ADDITIONAL REMARKS ABOUT *HEMICYCLASPIS* FROM JELØYA, SOUTHERN NORWAY

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Additional information is given about *Hemicyclaspis kiaeri* Heintz collected from the Ringerike Sandstone at Jeløya in 1954. *H. kiaeri* is in many respects very similar to *H. murchisoni* but possibly represents an independent species. The Ringerike Sandstone at Jeløya is less mighty than that at Ringerike. At Jeløya the border between the marine Silurian deposits and the continental Ringerike Sandstone is found only a few metres below sea-level. The fossiliferous beds at Jeløya belong to Lower Downtonian and are much younger than the agnathe-bearing beds at Ringerike.

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Hemicyclaspis from Jeløya was originally described by Kiær in 1931 as *H. murchisoni* Eich. The material at Kiær's disposal consisted of six more or less well preserved headshields, besides some other mostly indeterminable fragments. These fossils were collected in 1929-30 by J. Kiær, Th. Vogt and the present author. Five of the heads originated from dense, coarse, grey sandstone exposed along the coast of Nestangen on the west side of the island of Jeløya, and one came from corresponding deposits on the small island of Billøya; both islands are situated near the town of Moss on the east side of Oslofjorden.

This sandstone belongs to the mighty succession of red and grey Ringerike Sandstone that alternates in the lower part with shales, which again overlays the marine Silurian deposits in the Oslo Region.

When Stensiö's monograph on British cephalaspids was published (1932), it became quite obvious that the Jeløya form differed from the British one. In 1939 I therefore redescribed it and proposed naming it *Hemicyclaspis kiaeri* n.sp.

In 1945 Westoll published a paper about a new cephalaspid from Scotland. His description is based on only one not especially well preserved fragment of a headshield and some scales which seem to be similar to *Hemicyclaspis*. Westoll, however, introduced a new genus and species – *Hemiteleaspis heintzi*. Denison (1951) accepted this new form, but Wängsjö (1952) and White (Wängsjö 1952: 550) regarded it only as an indeterminable species of *Hemicyclaspis*. Finally, Ritchie (1967) stated '*Hemiteleaspis* is now generally accepted as a *Hemicyclaspis*'.

In 1953 R. H. Denison spent some time in Norway, and among other places visited, he also went to Jeløya, where he found some new fragments of *Hemicyclaspis* on the old locality.

In 1954 N. Heintz and the author spent a week on Jeløya collecting new material. Since then, during more occasional visits to Jeløya, new fragments of *Hemicyclaspis* have been found.

As a result, Paleontologisk Museum in Oslo houses ten new, more or less complete and fairly well preserved headshields, and about twenty other poorly preserved fragments. The whole new material quite obviously belongs to the same *Hemicyclaspis* species and gives us some supplementary information about its structure.

It seems apparent that in all the species belonging to the genus *Hemicyclaspis*, the headshields are somewhat broader than the lengths of the shields. As far as I know, only in one specimen from Great Britain (Br.M. N.H.P.8804), the length is just slightly greater than the breadth (45 × 44 mm).

In his original description Kiær only made mention of the fact that they vary in length from 42 to 65 mm, and that the greatest breadth in the posterior part is almost the same as the length (Kiær 1931: 420). In my redescription I stated that 'the headshields are somewhat broader than long' (Heintz 1939: 100).

The measurements of the new specimens show that the breadth is always greater than the length. But it seems that the specimens in the new material as a whole are somewhat larger than the older ones and vary in length from 50 to 65 mm (average 59) and in breadth from 62 to 76 mm (average 72).

H. murchisoni seems to be smaller than the Norwegian forms. According to Stensiö (1932: 78) there is only one specimen from Great Britain which almost corresponds with the biggest of the Norwegian forms. It is 65 mm long and 75 mm broad. The other seven specimens vary from 35 to 54 mm in length (average 43) and from 44 to 56 mm in breadth (average 52 mm), and are thus distinctly smaller than the Norwegian form. Even if we include the largest specimen when calculating the average figures, we still get much smaller average figures for *H. murchisoni* than for *H. kiaeri*, namely 46 × 59 mm for the first and 57 × 72 mm for the latter.

In my definition of the new form, *H. kiaeri*, I have especially emphasized the following four characters (Heintz 1939: 100). 1. The headshields are somewhat broader than long. 2. The rostral margin is missing the distinct rostral angle, but is evenly bent in a regular bow. 3. The median sensory field (*msf*) tapers gradually to a point posteriorly, thus missing the bifurcated posterior margin. 4. The posteriomedian dorsal crest of the headshield is absent.

The new material from Jeløya has on the whole confirmed these characters, except for the first one. As we have seen, *H. murchisoni* is also somewhat broader than long and the length-breadth index is almost identical in both species – 0.78 in *H. murchisoni* and 0.79 in *H. kiaeri*.

With regard to the rostral angle on the front margin of the headshield, it is always distinctly developed in *H. murchisoni*, but as a rule absent in *H. kiaeri*. However, among the new specimens there are some in which the rostral margin is not so evenly rounded, and a slight rostral angle may be observed. This is especially the case on headshields E 1223 (Fig. 1) and E 1229, where the

Fig. 1. *H. kiaeri* Heintz. PMO E 1223. Almost complete headshield. The dark 'brim' represents the part of the shield originally covered by the rock. The light, central part was not protected and is partly weathered. *bs* – incorporated body scales; *lsf* – lateral sensory field; *msf* – median sensory field; *orb* – orbits; *pin* – pineal plate; *scl* – sclerotical ossification; *sl* 1–6 – nerves to the lateral sensory fields.

rostral angle is quite clearly seen, even though not as pronounced as in *H. murchisoni*.

In the new material the median sensory field (*msf*) shows more clearly that it is not posteriorly bifurcated as in *H. murchisoni*, but is rounded or runs into a point not far from the posteriomedian margin of the dorsal shield (Figs. 1, 2, 3, *msf*).

Kiær (1931 : 42) mentions that the *msf* is not well preserved, but seems to be about half the length of the distance between the eyes and the posterior point of the headshield. Kiær's reconstruction (Fig. 3) corresponds to this description and shows that the *msf* is not only short, but also rather narrow.

The new material gives us a much more complete picture of the *msf* and its relation to the orbits and the pineal plate, in spite of the fact that the exoskeletal plates originally covering the *msf* are always missing (Figs. 1, 2, 3, *msf*). Kiær says that the orbits vary in size from 3.5 to 5 mm in breadth and from 4 to 6 mm in length, and that the distance between the orbits (the length of the pineal plate) corresponds to the breadth of the orbits. The measurements made on eight of the new shields show that the sizes of the orbits correspond rather well with those given by Kiær. The lengths vary from 5 to 7 mm (average 5.7 mm) and the breadths from 4 to 5 mm (average 4.4 mm). However, contrary to Kiær's assertion, the distances between the orbits are distinctly larger than their breadths, and vary from 5.5 mm to 8 mm (average 6.5 mm). Stensiö has not given any of these measurements for *H. murchisoni*, so we cannot compare our forms with those from Great Britain. In most of the new specimens (and in some of the old ones as well) the sclerotical rings (or some of them) and the pineal plate with the pineal opening are more or less distinctly seen (Figs. 1, 4, 5, *sc*, *pin*). Kiær mentioned neither the sclerotical ossifications nor the pineal plate, because these details were described for the first time by Stensiö in 1932.

Turning to the *msf*, we may state that Kiær's reconstruction gives a rather misleading picture. In fact the *msf* is broadest immediately behind the orbits, and tapers both anteriorly, where it almost covers the area between the orbits and the pineal plate, and posteriorly, where it gradually becomes smaller and ends bluntly near the posterior mediandorsal corner of the headshield

Fig. 2. *H. kiaeri* Heintz. PMO E 1224b. Nearly complete headshield. The *msf* is well preserved and tapers posteriorly. Bifurcated (?) posterior dorsal corner of the head without any crest. Abbreviations as in Fig. 1.

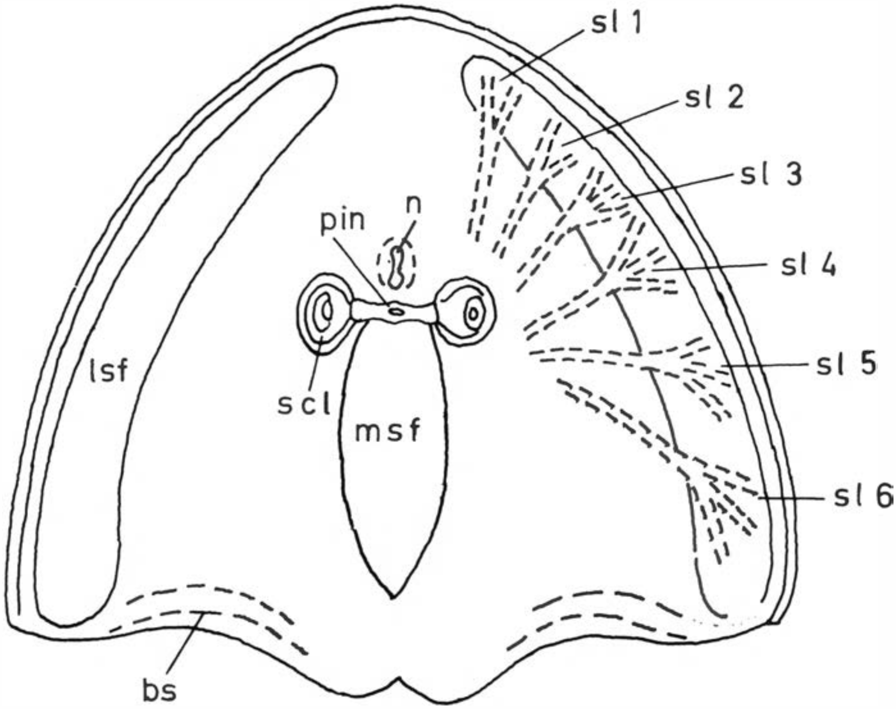

Fig. 3. *H. kiaeri* Heintz. Reconstruction of the headshield. Abbreviations as in Fig. 1.

(Figs. 1, 2, 3, *msf*). In fact the shape of the *msf* corresponds in the front part completely with that in *H. murchisoni*, but differs clearly from that in *Aceraspis robustus* from Ringerike (Heintz 1939: fig. 1, pl. 3) where the *msf* tapers in front and does not fill up the distance between the orbits and the pineal plate. In the posterior part, however, the *msf* in our form is most probably similar to that in *A. robustus*.

The posterior dorsomedian crest – always well developed in *H. murchisoni* (Stensiö 1932: 80) – is absent in *H. kiaeri*. The posterior dorsomedian part of the headshield is not particularly well preserved in any of the specimens of *H. kiaeri*, however, it is well enough preserved to show that the dorsomedian crest was never developed. In the best two new specimens (E 1224b and E 1228b) the posterior dorsal point of the headshield seems slightly lifted (Fig. 2).

In Kiær's reconstruction the posteriomedian dorsal corner of the headshield is rounded, while on Stensiö's reconstruction of *H. murchisoni* it is slightly bifurcated. As mentioned, the posterior part of the headshield is not especially well preserved in any of our specimens, and we cannot for certain give its shape. But in one specimen (E 1224b, Fig. 2), an indication of a bifurcated posterior corner may be seen, whereas in another (E 1228b), it seems to be absent.

In addition to the above mentioned characters we may add some new observations.

Parts of the sclerotical rings, which in the cephalaspids usually consist of more or less complete cup-like ossifications, can be seen in several of our specimens. The same is the case with regard to the pineal plate, which is well preserved in some of the specimens, partly with a distinct pineal opening (Figs. 1, 4, *pin*, *scl*).

The lateral sensory fields (*lsf*) that correspond with the median sensory fields (*msf*) are always missing the exoskeletal plates which originally covered them. The *lsf* are clearly seen on a number of specimens (Figs. 1, 2, 3, 5, *lsf*). They are narrower in the anterior part, gradually broadening posteriorly, and in this way correspond better with *H. murchisoni* than with *A. robustus*, where the *lsf* are broadest in the front part.

The course of the nerves running to the lateral sensory fields is more or less clearly seen in several specimens (as, e.g., E 1220a, E 1223, E 1224, E 1226a, E 1225, E 1228; Figs. 1, 2, 5, Sl_{1-6}), and shows a pattern very similar to that known in both *H. murchisoni* and *A. robustus*. In one specimen (E 1228b) parts of the vestibular division of the labyrinth cavity can also be traced. In two specimens (E 1227 and E 1228b) the front part of the headshield is well preserved and shows that a more or less broad supra-oralfield was developed in our form; this is also known from *H. murchisoni* (Stensiö 1932: pl. 2, fig. 4).

The sensory canals and the pit-lines in the headshield are unknown, apparently because of the rather poor preservation of the exoskeleton.

In a couple of the forms (e.g. E 1223b, E 1224b and others) one may see along the posteriolateral margin of the headshield (zonal part) one, two or more distinct marks, indicating that here the body scales have been incorporated in the shield (Figs. 1, 2, *bs*). As a rule one can see two such 'borders' running high up at the sides of the shields. As is well known, in *A. robustus* the border line between the headshield and the scale-covered body is not always distinct, and consequently it is rather difficult to determine where the headshield ends and the body begins (Heintz 1939: figs. 1, 2, pls. 1, 5, 6, 11).

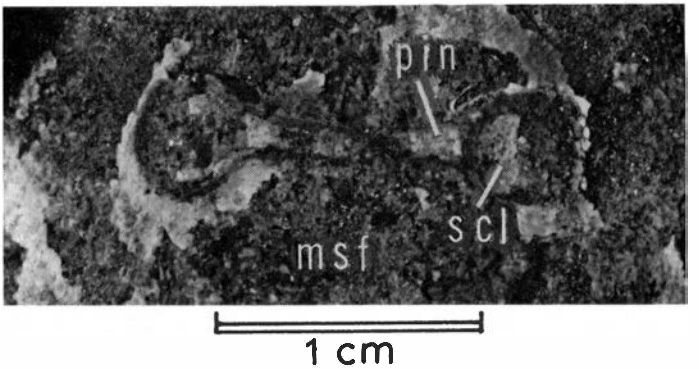

Fig. 4. *H. kiaeri* Heintz. PMO E 1223. Orbits with sclerotical ossifications (scl) and pineal plate (pin) with pineal opening. The same specimen is depicted in Fig. 1. Abbreviations as in Fig. 1.

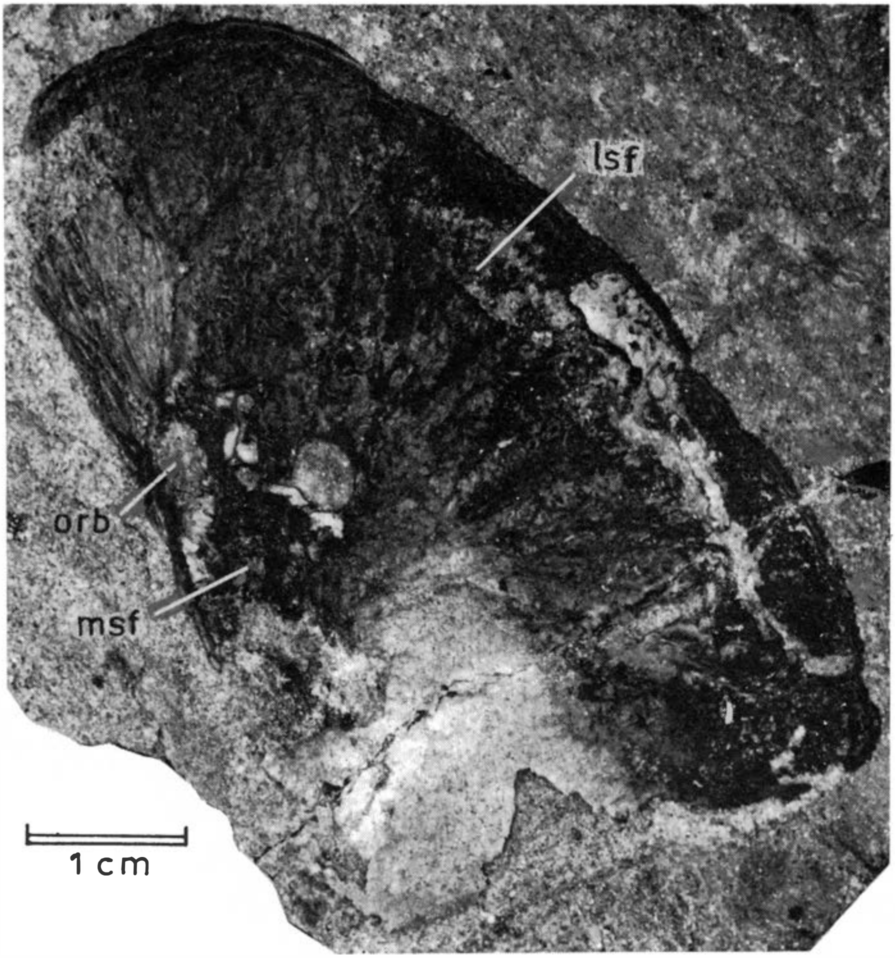

Fig. 5. *H. kiaeri* Heintz. PMO E 1220a. A well preserved right side of a headshield. One can see the orbits (without sclerotical ossifications), and the lateral sensory field with the sensory nerves. Abbreviations as in Fig. 1.

In *H. murchisoni* the border line between the head and body is quite plain according to Stensiö, and only one short bodyscale seems to be incorporated in the lower lateral part of the shield (Stensiö 1932: fig. 23).

Thus the Jeløya-form has many characters in common with *H. murchisoni*, only a few with *A. robustus* and some specific features. We may perhaps consider the question whether it was necessary to erect a new species for this form. Would it not be sufficient to regard it as the subspecies *H. murchisoni* var, *kiaeri*? However, since our species, in spite of all, has a number of characters which do not correspond with *H. murchisoni*, I prefer to keep the name *H. kiaeri*, adding to the definition that in many respects our form corresponds very closely to *H. murchisoni*.

It may be mentioned here that the present form in some respects reminds us of '*Hemiteleaspis heintzi*' (Westoll 1945), which is now generally accepted as a *Hemicyclaspis*. This shows that many variations of *Hemicyclaspis* have existed, which makes it difficult to separate precisely the different species (or subspecies) from each other.

Stratigraphical remarks

The Ringerike Sandstone at Ringerike was previously estimated to be of Upper Ludlovian–Downtonian age (Kiær 1911, 1924, Størmer 1934, 1935, Heintz 1939). The fossiliferous horizons on Rudstangen, and especially on Nes, belong to the very bottom of this series, only slightly above the passage-beds between the marine and continental deposits.

In the descriptions of the fauna from Nes (Heintz 1969) I came to the conclusion, however, that this fauna does not belong to the Upper, but to the Lower Ludlow, close to the border of Wenlock, thus being considerably older than was earlier assumed.

To determine fairly accurately the stratigraphical relation between the sandstone deposits at Ringerike and on Jeløya seems to be rather difficult. No fossils from the rich Ringerike fauna are known from Jeløya, and the only known species from Jeløya does not occur at Ringerike.

However, *H. kiaeri* is without doubt closely related to *H. murchisoni* – a guide fossil for the Lower Downtonian (D_1) in Great Britain (King 1925, White 1950, Allen, Dineley & Friend 1967). It seems reasonable to suppose that the fossiliferous deposits from Jeløya are of Lower Downtonian age, and thus considerably younger than the fossiliferous beds from Ringerike.

The mightiness of the sandstone deposits at Jeløya and Ringerike is difficult to compare, because at Ringerike the whole sandstone series, from the marine Silurian to the Permian conglomerate, may be measured, while at Jeløya only the upper part of the sandstone, from Permian conglomerate down to the sea-level is accessible, and how much of the sandstone lies beneath sea-level is hitherto unknown.

The mightiness of the sandstone at Ringerike – from the marine Silurian to the Permian conglomerate – is estimated by Kiær (1924, 1931) and Strand & Henningsmoen (1961) to be about 900–1,000 m. However, according to Whitaker (in Allen, Dineley & Friend 1967: 85), the thickness is about 1,250 m.

The measureable thickness of the Jeløya sandstone is considerably less. According to Kiær (1931), Th. Vogt supposed that the fossil-bearing horizon lay about 230 m below the Permian conglomerate. Schou-Jensen, who during recent years has studied the geology of Jeløya, estimates the sandstone to be more than 250 m (Schou-Jensen 1972). As the fossil-bearing horizon lay about 10–30 m above sea-level, Th. Vogt's and Schou-Jensen's determinations of the mightiness of the Jeløya sandstone correspond well with each other.

The question to consider is therefore how mighty the sandstone deposits from the sea-level down to the marine Silurian deposits situated below the sea actually are. If the mightiness of the sandstones at Jeløya and Ringerike are more or less identical, the border between the marine and continental deposits at Jeløya must be situated about 750 m below sea-level. The question can only be solved with certainty by drilling through the sandstone close to the sea-shore.

In the fall of 1970, Mr. Finn Aarefjord of Oslo Undervannsklubb dived from the northern point of Bevøya and brought up a stone from the sea bottom that appeared to be a Silurian limestone with some fossils – a rather unexpected discovery!

The next year Oslo Undervannsklubb contacted Institutt for geologi, Universitetet i Oslo, and together with cand. real Ørnulf Lauritzen, they started new investigations near Bevøya, which is a small island (about 1.5 km^2) separated from the most northern point of Jeløya by a narrow channel. Bevøya consists – like the northern point of Jeløya – of Permian conglomerates covered by basal tuffs, agglomerate and lava. The new investigations showed that north of Jeløya, and not particularly deep down, the bottom is made up of Silurian limestone. The fossils discovered in some samples are brachiopods that according to G. Henningsmoen (pers. comm.) are probably of Wenlockian age.

Unfortunately, the bottom near the beaches where the Ringerike Sandstone is developed has not yet been investigated. We cannot therefore state with certainty that the Wenlockian limestone is situated close to the coast of Jeløya. But it seems reasonable to assume, since the Wenlockian limestones were discovered N of Bevøya, that they cannot be situated especially deep down along the western coast of Jeløya. This indicates that the Ringerike Sandstone at Jeløya cannot be especially mighty, and so much less than at Ringerike.

Strand & Henningsmoen (1961) say that the Ringerike Sandstone becomes thinner southwards and is about 300 m thick in the Skien–Langesund district. Therefore it seems reasonable to suppose that the same is the case at Jeløya. Also, here the whole sandstone may not be thicker than about 300–400 m. If this is the case, the fossiliferous horizon at Jeløya is situated more or less in the middle of the sandstone deposits. As the thickness of the sandstone deposits at Ringerike is calculated to be about 1,000 m, the horizon corresponding to the fish-horizon at Jeløya must be situated about 500 m above the passage beds between the marine and continental Silurian (where the fossil agnathes from Ringerike appear). The Lower Downtonian age of the fossils from Jeløya thus corresponds well with the Lower Ludlovian age of the fossils from Ringerike.

REFERENCES

Allen, J. R. L., Dineley, D. L. & Friend, P. F. 1967: Old Red Sandstone of North America and Northwest Europe. *Proc. Int. Symp. Devon. Syst.* Vol. I, 69–98.

Bjørnholt, S. 1971: Froskemenn i upløyd mark. *Verdens Gang*, 2.10.1971.

Denison, R. H. 1951: Evolution and classification of the Osteostraci. *Fieldiana, Geol. 11*, (*3*), 157–196.

Heintz, A. 1939: Cephalaspida from Downtonian of Norway. *Skr. Nor. Vidensk. Akad. i Oslo, Mat.-Naturvidensk. Kl.*, 1939, 1–119.

Heintz, A. 1969: New Agnaths from Ringerike Sandstone. *Skr. Nor. Vidensk. Akad. i Oslo, Mat.-Naturvidensk. Kl.* 1969, No. 26, 1–28.

King, W. W. 1925: Notes on the 'Old Red Sandstone' of Shropshire. *Proc. Geol. Assoc. 36.*

Kiær, J. 1911: A new Downtonian Fauna in the Sandstone Series of Kristiania Area. *Vid. Selsk. Skr. I* (*7*), 1–22.

Kiær, J. 1924: The Downtonian Fauna of Norway. I. Anaspida. *Vid. Selsk. Skr. I* (*6*), 1–139.

Kiær, J. 1931: Hemicyclaspis murchisoni-Faunaen i den Downtoniske Sandsten på Jeløen i Oslo Fjorden. *Nor. Geol. Tidssk. 12*, 419–433.

Ritchie, A. 1967: *Ateleaspis tessellata* Traquair, a non-cornate Cephalaspid from the Upper Silurian of Scotland. *J. Lin. Soc.* (*Zool*). *47*, 69–81.

Schou-Jensen, E. 1972: Uddrag af rapport til NGU, etterår 1972. Ekskursjons veiledning. *Unpublished report*. pp. 16–18, a map.

Stensiö, E. A. 1932: The Cephalaspids of Great Britain. *Brit. Mus.* (*Nat. Hist.*) *Lond.* pp. I-XIV + 1–320.

Strand, T. & Henningsmoen, G. 1960: Cambro-Silurian Stratigraphy. *In* Holtedahl, O. (ed.), Geology of Norway. *Nor. Geol. Unders. 208*, 128–169.

Størmer, L. 1934: Merostomata from the Downtonian Sandstone of Ringerike, Norway. *Skr. Norsk Vit. Akad. I* (*10*). 1–125.

Størmer, L. 1935: Dictyocaris Salter, a large Crustacean from the Upper Silurian and Downtonian. *Nor. Geol. Tidsskr. 15*, 265–298.

Westoll, T. S. 1945: A new cephalaspid fish from the Downtonian of Scotland, with notes on the structure and classification of Ostracoderms. *Trans. R. Soc. Edinb. 61*, 341–357.

White, E. I. 1950: The vertebrate faunas of the Lower Old Red Sandstone of the Welsh Borders. *Bull. Brit. Mus.* (*Nat. Hist.*) *Geology I* (*3*), 49–67.

Wängsjö, G. 1952: The Downtonian and Devonian Vertebrates of Spitsbergen. IX. Morphologic and Systematic Studies of the Spitsbergen Cephalaspids. *Skr. Nor. Polarinst.* No. 97, 1–592.