alloktont) fjell, og man vet derfor ikke nøyaktig hvor de opprinnelig ble avsatt. Ved Ritland finnes fossilene også i et område med overskjøvne lag, men er funnet under disse, i stedeagne (autoktone) lag.

Et kart s. 27 viser de kjente forekomster av $lc\alpha$ -lagene i Skandinavia. Lagene er ikke kjent i de paraautoktone (foldede, dvs. litt forskjøvne) og autoktone lagene i Oslo-feltet, og mangler også i lagrekken flere steder i Sverige. Det ser ut som om en landmasse strakte seg fra Mjøsa til Skåne og Bornholm i $lc\alpha$ -tiden. Mot nord var dette Oslo-Skåne-landet begrenset av den kaledonske geosynklinal, mot øst av et grunnere havområde som bl. a. dekket Närke og Öland. Mot vest var Oslo-Skåne-landet antagelig sammenhengende med et annet land-område, som antagelig fantes syd for geosynklinalen, i det minste tidvis under hele kambro-silur-tiden, mens Oslo-Skåne-landet allerede senere i mellom-kambrisk tid sank under havet.

Paleontologisk Museum, Oslo

10. mai 1951.

REFERENCES

- Angelin, N. P., 1851—54: *Palaeontologia Scandinavica. Pars I. Crustacea formationis transitionis.* Pp. I—IX, 1—24, 21—92, pls. I—XLI. Holmia.
- Beecher, C. E., 1891: *Development of the Brachiopoda.* — Amer. Jour. Sci., ser. 3, 41, pp. 343—357. New Haven.
- Beyrich, E., 1845: *Über einige böhmische Trilobiten.* — Berlin.
- Bornemann, J. G., 1886: *Die Versteinerungen des Cambrischen Schichtensystems der Insel Sardinien.* — Nova acta der Ksl. Leop.-Carol. Deutschen Akad. der Naturforscher, 51, 1, pp. 1—147, pls. I—XXXIII. Halle.
- Broch, O. A., F. Isachsen, O. Isberg & T. Strand, 1940: *Bidrag til Skudenes-sedimentenes geologi.* — Norges geol. unders. 155, pp. 1—41. Oslo.
- Brøgger, W. C., 1878: *Om paradoxidesskifrene ved Krekling.* — Nyt Mag. for Naturvid., 24, 1, pp. 18—88, pls. I—VI. Kristiania (= Oslo).
- 1882: *Paradoxides Ölandicus-nivået ved Ringsaker i Norge.* — Geol. För. Stockholm Förhandl., 6, 4, pp. 143—148, pl. 8. Stockholm.
- Brongniart, A., 1882: *Histoire naturelle des crustacés fossiles. Les trilobites.* Paris.
- Cobbold, E. S., & R. W. Pocock, 1934: *The Cambrian area of Rushton (Shropshire).* — Philosoph. Trans. Roy. Soc. London, ser. B, 223, pp. 305—409, pls 38—45. London.
- Corda, A. J. C., in I. Hawle & A. J. C. Corda, 1847: *Prodrom einer Monographie der böhmischen Trilobiten.* — Abh. böhm. Gesell. Wiss., 5, pp. 129—292, pls. I—VII. Prag.
- Dalman, J. W., 1827: *Om palæaderna eller de så kallade trilobiterna.* — Kongl. Vetensk. Acad. Handl. 1826, pp. 1—109, pls. I—VI. Stockholm.
- Eichwald, E., 1840: *Ueber das silurische Schichtensystem in Ehstland.* — Zeit. für Natur- und Heilkunde, 1—2. St. Petersburg.
- Emmrich, H. F., 1839: *De Trilobitis. Dissertatio petrefactologica.* — Berlin.
- Goldschmidt, V. M., 1925: *Ueber fossilführende untercambrische Basalablagerungen bei Ustaoset.* — Fennia, 45, 1, pp. 3—11. Helsingfors.
- Hedström, H., 1923: *Remarks on some fossils from the diamond boring at the Visby Cement Factory.* — Sveriges geol. unders., ser. C., 314, pp. 1—26, pls. I—II. Stockholm.
- Henningsmoen, G., 1951: *Remarks on the classification of trilobites.* — Norsk geol. tidsskr., 29, pp. 174—217. Oslo.
- Holm, G., 1893: *Sveriges kambrisk-siluriska Hyolithidae och Conularidae.* — Sveriges geol. unders., ser. C, 112, pp. 1—172, pls. 1—6. Stockholm.
- Howell, B. F., 1933: *The classification of the trilobite subfamily, Centropleurinae.* — Medd. fra Dansk Geol. Foren., 8, 3, pp. 215—219. København.
- King, W., 1846: *Remarks on certain genera belonging to the class Pallio-branchiata.* — Ann. & Mag. Natur. Hist., 18, pp. 26—42. London.
- Kutorga, S. S., 1848: *Die Brachiopoden der Familie Siphonotretæ.* — Verhandl. russ.-kaiser. mineral. Gesell. St. Petersburg 1847, No. 12, pp. 250—286. St. Petersburg.

- Lake, P., 1931: A monograph of the British Cambrian trilobites. Part VI, pp. 121—148, pls. XV—XVIII. — Palæontogr. Soc. 1929. London.
- 1932: Idem. Part VII, pp. 149—172, pls. XIX—XXII. — Idem. 1930. London.
- 1935: Idem. Part IX, pp. 197—224, pls. XXVI—XXXI. — Idem. 1934. London.
- Linnarsson, J. G. O., 1869: Om Vestergötlands cambriska och siluriska aflagringer. — Kongl. Svenska Vetensk.-Akad. Handl., 8, 2, pp. 1—89, pls. I—II. Stockholm.
- 1876: On the Brachiopoda of the Paradoxides Beds of Sweden. — Bihang till Kongl. Svenska Vetensk.-Akad. Handl., 3, 12, pp. 1—34, pls. I—IV. Stockholm.
- 1877. Om faunaen i lagren med *Paradoxides ælandicus*. — Geol. Fören. Stockholm Förhandl., 3, pp. 352—375, pls. 14—15. (Also as Sveriges geol. unders., ser. C, no. 22.) Stockholm.
- Matthew, G. F., 1887: Illustrations of the St. John group. 4. — Proc. & Trans. Roy. Soc. Canada, 5, pp. 115—166, pls. I—III. Montreal.
- M'Coy, F., 1849: On the classification of some British fossil Crustacea. — Ann. & Mag. Natur. Hist., ser. 2, 4, pp. 161—279, 330—335, 392—414. London.
- Novak, O., 1891: Revision der Palaeozoischen Hyolithiden Böhmens. — Abhandl. k. böhm. Gesell. Wiss., ser. 7, 4, pp. 1—49, pls. I—VI. Prag.
- Poulsen, C., 1942: Nogle hidtil ukendte Fossiler fra Bornholms Exsulanskalk. — Medd. fra Dansk Geol. Foren., 10, pp. 212—235 (1 pl.). København.
- Resser, C. E., 1939: The Spence Shale and its fauna. — Smithsonian Misc. Coll., 97, 12, pp. 1—29, pls. 1—6. City of Washington.
- Richter, R., 1932: Crustacea (Paläontologie). — Handwörterbuch der Naturwiss., 2nd. ed., pp. 840—863. Jena.
- Richter, R. & E., 1940: Die Saukianda-Stufe von Andalusien, eine främde Fauna im europäischen Ober-Kambrium. — Abhandl. senckenberg. naturf. Gesell., 450, pp. 1—88, pls. 1—5. Frankfurt a. M.
- Salter, J. W., 1864: A Monograph of British Trilobites. — Pp. 1—244, pls. 1—30. Palæontogr. Soc. London.
- 1866: On the fossils of North Wales. — Mem. Geol. Survey, 3, 1866, appendix, pp. 239—381. London.
- Schuchert, C., 1896: Brachiopoda. In text-book of paleontology by Zittel and Eastman, 1, pp. 291—343.
- Seebach, K. von, 1865: Beiträge zur Geologie der Insel Bornholm. — Zeit. deutsch. geol. Gesell., 17, 2, pp. 338—347. Berlin.
- Sjögren, A., 1872: Om några försteningar i Ölands Kambriske lager. — Geol. Fören. Stockholm Förhandl., 1, pp. 67—80, pl. 5. Stockholm.
- Skjeseth, S., 1952: On the lower Didymograptus zone (3 B) at Ringsaker, and contemporaneous deposits in Scandinavia. — Norsk geol. tidskr., 30.
- Störmer, L., 1925: On a Lower Cambrian fauna at Ustaoset in Norway. — Fennia, 45, 1, pp. 12—22, pls. I—II. Helsingfors.

- Strand, T., 1929: The Cambrian beds of the Mjøsen district in Norway. — Norsk geol. tidsskr., 10, 3—4, pp. 307—365, pls. I—II. Oslo.
- 1948: On the Middle Cambrian of Hadeland (Oslo region, Southern Norway). — Norsk geol. tidsskr., 27, pp. 89—96. Oslo.
- Swinerton, H. H., 1915: Suggestion for a revised classification of trilobites. — Geol. Mag., ser. 6, 2, pp. 487—496, 538—545. London.
- Wahlenberg, G., 1821: Petrificata Telluris Svecana. — Acta Soc. Regiae Sci. 8. Stockholm.
- Walcott, C. D., 1902: *Cambrian Brachiopoda: Acrotreta; Linnarsonella; Obolus*; with description of new species. — Proc. U. S. Nat. Mus., 25, pp. 757—612.
- 1908: Cambrian Brachiopoda; description of new genera and species. — Smithsonian Misc. Coll., 53, 3, pp. 53—137, pls. 7—10. City of Washington.
- 1908 b: Cambrian Geology and Paleontology. No. 4. Classification and terminology of Cambrian Brachiopoda. — Smithsonian Misc. Coll., 53, pp. 138—165. City of Washington.
- 1912: Cambrian Brachiopoda. — Monographs U. S. Geol. Survey, 51, pp. 1—872, pls. I—CIV. City of Washington.
- 1920: Cambrian Geology and Paleontology, IV. No. 6. Middle Cambrian Spongiae. — Smithsonian Misc. Coll., 67, 6, pp. 261—364, pls. 60—90. City of Washington.
- Wenz, W., 1938: Gastropoda. Teil I. — Handbuch der Paläozoologie, 6, 1 (edit.: O. H. Schindewolf). — Berlin.
- Westergård, A. H., 1936: *Paradoxides oelandicus* Beds of Öland. — Sveriges geol. unders., ser. C, 394, pp. 1—66, pls. I—XII. Stockholm.
- 1946: Agnostidea of the Middle Cambrian of Sweden. — Idem. 477, pp. 1—140, pls. 1—16. Stockholm.

PLATE 1

The photographs are not retouched. The specimen in fig. 1 was photographed immersed in alcohol; the specimens in figs. 2—4 were whitened with ammonium chloride, Photographer: Miss B. Mauritz.

PMO. = Paleontologisk Museum, Oslo.

SM. = Stavanger Museum.

- Fig. 1. *Paradoxides oelandicus* Sjögren. Pygidium and thorax. SM. 1951/52. $\times 1.7$.
2. *Paradoxides* sp., probably of the *oelandicus* group. Cranidium. SM. 1951/52. — $\times 1.7$.
3. *Paradoxides pinus* Westergård. Disconnected dorsal shield. PMO. 66399. — $\times 1.6$.
4. Counterpiece of specimen in fig. 3. — PMO. 66400. — $\times 1.6$.



1



2



3



4

PLATE 2

The photographs are not retouched. All specimens were whitened with ammonium chloride before being photographed.

Photographer: Miss B. Mauritz.

PMO. = Paleontologisk Museum, Oslo.

- Fig. 1. *Ptychoparia anderseni* sp. n. Holotype. External mould of cephalon and thorax. PMO. 66300. $\times 2.7$.
2. *Ptychoparia anderseni* sp. n. Artificial cast of the holotype (fig. 1). — $\times 3$.
3. *Acrothele (Redlichella) granulata* Linnarsson. Ventral valve. PMO. 66391. — $\times 5$.
4. *Lingulella* sp. Ventral valve. PMO. 66392. — 3.7 .
5. *Peronopsis fallax* (Linnarsson). Cephalon and pygidium. PMO. 66393. — $\times 10$.
6. Orthoid brachiopod. PMO. 66394. — $\times 4$.
7. Problematicum. PMO. 66395. — $\times 2.3$.
8. *Protospongia?* sp. Spicule. PMO. 66396. — $\times 10$.
9. *Chancelloria* sp. Spicule. PMO. 66397. — $\times 10$.



1



2



3



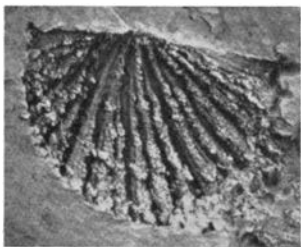
4



5



7



6



8



9