

7. A problematic Fossil from the Lower Cambrian of Kinnekulle.

By

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While examining the levelled subcambrian landsurface and the bottom-layers of the Cambrian at the foot of Kinnekulle, I found the fossiliferous block described in the following pages.¹

Kinnekulle, as well as the other table-mountains of Wästergötland, between Lake Wener and Lake Wetter, is made up of a series of paleozoic rocks, the undermost divisions of which are black bituminous shales («alum-shales») and quartz-sandstone, the former representing upper and middle Cambrian (*Olenus*- and *Paradoxides*-beds), the latter lower Cambrian (*Olenellus*-beds). The sandstone reaches a thickness of about 34 m. and has been divided into an upper part, 24 m. thick, named *Lingula*-sandstone, and a lower part, 12 m. thick, named *Mickwitzia*-sandstone. The former is more fine-grained and of a gray or yellowish colour and is in some layers speckled with rusty spots after pyrite, the latter is somewhat coarser and harder, less rusty, and in some banks nearly white; it is not distinctly separated from the overlying *Lingula*-beds. Its bottom-banks are interstratified with thin layers of a greenish clay or shale, rich in small, white mica scales. Immediately at the bottom, the sandstone becomes felspar-bearing and grades into a graywacke or into a thin conglomeratic layer, with scattered pebbles of quartz, flakes and fragments of the underlying weathered gneiss and other rock-species. Cross-bedding and ripple-marks are common in the undermost sandstone-beds.

Determinable fossils are very scarce and restricted to the two *Brachiopod*-species, after which the two divisions of the sandstone have been named. Various tracks, trails, and other impressions are, on the other hand, very frequent and especially characteristic of the interstratified

¹ This paper is to be regarded as a sequel to another study, published in this Volume under the title: Über die subkambrische Landfläche am Fusse vom Kinnekulle, by A. G. HÖGBOM and N. G. AHLSTRÖM.

clay-sheets. Some of these fossils are of the same kind, as those found in the neighbouring hill of Lugnås, e. g. the tracks interpreted as crustacean prints (*Cruziana* a. o.), but other fossils of the lower Cambrian of Kinnekulle are not met with at Lugnås. This is the case as regards *Scolithus linearis* which is very characteristic of some banks of the *Mickwitzia*-beds (see page 79 in this Volume). Another peculiar fossil occurring in the lower banks of the *Lingula*-sandstone of Kinnekulle, which is not found at Lugnås, may also be mentioned. It consists of a great number of rays (up to 30 and more), radiating from a centre in all directions on the surfaces of the banks. In the centre there occur in some samples circular spots of the same colour as the rays and about 5 mm. in diameter. The rays have a uniform thickness of a few mm. and a length varying generally between 5 and 10 cm. They stand out a little in high-relief, but are more conspicuous against the darker sandstone through their grayish white colour. *Medusae*, the fossils through which Lugnås is especially renowned¹ have not been found at Kinnekulle.

In addition to what has been demonstrated in the paper by the author and N. G. AHLSTRÖM mentioned above, it may be remarked that the bottom-beds of the sandstone-formation evidently have been formed under tidal changes of level, and that the thin clay-layers may have been deposited in tidal lagoons. They are sometimes broken into pieces, in the same way as may be seen in recent lagoon-mud, shrunk by drying up at ebb-time. Furthermore, it can be concluded from the mode of bedding of the sandstone, the nature of the bottom-conglomerate, and the morphology of the subcambrian landsurface in this part of Sweden, that the material of the sandstone-formation is autochtone and has not been transported by rivers. The occurrence of windworn pebbles, the generally well rounded quartz-grains of the sandstone-banks, and other features indicate that this formation is derived from eolian sand and weathering products, previously covering the precambrian landsurface over which the cambrian sea flooded.

The fossil, reproduced and described here, lies in a sandstone-slab, found in the high-water line at the foot of the sandstone-cliff, on the north side of the pier at Trollmen. Obviously the block is broken down from the cliff, but it could not be decided, whether it had come from the *Mickwitzia*-beds, which form the main part of the cliff, or from the overlying *Lingula*-banks; the latter alternative, however, seems more likely; inasmuch as the stone more resembles some varieties of the *Lingula*-sandstone.

From a lithological point of view the block may be characterized as a fine-grained, yellowish, cross-bedded sandstone, with rusty small spots after pyrite, and covered on the surface with a chocolate-coloured film, as is the case with all the sandstone-blocks of the shore-beach of this locality.

¹ A. G. NATHORST, Om spår af medusor i kambriska lager. K. Vet. Akad. Handl. Bd 19. Stockholm 1881.

Last summer I intended to make a closer examination of the locality, but on account of the abnormally high water of the lake, the foot of the cliff was not then accessible.

In addition to the features of the fossil in question shown clearly on Figures 1 and 2, some remarks may be made. The furrow-formed impressions reach a depth of 5—8 mm., a width of 30—35 mm., and a maximum length of 3 dm. or a little more. Some of the specimens have a constant width, other specimens grow smaller towards the one end. The furrows are crossed by transversal, curved ridges, through which the fossils appear as though segmented, and these ridges are convex towards the wider end of such samples of the fossil which do not have a constant width. In some specimens the furrows are not wholly straight-lined, and the segments are a little displaced, in the same manner as may sometimes be seen in the case of segments of trilobites. Three furrows are partly concealed under rests of the covering sandstone-layer, and in these cases no structure or segmentation comes in sight. A noteworthy feature is that in some specimens there runs at the bottom of the furrow either a suture-like line or an indistinct ridge, the former appearing on the great furrow in the middle of Fig. 1; indications of the latter are to be seen at the right end of the long specimen which crosses the lower right corner of Figs. 1 and 2.

Regarding the interpretation of this fossil, it seems to be excluded that it is formed as trails of a crawling organism. It may be suggested, as more likely, that the furrows with their transversal ridges be consecutive caudal prints, for instance of a swimming crustacean animal. In fact, there is some resemblance to the caudal tracks, which NATHORST in his renowned experimental studies¹ obtained through a swimming *Crangon vulgaris*. It seems, however, quite as probable, that the fossils represent embedded segmented animals, the segments of which have been so loosely jointed together that, through the decaying of the organic matter, they have been in some cases a little displaced. It may be remarked, that the Figures 1 and 2 turned upside down, by which the fossils appear in high relief, give more an impression of being bodily segmented fossils than mere tracks.

Prof. C. WIMAN has kindly drawn my attention to a somewhat similar fossil in a block of *Olenellus*-sandstone from the South Bottnian, which he has mentioned and figured in a paper published twenty years ago.² This fossil consists of some few segments in high relief and of about the same size as the fossils described above. Probably of the same character is a fossil that I have seen some years ago in a block of Cambrian sandstone at the railway-station of Wartosfta in Wästergötland. The

¹ A. G. NATHORST, Om spår af några evertebrerade djur m. m. och deras paleontologiska betydelse. K. Vet. Akad. Handl. Bd. 18. Stockholm 1881.

² C. WIMAN, Studien über das nordbaltische Silurgebiet. Bull. Geol. Inst. Upsala, Vol. VI, Upsala 1905, page 56 and Plate IV, Figg. 5 and 6.

block lies in the railway-platform, just in front of the clock of the station-house. The surface of the block shows two longitudinal sections of about a decimeter in length and two centimeters in width. It reminds one of sections of *orthoceratites*, and there are also indications of a median line and curved transversal lines. As the fossils were not very distinct and I had only a moment for observation, I cannot attach much importance to it, but only note it as an observandum for the future.



Fig. 1. Fossil consisting of furrow-formed, segmented impressions on a bed-plane of the lower Cambrian sandstone at Kinnekulle. About $\frac{9}{10}$ natural size.

Under the kind guidance of Prof. E. STENSIÖ I have had the opportunity of seeing the collections of Cambrian tracks, trails, and other problematica in the Riksmuseum of Stockholm. In the very rich collections from the *Mickwitzia*-beds of Lugnås the fossil here described is absent, but there is a block, collected by Mr. G. LILJEVALL at the shore of Lake Wener, between Råbäck and Hällekis (about 3 km. north of the find from Trollmen, described above), which contains a sample of this fossil, represented in high relief. It lies in a grayish white, fine-grained sandstone resembling varieties of the *Lingula*-sandstone, exposed in the beach and the cliff of the immediate neighbourhood.

The fossil is of the same size as the larger specimens in the Figures 1 and 2, and, as in these, no end is to be seen. It is also segmented in the same manner, but no trace of a median line appears. The convexity of the segments is turned towards the thinner end of the fossil, which is contrary to the case in the above-described specimens. This difference, however, is of little significance. If the fossils represent embedded cylindrical bodies, their thinning out in one direction or the other may be caused by their being somewhat more deeply embedded under the



Fig. 2. The same fossil-bearing sandstone-block as in Fig. 1. The light falling in another direction.

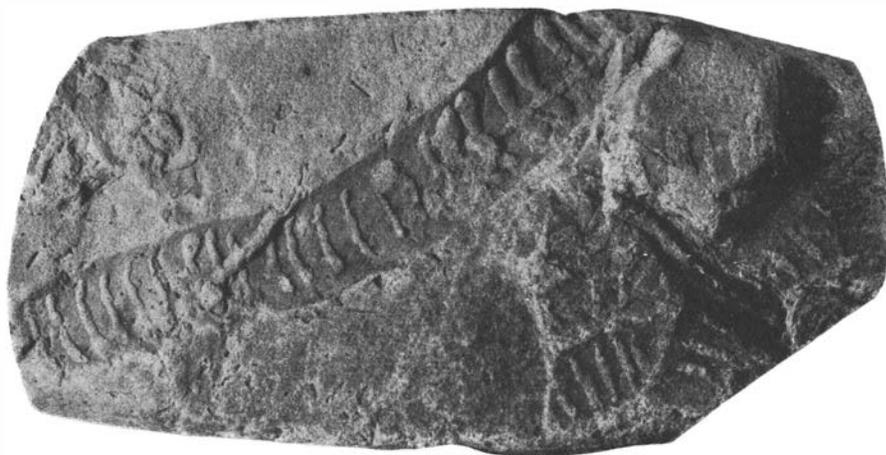
bed-plane of the rock at one end than at the other. If the fossils are interpreted as tracks, the difference named may be caused, either by different resistance to the impressions in different parts of the surface over which the animal has moved, or — supposing that the impressions are, for instance, caudal prints of a swimming animal — that the animal has withdrawn from the bottom or approached the bottom while swimming.

In the collections of the Riksmuseum a fossil is represented which may be compared with the fossils from Kinnekulle. As Prof. STENSIÖ has pointed out to me, it is described by NATHORST already in 1897.¹

¹ A. G. NATHORST, Ett märkvärdigt spår från Tessini-sandstenen på Öland. Geol. Fören. Förhandl. Bd. 19. Stockholm 1897, p. 361—365.

For better comparison with the fossil from Kinnekulle figured above, a specimen, found in a sandstone-block at Stora Rör on Öland, is here reproduced after a photograph, for which I am indebted to Prof. STENSIÖ.

This specimen in all respects resembles the specimens figured by NATHORST in his above-named paper. Although it also reminds one of the fossil from Kinnekulle, there are, nevertheless, some striking differences. The fossils from Öland are only half as large; the ridges at the bottom do not reach the border of the furrows and have club-shaped ends; there are no indications of a median line, as might be expected — considering the distinctness of the structure — if the fossils were of the same kind as the fossils from Kinnekulle. All specimens of the former are,



E. Stensiö photo.

Fig. 3. Fossil in a sandstone-block from Öland. About $\frac{1}{5}$ natural size.

furthermore, strongly curved, while the latter are tolerably straightlined. NATHORST has attached particular importance to the unequal distance between consecutive ridges in some of the specimens figured by him. In this respect also, there is a difference between the fossils from Kinnekulle and those from Öland.

Having discussed several possibilities, NATHORST, eventually, comes to the conclusion that the fossil described by him may represent tracks of an animal, and he compares it with tracks of *Climatichnites Wilsoni* LOGAN from the Potsdam-sandstone of North America and with *Harlania Halli* GÖPPE.¹ In these fossils, however, a median line (furrow or ridge) occurs, and other dissimilarities are also met with. It can be said that these fossils in some respects show closer resemblance to the fossil

¹ The literature treating these fossils is given in »Litteraturförteckning» of the treatise by NATHORST mentioned above (page 217, not).

from Kinnekulle. Thus, for instance, they have, in common, in addition to a median line, that the transversal ridges continue to the border of the furrow and that the ridges are more or less curved.

Besides the differences already named between the fossils from Kinnekulle and those from Öland, there also seems to be a difference regarding their stratigraphical position. The former occur in the lower Cambrian, probably the undermost banks of the *Lingula*-sandstone, the latter are found in blocks which are referred to the *Paradoxides-Tessini*-beds of the middle Cambrian, exposed along the western coast of this island. Lithologically, the fossil-bearing block from Stora Rör consists of a light gray, fine-grained, hard sandstone, with black spots of glauconite. The block from Röhälla, described by NATHORST, differs from the block from Stora Rör only by being of a darker gray and partly somewhat rusty.

It may be added that a third find of this fossil was made in 1902 by Prof. C. WIMAN at Borge Hage on the western coast of Öland. It is only a fragment, consisting of some few segments in a glauconite-bearing sandstone and of the same character as the finds described above. The block is kept in the Paleontological museum of Upsala.

The finds from Öland are all made as loose boulders; their stratigraphical position is, therefore, somewhat dubious. Their reference to the middle-cambrian *Tessini*-beds is founded on their lithological similarity to some varieties of the sandstone belonging to these beds, especially on the occurrence in this sandstone, as well as in the named blocks, of glauconite. This opinion seems to be so much more well grounded, as banks of the same middle-cambrian sandstone appear along the western shore of Öland, where the fossiliferous blocks have been found.

It may, however, be remarked that glauconite-bearing banks also occur in the sandstone of the lower Cambrian, the *Olenellus*-sandstone, which, likewise, is present along the same shore and at the bottom of the sea, close to the western coast of Öland.¹ There is, therefore, a possibility, which may be taken into consideration, that the fossiliferous blocks, described above, are derived from this sandstone and by the land-ice have been transported up to the shore. Both sandstone-horizons are mostly covered by the sea or by glacial deposits; because of this circumstance our knowledge of their lithological characteristics is quite incomplete and hardly allows a decision as to the horizon from which the fossils in question have come.

Although I am not able to interpret the true nature of the fossils from Kinnekulle treated here or to express an opinion as to their systematic position in the animal kingdom, I have thought that this commu-

¹ See H. MUNTBE, Beskrifning till Kartbladet Kalmar, Sveriges Geol. Undersökn. Ser. A c N:o 6, Stockholm 1902, p. 25, and JOH. CHR. MOBERG, Historical-Stratigraphical Review of the Silurian of Sweden, *ibid.* Ser. C, Nr. 229, Stockholm 1911, p. 198.

nication might have some interest. Our knowledge of the oldest Cambrian fauna is still so deficient that even such finds deserve to be recorded, which at present seem to be mere curiosities. Probably a closer examination by a paleontologist of the extended banks of *Lingula*-sandstone, uncovered in the shore-beach between Hällekis und Råbäck by low water, might give some new finds. These sandstone-banks are rich in tracks, trails, and other impressions, to a great part differing from those known from the renowned *Mickwitzia*-beds of Lugnås.

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