

ON
THE BRACHIOPODA OF THE PARADOXIDES BEDS
OF SWEDEN.

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WITH 4 PLATES.

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I. Introductory Remarks.

As far back as about fifty years ago, it was noticed by WAHLENBERG and DALMAN that the alum-schists of Sweden contain a peculiar fauna, totally different from that of the overlying strata.¹⁾ The importance of this geological horizon was not, however, fully appreciated, until Mr. BARRANDE pointed out its wide range, and showed that the oldest fossil-bearing strata of Bohemia contained a fauna analogous to that of the Swedish alum-schists. The "Primordial zone", of which these Swedish and Bohemian deposits were made the types, was soon recognized in several countries, but its classification has not been worked out in detail until within the last few years.

The first attempt to establish subdivisions in the Primordial zone of Sweden was made by Professor ANGELIN, by whom it was divided into two "regions", regio A. Olenorum and regio B. Conocorypharum.²⁾ Their stratigraphical relation to each other was not made out, but the latter, having a richer fauna, was considered the younger. The regio Conocorypharum was stated to occur only at Andrarum in Scania and in the island of Bornholm, while all the Primordial strata of the other Swedish provinces were, as a whole, referred to the regio Olenorum.

When I began to study in detail the Primordial zone of Westrogothia, I soon found that the *Oleni* were exclusively confined to the upper portion of the alum-schists, and that the lower contained quite different genera, as *Paradoxides* and *Conocoryphe*. I therefore proposed to restrict the regio Olenorum to the upper portion of the alum-schists and refer the lower portion, in which no *Oleni* occur, to the regio Conocorypharum,

¹⁾ See, for instance, WAHLENBERG, Geologisk afhandling om Svenska jordens bildning, Upsala 1824, pp. 38, 52, etc.; DALMAN, K. Vet. Akad. Handl. 1826, p. 150.

²⁾ Palæontologia Scandinavica, p. III, IV.

which must consequently be the older of the two regions. ¹⁾ I also endeavoured to show that the regio Conocorypharum, thus defined, might in Westrogothia be divided into three subdivisions, and that of these the middle one was equivalent to ANGELIN's typical regio Conocorypharum, ²⁾ which is identical to the "Andrarum limestone" of his geological map of Scania, the two others having been referred by him to his regio Olenorum. Considering, however, that, wherever the Primordial zone occurs in Sweden, *Paradoxides* is the most characteristic genus of its lower portion, of which Professor ANGELIN's regio Conocorypharum is, in its original sense, only a subdivision, I have later proposed to use the name Paradoxides beds, or, as schists are in Sweden the prevailing rocks, Paradoxides schists ³⁾, for the lower part of the alum-schists, and of the Swedish Primordial zone in general. In a similar sense Mr. BARRANDE has previously used the term *Phases à Paradoxides*, but the erroneous accounts given by Professor ANGELIN of the fauna and position of the regio Olenorum have led him to refer also the Olenus schists to his *Phases à Paradoxides*, while he correctly refers their British equivalents to the *Phases postérieures aux Paradoxides*. The three subdivisions of the Paradoxides beds of Westrogothia are the following:

3. Strata with *Agnostus lævigatus*.
2. » » *Paradoxides Forchhammeri*.
1. » » *Paradoxides Tessini*.

Soon after the Primordial succession had been worked out in Westrogothia, Dr. NATHORST began his important researches in the Primordial rocks of Andrarum in Scania. ⁴⁾ He ascertained that the typical regio Conocorypharum, or the Andrarum limestone underlies in Scania also the Olenus beds. Besides, he found, below the horizon of the Andrarum limestone, several fossiliferous strata, before unknown, containing various species of *Paradoxides* and other Primordial genera. Professor TORELL ⁵⁾

¹⁾ Bidrag till Vestergötlands geologi, Öfvers. af K. Vet. Akad. Förhandl. 1868.

²⁾ Om Vestergötlands Cambriska och Siluriska aflagringar, K. Vet. Akad. Handl., Bd 8, N:o 2, 1869, p. 42.

³⁾ Zeitschrift der Deutschen geologischen Gesellschaft, 1873, p. 698.

⁴⁾ See NATHORST, Om lagerföljden inom den kambriska formationen vid Andrarum i Skåne, Öfvers. af K. Vet. Akad. Förhandl. 1869.

⁵⁾ Petrificata suecana formationis cambricæ, Acta Universitatis Lundensis for 1869, printed 1870.

has since given in a tabular form an account of the Paradoxides beds of Andrarum. They are arranged and termed by him as follows.

Agnosti lævigati strata.

Selenopleuræ strata.

Paradoxidis Davidis strata.

Paradoxidis Hicksi strata.

Paradoxidis Wahlenbergi strata.

Of these the "Selenopleuræ strata" correspond to the "Andrarum limestone" and to those above termed by me strata with Paradoxides Forchhammeri. "Paradoxidis Hicksi strata" are equivalent to the Westrogothian strata with Paradoxides Tessini. The other two divisions do not occur in Westrogothia. The strata with Paradoxides Davidis are, as far as hitherto known, peculiar to Scania. "Paradoxidis Wahlenbergi strata" have not been found in any other locality in Sweden, but they occur in Norway; the Paradoxides occurring in these strata is, as far as can be made out from the imperfect materials I have myself collected or seen in the museum of Lund, identical to the *Paradoxides Kjerulfi*, which I have found in Norway, in a horizon underlying that of *Paradoxides Tessini*.¹⁾ This undermost part of the Paradoxides beds may therefore be termed the strata with Paradoxides Kjerulfi.

Of special interest are also the Primordial rocks of the island of Öland, which have been made known, chiefly by the labours of Mr. SJÖGREN.²⁾ The Paradoxides beds are divided by him into two divisions, of which the lower, consisting of arenaceous flagstones, is characterized by Paradoxides Tessini, the upper, consisting of greenish shales with intercalated calcareous and arenaceous beds, by Paradoxides ölandicus. Some time ago I found, from rock specimens collected by Dr. WALLIN and containing Brachiopoda characteristic of the strata with Paradoxides Forchhammeri³⁾, that there occurs also a third division. Since then I have myself visited Öland and found the strata with Paradoxides Forchhammeri at Södra Möckleby. They are

1) See LINNARSSON, Om några försteningar från Sveriges och Norges "Primordialzon", Öfvers. af K. Vet. Akad. Förhandl. 1871.

2) See SJÖGREN, Anteckningar om Öland, Öfvers. af K. Vet. Akad. Förhandl. 1851; Bidrag till Ölands Geologi, Öfvers. af K. Vet. Akad. Förhandl. 1871; Om några försteningar i Ölands Kambriska lager, Geol. Fören. Förhandl., Bd I, 1872.

3) See Geol. Fören. Förhandl., Bd II, N:o 4, p. 79.

there immediately overlain by the Olenus beds, the strata with *Agnostus lævigatus* being entirely wanting in that place. Thus the succession in the Paradoxides beds of Öland is:

3. Strata with Paradoxides Forchhammeri.
2. » » Paradoxides ölandicus.
1. » » Paradoxides Tessini.

The relative position of 1 and 2 I give on the authority of Mr. SJÖGREN. During my visit to Öland I could nowhere find a superposition showing their relation. In two places I saw the strata with Paradoxides Tessini lying immediately beneath those with Paradoxides Forchhammeri. Wherever the strata with Paradoxides ölandicus were exposed, neither of the other two divisions was visible in the vicinity.

The Paradoxides beds of our other provinces are partly less important than the preceding, partly very insufficiently known. In Nerike the three divisions known from Westrogothia are represented, but they are less developed, at least the two upper ones. The strata with Paradoxides Tessini are greenish and shaly, with intercalated bands of limestone; the others consist, as usual, of alum-schists with bituminous limestone.¹⁾

In Ostrogothia no complete sections of the Paradoxides beds are hitherto known. A few years ago I found, in some loose slabs of alum-schist, some of the fossils characterizing the strata with Paradoxides Forchhammeri and those with *Agnostus lævigatus*, and recently I have also found the same divisions *in situ* at Pålstorp and Knifvinge.

The strata with Paradoxides Tessini and those with Paradoxides Forchhammeri have been found in Jemtland,²⁾ the latter, however, not *in situ*, only in detached stones. Besides, there occurs, for instance at Lillviken near Östersund, a non-bituminous schist with *Paradoxides* and *Ellipsocephalus*, the position of which has not yet been fully ascertained. It seems to correspond most nearly to the strata with Paradoxides ölandicus, but the fossils hitherto found can hardly be identified with full certainty.

¹⁾ For further particulars see LINNARSSON, Öfversigt af Nerikes öfvergångsbildningar (Öfvers. af K. Vet. Akad. Förhandl., 1875, N:o 5).

²⁾ See LINNARSSON, Anteckningar om den kambrisk-siluriska lagerföljden i Jemtland, Geol. Fören. Förhandl. 1872.

Finally, the Paradoxides beds occur also in Lapland,¹⁾ but of their distribution and of the succession of the strata in that distant region very little is known.

From what has been stated above, it will be found that there are in the Swedish Paradoxides beds at least six divisions, each containing its peculiar fossils. These divisions may be arranged as follows:

6. Strata with *Agnostus lævigatus*.
5. » » *Paradoxides Forchhammeri*.
4. » » *Paradoxides ölandicus*.
3. » » *Paradoxides Davidis*.
2. » » *Paradoxides Tessini*.
1. » » *Paradoxides Kjerulfi*.

It must, however, be remembered that the relative position of the strata with *Paradoxides ölandicus* is not yet settled.

The fauna of the Paradoxides beds is far richer than that of the Olenus beds, though in the former too only a few classes of the animal kingdom are represented. The Trilobites have a decided preponderance. Professor ANGELIN has described about 30 species of them. To these there are to be added a large number, partly undescribed, partly described by Mr. SJÖGREN and myself. Of other Crustacea only a *Leperditia* has been described. The Mollusca are only represented by two classes, the Pteropoda and the Brachiopoda. Of the former only some species of *Hyolithus* are known. More numerous are the latter. Of Sponges Dr. NATHORST mentions from the Paradoxides beds of Scania a *Protospongia*. Bryozoa, Corals and Echinodermata are totally unknown from the Paradoxides beds, as, indeed, from the whole Primordial zone of Sweden.

The Brachiopoda, though comparatively numerous and, next to the Trilobites, by far the most important fossils of the Paradoxides beds, have hitherto met with but little attention. Among the Brachiopoda described by WAHLENBERG, DALMAN and HISINGER only one species, *Orthis lenticularis*, belongs to the Primordial zone, and this occurs in the Olenus beds. No Brachiopoda have since been described from the Primordial zone of Sweden,²⁾ but the following enumeration of the Primordial Bra-

¹⁾ See LINNARSSON, Försteningar från Lappland, insamlade af Hrr E. SIDENBLADH och E. ERDMANN, Geol. Fören. Förhandl. 1874, N:o 4.

²⁾ From the rocks below the Primordial zone I have myself described two species, *Obolus (?) monilifer* and *Lingula (?) favosa* (Geol. Magazine 1869; Geognostiska och palæontologiska iakttagelser öfver Eophyton-sandstenen

chiopoda of Scandinavia is given by Mr. BARRANDE,¹⁾ from communications by Professor ANGELIN:

Brachiopodes de la Faune primordiale de Scandinavie.

	Genres.	Especies.	Observations.	Localités.	
Reg. B.	Lingula	1	} Bornholm.	
	Orthis.....	1		
	? Atrypa (micula DALM.) ²⁾	1	forme arrondie qui rappelle celle d' <i>Obolus</i> et se rapproche de <i>Lingula</i>		
Reg. A.	Lingula	1	} Oeland.	
	Orbicula.....	1		
	Orthis	}	1	analogue à <i>Orth. pecten</i> ...	Oeland.
			1	anal. à <i>Orth. elegantula</i> ...	Bornholm.
	? Atrypa (lenticularis DALM.).....	}	1	accompagne souvent les <i>Olenus</i>	Oeland.
					Westrogothie. Scanie.

Of the eight species enumerated in the preceding list only four, all from the regio A Olenorum, are stated to occur in Sweden. As Professor ANGELIN refers to his regio A not only the Olenus beds, but also the lowest and highest parts of the Paradoxides beds, it is uncertain whether any of these species belong to the Paradoxides beds.— In studying the Primordial deposits of Westrogothia, I found that the strata with Paradoxides Forchhammeri abounded in Brachiopoda, which I, partly erroneously, referred to the genera *Orthis*, *Obolella*, *Discina* and *Lingula*.³⁾ This induced me to direct special attention to the Brachiopoda of the Paradoxides beds in general, and therefore I have, of late, brought

i Vestergötland, K. Vet. Akad. Handl. Bd 9, N:o 7, 1871). The generic position of both is very doubtful. At least the former should probably form a new genus.

1) Parallèle entre les dépôts siluriens de Bohême et de Scandinavie (Aus den Abhandlungen der kön. böhm. Ges. der Wiss. V. Folge, 9 Bd.) Prague 1856, p. 43.

2) Atrypa micula is cited by DALMAN (K. Vet. Akad. Handl. 1827, p. 135) from a black limestone at Fågelsång, and is probably a Lower Silurian species. It can hardly be identified from the short description of DALMAN.

3) Om Vestergötlands Cambriska och Siluriska aflageringar, p. 21.

together as many of them as I could. The richest harvest I have made in Westrogothia, but also from Scania, Nerike, Öland, and Jemtland I have brought home collections for the museum of the Geological Survey. From Öland the museum of the Geological Survey also possesses some species of Brachiopoda collected by Dr. WALLIN in the Paradoxides beds of that island. Dr. LUNDGREN has kindly placed at my disposal all the specimens from Andrarum in the museum of the university of Lund. I am also indebted to Professor JOHNSTRUP of Copenhagen for the liberal manner in which he has permitted me to make use of the rich collection of Brachiopoda made by him in the island of Bornholm. In that island the "Andrarum limestone" contains quite the same Brachiopoda as in the original locality in Scania, and, as many of the specimens sent by Professor JOHNSTRUP excel the Swedish ones, I have also had some of the former figured. Though I have thus had an opportunity of using most of the collections hitherto made in Scandinavia, I must own that the materials are still, in many respects, insufficient, but, notwithstanding, I have thought it advisable not to defer any longer giving an account, though imperfect, of the species found. Before describing them, I will say a few words of their mode of occurrence, and the state of preservation in which they are usually found.

The Brachiopoda, like most other fossils, are comparatively seldom met with in the schistose and shaly beds which chiefly constitute the Swedish Primordial zone, and, when found, they are often so compressed as to be hardly recognizable. They occur more copiously in the intercalated layers and nodules of limestone, and in these their shape is usually not at all altered through pression or contortion. The shell substance is also usually perfectly preserved in the limestone, but it sticks so fast to the rock that it is often impossible, among thousands of specimens, to obtain one single entire valve. Both valves I have not in any instance found united, with the exception of one specimen of *Acrothele*. The best specimens are obtained where the rock is somewhat weathered; there one may sometimes, though seldom, succeed to get loose an entire valve, even of the larger species, as the *Orthides*; of the smaller species it is less difficult to obtain entire valves.

The number of the Brachiopoda varies much in the different divisions of the Paradoxides beds. In the strata with Paradoxides

Forchhammeri they are most numerous, particularly in Westrogothia, where the limestone of that division is often replete with closely packed fragments of their valves. Even in Nerike, Öland, and Jemtland some species occur abundantly in the same division, while again in Scania they are comparatively scarce, the Trilobites having a great predominance in the Andrarun limestone of that province. In the other divisions the Brachiopoda are not numerous, and most of the species found are identical with species occurring in the beds with Paradoxides Forchhammeri, or, at least, very nearly related to them.

II. Descriptions of the Species.

Orthis Lindströmi n. sp.

Pl. I, pl. II, figs. 9—12.

Rotundato-quadrate, wider than long, broadest anteriorly. Hinge-line straight, less than the width of the shell; cardinal angles rounded; front subtruncated or, sometimes, slightly indented. Ventral valve very gently convex, most so near the beak, without fold or sinus; beak small; area low, directed backwards, but not distinctly seen in any of the specimens obtained. Dorsal valve rather deeper than the opposite one, divided longitudinally by a sinus, which extends from the beak and anteriorly often becomes obliterated. In the interior of the ventral valve the cardinal area is shallow, rhombic, usually marked with concentric wrinkles; from its anterior margin there extend on either side two parallel furrows, enclosing a slight ridge; after having run parallel for a space, these furrows bend asunder, so that the two middle ones meet in the median line, whereas the two outer ones bend outwards and backwards, parallel to the circumference of the valve; this feature is usually best seen in the internal casts; outside the furrows there is a space covered with numerous, very delicate, branched, radiating veins. The spaces within the furrows are, on the contrary, smooth. Of the dorsal valve I have not been able to obtain any good interiors; especially the hinge-margin is always in a bad state of preservation, as it sticks very hard to the rock because of its

inequalities; in weathered stones only can it be obtained tolerably perfect, but worn and indistinct (as fig. 7); the small cardinal process seems to be bifid; from under this process there extends a flattened mesial ridge, which usually soon becomes obliterated; the muscular scars are small and very obsolete. Surface of the valves marked by numerous radiating ribs, intersected by numerous concentric lines of growth, of which, in the adult, one or two are more marked and imbricating. The radiating ribs increase in number through interpolation; a real bifurcation I have not seen in any instance, though a younger rib often begins not in the middle between two older ones, but much nearer to the one of them. The interpolation takes place very irregularly.

Full-grown specimens vary but little in shape and ornamentation. Only in the interior are the features much more marked in some specimens than in others. The young individuals vary more. Fig. 9 represents a ventral valve with one imbricating line near the margin; it is somewhat narrower anteriorly than the typical specimens. Fig. 10 represents another ventral valve, in which no such line has yet been developed. The dorsal valves figs. 11 and 12, in pl. II, belong, I think, to young examples of this species, though they differ somewhat from the type, being more transversely oval, and less widening anteriorly; besides, in one of them the cardinal angles are more acute than usual.

Some adult, typical specimens measured:

	Length.	Breadth.
Dorsal valve.....	11 mm.	13 mm.
» »	14 »	17 »
Ventral »	12 »	14 »

Some junior specimens, in which the characters of the adult were not yet developed, measured:

	Length.	Breadth.
Dorsal valve.....	9 mm.	12 mm.
» »	7 »	9,5 »
» »	8 »	10 »

I do not know any species, with which this can be confounded. At least the adult specimens are always easily recognized. In the young ones the characters are less marked; especially in the dorsal valves. The interior and the internal cast of the ventral valve is in all stages of growth easily recognized.

Orthis Lindströmi is confined to the strata with *Paradoxides Forchhammeri*. In these it is not rare at Kinnekulle and Lovened in Westrogothia, and at Södra Möckleby in the island of Öland. In Jemtland I have found it in loose stones at Lillviken.

***Orthis exporrecta* n. sp.**

Pl. II, figs. 13—19, pl. III, figs. 20, 21.

Circumference of the shell transversely oval or nearly semi-circular; hinge-line shorter than the width of the shell; cardinal angles rounded; front gently curved or nearly straight. Surface covered with numerous radiating ribs, crossed by a large number of extremely minute concentric striæ, visible only under the lens, and by a few more marked. The ribs increase in number through interpolation, but most of them, though of very unequal coarseness, begin at the umbone, where they are so subtle as to be hardly discernible. The ribs are usually rounded and broader than the interstices; sometimes though seldom they are somewhat angular and narrower than the interstices. Ventral valve without fold or sinus, very convex, most so near the beak and at the sides, somewhat depressed in the anterior portion of the mesial part. Beak pointed and directed backwards. Area high, but not well visible in any specimen. In the interior the muscular impression is small but deep, subrhomboidal, or curved anteriorly, surrounded by a raised edge, and divided longitudinally by two linear ribs. From the anterior margin of the muscular depression two slightly diverging shallow furrows extend a longer or shorter space, while near the margin there are several radiating furrows. Dorsal valve very gently convex or almost flat, with a slight mesial depression, shallowing and widening forwards. In the interior the cardinal process is triangular, undivided, situated between two widely diverging brachial plates. From under the cardinal process a widish, flattened, mesial ridge extends a longer or shorter space, separating the muscular scars, which are small and indistinct. Those of the anterior pair are oblong and longitudinal, the posterior shorter and transverse.

Some specimens measured:

	Length.	Breadth.
Ventral valve.....	8 mm.	10 mm.
» » 	6 »	7 »

	Length.	Breadth.
Dorsal valve.....	8 mm.	11 mm.
» »	6 »	9 »

Though I have collected thousands of specimens of this species, I have only found a very few tolerably good ones. The internal casts are generally the best, but even these are nearly always defective or obscure in the cardinal region. I have had some casts figured. Figs. 14 and 15 represent typical forms of the internal cast of the ventral valve; fig. 16 represents a specimen somewhat deviating through the radiating ribs, which are unusually coarse and extend to the cardinal region. In the figured internal cast of the dorsal valve (fig. 19) the lobes corresponding to the grooves in the interior between the cardinal process and the brachial plates are larger than usual.

Among previously described species none, perhaps, is more nearly related to this than *O. Hicksi* (SALT.) DAV. The latter, however, differs by having fewer and coarser ribs. It also seems to have the beak less pointed, and the area lower than *O. exporrecta*.

O. exporrecta occurs chiefly in the strata with *Paradoxides Forchhammeri*. In Westrogothia it is by far the most abundant fossil of that horizon, and it is very plentiful wherever these strata are accessible, as at Kinnekulle, Lovened, and Gudhem. I have also found it in several places in Nerike; at Södra Möckleby in Öland; and, in loose stones, at Lillviken in Jemtland. In the strata with *Agnostus lævigatus* I have found some few specimens at Carlsfors in Westrogothia, near the north end of mount Billingen. At Andrarum in Scania and at Bornholm, where the strata with *Paradoxides Forchhammeri* contain a very rich fauna, this species, as well as the preceding one, seems to be altogether wanting.

Orthis Hicksi (SALT.) DAV. aff.

Pl. III, figs. 22, 23.

By the above name I will designate, provisionally, a species of which hitherto, besides a single interior of the dorsal valve, only a very few, mostly incomplete, internal casts have been found, and for which, therefore, I will not create a new specific name. It is nearly related to the preceding, but perhaps still more so to the British *O. Hicksi*, though I do not think it im-

probable that it will turn out to be an independent species, when sufficient materials have been obtained.

The ventral valve, judging from the internal cast, is moderately and evenly convex. The area is not seen in the cast, but it seems to be much lower than in the preceding species. The muscular depression is small, surrounded by a raised border, to which, in the cast, corresponds a depression. The internal cast is covered with a few sharp, distant, radiating ribs, with concave interspaces. Most of them extend from the muscular depression to the margin. Between these only a few shorter ribs are interpolated. — The dorsal valve is nearly semicircular, or semi-elliptical, gently convex, with a shallow longitudinal depression extending from the umbone to the front. In the interior the small cardinal process is situated between two widely divergent brachial plates. The muscular scars are strongly marked and separated by a wide mesial ridge, which extends from the cardinal process to the front. The anterior pair are oblong, longitudinal, the posterior more rounded. The internal cast, like that of the ventral valve, is covered with distant, sharp, angular ribs, the number of which, near the anterior margin, is about 20. Two dorsal valves measured:

Length 6 mm. Breadth 9 mm.
 » 6,5 » » 9 »

In most respects this species, as has already been stated, bears a great analogy to the preceding one, especially to such examples as fig. 16. The most important differences are, as far as can be judged from the imperfect materials, the following. The ventral valve is less convex, and the muscular depression in its interior not so distinctly trilobed as in the preceding species. The dorsal valve, on the contrary, seems to be somewhat deeper than in the preceding, and the muscular scars are more strongly marked. The radiating ribs, at least on the internal casts, are fewer, stronger, and more angular. In this latter respect it agrees more with *O. Hicksi*, the valves of which seem also to have a similar form. Their relation cannot, however, at present be ascertained in a satisfactory manner.

This species seems to be confined to the strata with Paradoxides Forchhammeri. I have only found it at Kinnekulle and Lovened in Westrogothia, and at Södra Möckleby in the island of Öland.

Genus *Lingula*, or *Lingulella*.

Pl. III, figs. 24—30.

Of *Lingula* or *Lingulella* various forms occur in the Paradoxides beds of Sweden, but the materials obtained are very scanty and insufficient, so that it is hardly possible to limit and characterize the species in a satisfactory manner.

From the other Swedish forms differs considerably, especially through its comparatively large dimensions, one species, figs. 29 and 30, which occurs in the strata with Paradoxides Kjerulfi at Andrarum in Scania. The specimens are, however, too defective to allow a satisfactory determination of the specific characters. Fig. 29, of an external cast, seems to be nearly complete, and to give a tolerably exact idea of the general shape; fig. 30 shows a more mutilated internal cast. The shell is very slightly convex. The outline is ovate or somewhat pentagonal. The surface is not preserved in any specimen, nor are the external casts distinct enough to give information of its ornamentation. The species was first found by Dr. NATHORST, and it may therefore be named *Lingulella* (?) *Nathorsti*. The specimens figured measure:

Length 9 mm. Breadth 7,5 mm.

» 12 » » 9 »

In the strata with Paradoxides Forchhammeri there occur other forms of *Lingula* or *Lingulella*, figs. 24—28, which are all more convex and of a smaller size, varying from 3 to 6 mm. in length. Their shape is somewhat different, but as the materials are very scanty, I do not feel certain, whether they belong to one or more species, and therefore I will not, at present, affix to them any specific denominations. Some specimens (figs. 24, 25) are ovate, with the sides curved and gradually merging into the obtusely pointed beak. In others (fig. 28) the beak is more acutely pointed, with nearly straight slopes. Finally, the shell is in some specimens (fig. 26) somewhat pentagonal, though not with quite straight sides. The shell surface is in none so well preserved that its ornamentation can be made out. The interior is almost unknown. In one specimen a low, flattened, or somewhat concave, mesial ridge is seen to extend, slightly widening, from the beak to about the middle of the shell. In the same specimen small punctiform pits, resembling those occurring in the interior of *Lingulella Davisi*, are seen. — The forms here referred to occur in the strata with Paradoxides Forchhammeri at Kinne-

kulle and Lovened in Westrogothia, at Andrarum in Scania, and in the isle of Bornholm. Also in the arenaceous flagstones which in the island of Öland contain *Paradoxides Tessini* similar forms are found.

***Obolus* (?) sp. indet.**

Pl. III, fig. 31.

Because of its general shape, I refer to the genus *Obolus* a species of which the materials are very unsatisfactory, so that I will not create for it a specific name, though it is easily distinguished from all the Primordial Brachiopoda of Sweden. The best specimen is an interior (fig. 31), somewhat mutilated anteriorly, and with the innermost shell layers partly exfoliated. Its width is 16 mm., the length about 14 mm. The shell is very slightly convex; its circumference resembles a sector of a circle; the front is broadly rounded; the slopes forming the beak seem to be nearly straight, and make a somewhat obtuse angle. The surface is not well preserved in any specimen; judging, however, from some small fragments, I should think that a concentric striation is prevailing, but that there are also radiating ribs. In the inner shell layers little more than a longitudinal striation is seen; the innermost are perforated by small punctiform pits. The inner layers are polished and glossy, the outermost seems to be opaque.

Of this species I have only found a few, mostly very fragmentary specimens at Lillviken in the province of Jemtland, in loose masses of bituminous limestone, belonging to the strata with *Paradoxides Forchhammeri*. They were associated with *Orthis Lindströmi*, *Orthis exporrecta* and *Acrothele coriacea*. The species is, in its general shape, not unlike *Obolus plumbeus* SALT., which is, however, distinguished by having the surface polished and marked with very distinct radiating striae. The latter also occurs at a much higher horizon.

***Acrotreta socialis* v. SEEBACH.**

Pl. III, figs. 32—35.

Acrotreta socialis v. SEEBACH, Zeitschr. der Deutschen geol. Gesellschaft, vol. XVII, 1865, p. 341, pl. VIII a, figs. 1—4.

Shell small, nearly circular in circumference, but somewhat truncated posteriorly. Ventral valve acutely conical, with the

posterior side flattened, thus forming a sort of false area. This area is often somewhat depressed longitudinally, but without any distinct groove. Beak pointed, not very excentric; profile from the beak to the anterior margin straight, from the beak to the posterior margin usually very slightly convex. The surface is smooth, as far as I can see. At the apex I have not been able to discern any foramen, but I have only seen a very few specimens with the shell preserved, and, owing to its extreme minuteness, the foramen, even if extant, might be very difficult to discern. The interior is not visible in any of the specimens at hand, but the internal cast (fig. 34) shows at the apex a groove, bordered by two longitudinal, subparallel ridges. — The dorsal valve is very slightly and uniformly convex, marked with concentric lines of growth. Its beak is marginal. The interior is unknown. — The diameter of the shell seldom exceeds 2 mm., the length being usually very little less than the width. The height is about half the width.

Acrotreta socialis was originally described by Professor v. SEEBACH from the regio Conocorypharum, or the strata with *Paradoxides Forchhammeri*, in the island of Bornholm. Though the species I have before me does not agree in every respect with the above cited description and figures by Professor v. SEEBACH, I do not hesitate to adopt for it the specific name given by him. It occurs abundantly in the strata with *Paradoxides Forchhammeri* in the island of Bornholm, whence it has been sent me by Professor JOHNSTRUP under the name of *A. socialis*. The want of agreement in certain instances between my specimens and the description of Professor v. SEEBACH is probably due to the circumstance that he has, as it seems, made up his description from specimens belonging to more than one species. That he has included in his *Acrotreta socialis* really different species may be inferred with great probability even from his statement that it occurs also in the Graptolite schists. Hence he concludes that these also belong to the regio Conocorypharum, but it is quite unquestionable that the Graptolite schists occupy a much higher horizon, ¹⁾ and it is not probable that they have any species in common with the regio Conocorypharum; at least I have not found, or seen in the collections from Bornholm any species

¹⁾ The Graptolite schists referred to by Professor v. SEEBACH are, no doubt, the middle Graptolite schists (or *Dicranograptus* schists), the place of which is about the middle of the Lower Silurian.

from the Graptolite schists which I can identify with the *A. socialis* of the regio Conocorypharum. It seems probable that from the true regio Conocorypharum also more than one species has been referred by Professor v. SEEBACH to the *A. socialis*. The exteriors figured by him belong probably to the same species for which I have retained the name, though I can see no traces of the minute warts with which, according to him, the surface is covered, and though the relative dimensions do not quite agree. On the other hand it does not seem improbable that the description and figures of the interior are made from specimens of *Obolella sagittalis*, but they do not give an altogether clear idea of the features which should be illustrated. The two protuberances near the hinge margin of the smaller valve, which are especially pointed out as something very characteristic, and which are said to remind of the hinge teeth of the Terebratulida, might well be the projecting muscular scars of *Obolella sagittalis*. I must, however, repeat that I do not myself know the interior of *Acrotreta socialis*, and that, therefore, in this matter I can set forth only a conjecture.

As to the generic position, I can scarcely doubt that the species is to be referred to the genus *Acrotreta*, though I have not myself been able to discern the foramen at the apex. In general shape it resembles very much the species formerly described from Russia and Canada, but it is lower. From the Russian type, *A. subconica* KUT., it differs also by not having any distinct groove in the false area of the ventral valve.

Acrotreta socialis occurs chiefly in the strata with Paradoxides Forchhammeri, in which it has been found at Kinnekulle and Lovened in Westrogothia, and in the island of Bornholm. In the strata with Paradoxides ölandicus, Dr. WALLIN has found it at Borgholm in the island of Öland. Perhaps it also occurs in a limestone band between the strata with Paradoxides Kjerulfi and those with *P. Tessini* at Andrarum in Scania. This limestone band is crowded with fragments of Trilobites, especially a *Paradoxides*, but they are so imperfect that it has not been possible to determine any species. It cannot, therefore, at present be settled to which division this limestone is to be referred. Besides Trilobites it only contains an *Acrotreta*, which I cannot, from the imperfect materials, separate from *A. socialis*, and an *Acrothele*, which will be referred to in the sequel.

Obolella sagittalis (SALT.) DAV.

Pl. III, figs. 36—41.

Obolella sagittalis Dav., Geol. Mag., Vol. V, 1868, p. 309, pl. XV, figs. 17—24.

» » Dav. Monograph of British Silurian Brachiopoda, p. 339, pl. L, figs. 1—14.

Nearly circular, a little wider than long, rather broader anteriorly. Surface smooth, polished. Ventral valve moderately and uniformly convex; beak situated near the posterior margin, bent backwards and perforated by a minute, round foramen, which, however, I have seen only in one single specimen. Between the beak and the margin there is no distinct area to be seen in this specimen, which is very well preserved, and therefore it probably never occurs. I have not found any interior of the ventral valve, but internal casts are common. They show a rounded groove at the apex, and two smaller ones behind that. In the interior of the dorsal valve two projecting muscular scars, of variable size and shape, are situated close to the posterior margin. Between them a nearly linear, but slightly widening mesial ridge extends from the margin to about the middle of the valve. Its length varies, so that in some specimens it does not reach the middle, while in others it exceeds it. Close to the mesial ridge there is, on either side, a smaller, almost parallel ridge. The anterior muscular scars I have not been able to discern. — The dimensions of the shell are always small, the larger diameter hardly exceeding 4 mm. Some specimens measure:

Length 3 mm. Width 4 mm.

» 3 » » 3,5 »

» 2,5 » » 3 »

Though the Scandinavian species above described does not in every respect agree with the admirable figures and descriptions given by Mr. DAVIDSON, the differences do not seem to be greater than to admit of an identification with the English species. Mr. DAVIDSON tells us that he has not seen in the English species any groove for the passage of a pedicle, but I do not think it impossible that more ample materials will show this character to be common to both, and that this disagreement will thus be removed. The interior of the ventral valve agrees completely, judging from the numerous internal casts I have had an oppor-

tunity of examining. Not quite so well do the interiors of the dorsal valve agree, but the differences may depend only on individual variations and, perhaps, also on the mode of preservation. The greatest difference seems to be in the shape of the longitudinal ridges. The two lateral ones are not mentioned by Mr. DAVIDSON, but they are indicated by the branches figured behind the anterior muscular scars. In the Scandinavian specimens examined by me the lateral ridges are more separated from the mesial one, and not so small in comparison with it. The circumstance that the anterior muscular scars have not been observed in the Scandinavian specimens cannot be considered as proving a real diversity, as that circumstance must be owing to the mode of preservation.

Acrothele n. g.

Shell corneous, composed of several laminæ, the inner smooth and polished, the outermost one rough and opaque. Ventral valve slightly conical, with excentric umbone, pierced by a minute foramen, in front of which there are, at least in one species, two small wart-like protuberances; the field between the umbone and the posterior margin is usually a little flattened, thus forming a slight indication of a false area. Dorsal valve with marginal umbone, consisting of two wart-like protuberances. In the interior of the dorsal valve there are two oblong, diverging muscular scars close to the posterior margin, and two small, rounded scars near the middle. The muscular scars are separated by a longitudinal ridge.

The above generic description is chiefly founded on one of the two species found, as I have not had any opportunity of examining the interior of the other, of which the materials have been imperfect also in other respects. The two species are, however, so similar in general shape that it is probable that the inner characters also are much the same. The most nearly related genera are, I think, *Obolella* and *Acrotreta*. The former differs, according to the generic description given by Mr. BILLINGS, by having the shell calcareous, though I think that species with corneous shell substance have, by some authors, been also referred to this genus. Of *Acrotreta* the interior is nearly unknown. In external characters it has many undeniable affinities to *Acrothele*. Thus they have both the dorsal valve flattened, with mar-

ginal umbone, and the ventral valve conical, with excentric umbone, and perforated by a small round foramen. *Acrothele* differs, however, at least from the typical species, such as *Acrotreta subconica* KUT. and *A. gemma* BILL., by having the ventral valve much lower, and the false area only very slightly indicated. More nearly related than the typical species is probably the doubtful *Acrotreta Nicholsoni* DAV. Among the Russian Brachiopoda described by KUTORGA¹⁾ *Siphonotreta tentorium* may also be a somewhat allied species. As KUTORGA himself remarks, it differs much from the typical *Siphonotreta*, but also from *Acrotreta*, by not having any traces of a false area. Like the true *Siphonotreta* it is said to have the surface covered with warts and spines. I do not think it improbable that some species described as *Discinæ* will prove to belong to this genus, for in many species the characteristic longitudinal slit in the ventral valve has not been observed. Thus, for instance, I may suppose that the *Discina primæva* BARR. & VERN.²⁾ is founded on a ventral valve of this genus.

Acrothele coriacea n. sp.

Pl. IV, figs. 44—48 (and 49, 50?).

Almost circular in outline, but a little wider than long, broadly rounded anteriorly, somewhat truncated posteriorly; greatest width usually a little before the middle. Outermost shell layer rough, somewhat like leather, not distinctly granulated, usually of a dull brown or nearly black colour, but in some few Westgothian specimens bluish. — Ventral valve slightly conical, with the umbone very excentric, its distance from the anterior margin being two or three times that from the posterior. The umbone consists of two very small wart-like protuberances. Close behind the warts the shell is perforated by a foramen which, owing to its extreme minuteness, is usually difficult to discern. Between the umbone and the posterior margin there is a narrow, triangular, somewhat flattened space, which might be considered as an indication of a false area. This area is, however, very faintly marked and not sharply separated from the other part of the shell, nor is there any trace of a longitudinal groove as in

¹⁾ Ueber die Brachiopoden-Familie der Siphonotretææ, Verhandl. der Kais. Mineral. Gesellschaft 1847.

²⁾ Bull. Soc. Géol. Fr., t. XVII, p. 532, pl. VIII, fig. 4.

Acrotreta subconica and *Acrotreta Nicholsoni*. The surface of the shell is marked by numerous lines of growth, which are most conspicuous in the false area, over which they continue uninterrupted. Some specimens show in the anterior part a very slight indication of radiating ribs. Of the interior I have not found any examples quite satisfactory. It is smooth and polished; in a few specimens only some radiating lines are very faintly indicated. The foramen is larger than at the surface, and always easily perceptible. Before the foramen there is a semicircular ridge, judging from the internal casts, which in that place always exhibit a semicircular groove. The false area is also slightly indicated in the interior and in the internal casts. Of the muscular scars I have not been able to detect any trace. — The dorsal valve is almost flat. The umbone is marginal, with two wart-like protuberances as in the ventral valve. From the umbone a very slight depression is often seen to extend to about the middle of the valve. The surface is rough, with several concentric lines of growth, which cross the posterior margin of the shell. Of the interior I have only found one single good specimen (fig. 48). As it exhibits some remarkable features, I shall describe it in some detail, though I am uncertain whether this description will, in every respect, be generally applicable. Near the umbone there is a small polygonal space, marked with several equidistant ridges and grooves, parallel to the margin of the space. This I cannot interpret otherwise than as the scar of an umbonal muscle, corresponding to that of *Lingula*. The umbone itself is in this specimen somewhat mutilated, but from another specimen it appears that there are two extremely minute pits, corresponding to the wart-like protuberances on the external surface of the shell. From the anterior part of the wrinkled polygonal space a low, dome-shaped, longitudinal ridge extends to about the middle of the valve, where it sends off, on both sides, some very faint linear ribs. The longitudinal ridge separates two pair of muscular scars, which are shallow and only feebly marked. The posterior are oblong, oval, concentrically wrinkled, directed obliquely forwards and outwards, bordered on the inner side by linear ridges, on the exterior by a gently curved slope, which gradually merges into the flattened margin of the shell. The anterior scars are very small, nearly round. Finally, there seems to be in the anterior part of the longi-

tudinal ridge an oblong scar, which might be produced by the "anterior oclusors." Some specimens measure:

Length 9 mm. Breadth 10 mm.

» 8 » » 9 »

» 4,5 » » 5 »

» 3 » » 3,5 »

Acrothele coriacea is the most widely spread species in the strata with *Paradoxides* Forchhammeri. In the north I have found it in loose stones at Lillviken in Jemtland, in the south at Andrarum in Scania. It is also common in the interjacent provinces. In Westrogothia it occurs at Kinnekulle and Lovened; in Nerike at Sanna, Hjulsta, Vinala, and Vrana; in Öland at Södra Möckleby. That it also occurs in Bornholm is shown by specimens sent by Professor JOHNSTRUP; these are, however, few in number, and it seems therefore to be rather scarce in that island.

At Andrarum a similar form occurs in the limestone band, above referred to, lying between the strata with *Paradoxides* Kjerulfi and those with *Paradoxides* Tessini. I have only examined some very few specimens, communicated from the museum of Lund by Dr. LUNDGREN. They are not in such a state that I will venture to express a decided opinion of their relation to the preceding species, but, if not identical, they are certainly nearly allied to it. I have prepared figures of two specimens, the only ones tolerably perfect. The one (fig. 50) is an internal cast of the ventral valve. It is nearly circular, the length being 5,5 mm., the breadth 6 mm. The umbone is perforated by a round foramen; it is not very excentric, the distance from the anterior margin being hardly twice that from the posterior. The other specimen (fig. 49) is an interior of the same valve, in which the inner shell layers are in part exfoliated. It seems more transverse, but the margins are not quite perfect, and the real shape cannot, therefore, be exactly ascertained. The umbone is more eccentric; it is perforated by a round foramen, and before that two minute pits are seen, indicating that also in this there are on the exterior two wart-like protuberances. The shell surface is not visible in any specimen; nor have I seen any dorsal valve.

Acrothele granulata n. sp.

Pl. IV, fig. 51 (and 52?).

Almost circular, a little wider than long. Ventral valve slightly conical. Umbone pointed, very excentric, the distance from the front being about four times that from the posterior margin. Its shape cannot be exactly defined from the materials hitherto obtained. Of a false area there is hardly more than a slight trace, only a very narrow space between the umbone and the posterior margin showing a slight difference from the other parts of the shell. The anterior part of the valve is depressed. The inner shell layers are smooth and polished, the outermost one opaque, granulated and marked near the circumference by concentric lines of growth. The interior is unknown as well as the dorsal valve. The only specimens of the ventral valve measure:

Length	8 mm.	Breadth	9 mm.
»	8,5 »	»	10 »
»	9,5 »	»	11 »

Though the scanty materials give but an imperfect knowledge of this species, it cannot be questioned that it is very nearly allied to *A. coriacea*. It seems, however, to be distinct by having the umbone more pointed and excentric, the surface distinctly granulated, and the false area hardly indicated. It is also, upon the average, larger.

Acrothele coriacea has been found in Jemtland at Lillviken near Östersund, and in a section at the river Billstaån in the parish of Hackås. The rock which has yielded it probably belongs to the strata with *Paradoxides ölandicus*.¹⁾

In the island of Öland Dr. WALLIN has found, near Borgholm, in the strata with *Paradoxides ölandicus* one single dorsal valve (fig. 52) the sculpture of which resembles that of the ventral valves from Jemtland above described, and which may possibly belong to the same species. This valve is, however, more transverse, its length being 10, its breadth 13 mm. It is gently and uniformly convex, not so flat as the dorsal valve of *A. coriacea*, but I do not think it impossible that its original shape has been somewhat altered.

¹⁾ Cfr. *ante*, p. 6.

Kutorgina cingulata BILL., var. **pusilla**.

Pl. IV, figs. 53, 54.

- Cfr. *Kutorgina cingulata* BILL., Pal. Fossils of Canada, Vol. I,
p. 8, figs. 8—10.
» » DAV., Geol. Mag. 1868, p. 312; pl.
XVI, fig. 10.
» » DAV., Monograph of Brit. Silurian Bra-
chiopoda, p. 342, pl. L, fig. 25.

Shell small, transversely oval, broadest about the middle. Hinge-line straight, shorter than the width of the shell; cardinal angles rounded. Shell substance apparently corneous. Surface marked with numerous, sharply marked, concentric lines of growth.

Length 3 mm. Breadth 4 mm.

As I have not had an opportunity of examining more than a very few specimens, I have thought proper not to create a new species at present, but provisionally to refer this species, as a variety, to the *Kutorgina cingulata* of BILLINGS, though I am by no means certain of the specific identity. Imperfect as our knowledge is, as well of the Canadian as of the Scandinavian form, their agreement in general aspect makes it probable that they are at least nearly allied. The greatest difference is in the size, which in the Scandinavian is many times less. It is also more transverse than the specimens figured by Mr. BILLINGS. More nearly it resembles the English figured by Mr. DAVIDSON. In the specimens from Bornholm the only ornamentation of the surface consists in the concentric lines; in a specimen from Östra Ryninge in Nerike there is also a slight indication of radiating ribs.

This species is rare in the strata with *Paradoxides Forchhammeri* in the island of Bornholm (Museum of Copenhagen). One single specimen, a little differing, I have found in the strata with *Agnostus lævigatus* at Östra Ryninge in Nerike.

Iphidea ornatella n. sp.

Pl. III, figs. 42, 43.

Shell small, transversely oval; sides and front rounded; hinge-line straight, or nearly so, shorter than the width of the

shell; cardinal angles rounded. Surface marked with retiform eminences, including small excavations. The eminences often swell out and become higher at the crossing-points, thereby giving to the surface a somewhat granulated appearance (as in fig. 43). In some specimens there are also more or less distinct radiating ridges, especially near the median line of the shell. The shell substance is apparently corneous, but I have not been able to discern more than one layer. The colour in the specimens from Bornholm is black, in those from Westrogothia more brown. — Ventral valve convex, subconical. Beak erect and pointed, pierced by a minute, round foramen. The posterior, visible only in one specimen, is truncated, so as to form a false area, which has in the middle a triangular fissure, arched over, in the upper part only, by a convex pseudodeltidium. — Dorsal valve less convex, somewhat flattened along the middle; greatest height at the beak, which is not, however, so prominent as in the opposite valve. Hinge-area not visible in any of the specimens. — Interior of both valves unknown. Two specimens measured:

Length 3 mm. Breadth 4 mm.

» 2 » » 3 »

There are so many analogies between this species and the *Iphidea bella* BILL. (Pal. Foss., vol. II, pt. I, p. 76) that I think it scarcely dubious that they belong to one and the same genus, though the internal characters of neither are known. The Swedish species differs by having the false area narrower and occupying only the upper part of the triangular fissure. The sculpture of the shell surface is also different, and the size many times smaller. To *Orthisina* this genus has certain analogies, but I think that they are only superficial. It seems to be well distinguished by the nature of the shell substance. Probably it is most nearly allied to *Kutorgina*.

Iphidea ornatella occurs in the strata with *Paradoxides Forchhammeri*. In Westrogothia I have found a few specimens at Lovened. From Bornholm several specimens have been sent by Professor JOHNSTRUP.

As will be seen from the above descriptions, the Brachiopod fauna of the Swedish *Paradoxides* beds is well deve-

loped in comparison with that of contemporary formations. In no other country have so many specific or generic forms been found. From the Primordial zone of Bohemia Mr. BARRANDE mentions only two species, *Orthis Romingeri* BARR. and *Obolus bohemicus* BARR. mscr. Of the same age as the Bohemian Primordial zone is evidently the Spanish, from which BARRANDE and VERNEUIL have described four species of Brachiopoda, namely *Discina primæva*, *Orthis primordialis*, *Orthisina vaticina* and *Orthisina Pellico*.¹⁾ Besides these, two undescribed species of uncertain genus are stated to occur. In the Baltic provinces of Russia the oldest fossiliferous beds contain several species of Brachiopoda, but among these beds there are none which can be parallelized with the Paradoxides beds. In Great Britain several species have been brought to light in the Menevian and underlying rocks, which correspond to the Swedish Paradoxides beds and, in part, to the sandstones underlying the Paradoxides beds. Up to this day, however, as far as I know, only six species have been described, namely *Lingulella ferruginea* SALT. and *primæva* HICKS, *Discina pileolus* HICKS, *Obolella sagittalis* (SALT.) DAV., *Obolella maculata* HICKS and *Orthis Hicksi* (SALT.) DAV. To these might perhaps be added *Kutorgina cingulata* BILL., but the age of the English rock which has yielded it is not yet settled; by the English geologists it is supposed to belong to a higher horizon than the Menevian. As to the American forms, I am not certain that I can give a complete enumeration, partly because the descriptions are scattered in many publications, of which perhaps some may be unknown to me, partly because it does not yet seem to be quite made out which of the American beds belong to the Paradoxides period. The best known representative of the Paradoxides zone in America is the St. Johns group of New Brunswick. From that Mr. HARTT has named four species, *Lingula Matthewi*, *Obolella transversa*, *Discina acadica* and *Orthis Billingsi*.²⁾ One undescribed species of *Lingula* and one of *Orthis* are also said to occur. In the first volume of his Palæozoic Fossils Mr. BILLINGS describes several Brachiopoda from the Potsdam sandstone, of which at least three, *Obolus labradoricus*, *Obolella chromatica* and *Kutorgina cingulata*, occurring on the north shore of the Straits of

¹⁾ Bull. Soc. Géol. Fr., vol. XVII, p. 532 *et seqq.*

²⁾ See DAWSON, Acadian Geology, 1868, p. 664.

Belle Isle, seem to belong to the Paradoxides period, as they are said to be associated with *Olenellus Thompsoni*, which has no affinity to *Olenus*, but is a true *Paradoxides* (or *Anopolenus*). Of the species described in the second volume *Obolella misera*, and probably *Iphidea bella* belong to the Paradoxides period. Finally, Mr. MEEK has described from Montana one species, *Iphidea* (?) *sculptilis*,¹⁾ which is probably of the same age.

These are, as far as I know, all the Brachiopoda hitherto published from the Paradoxides beds of Europe and America. The number of forms which have received distinct specific names is about 29. Several species have also been mentioned to which no specific name has been assigned. Even including these latter, the Brachiopoda are few in number, when compared with the Trilobites, of which already about 150 species have been described, new ones being added in quick succession. Mr. BARRANDE states in 1871²⁾ the total number to be 168, but this number is too high, as he comprises the whole Swedish Primordial zone in the "Phases à Paradoxides". In the *Olenus* beds not a single *Paradoxides* occurs, nor any representatives of most other Trilobite genera characterizing the Paradoxides beds in Sweden, as well as in other countries. It is not unlikely, however, that this number will soon be reached, or even surpassed. Next to the Trilobites the Brachiopoda are the most important part of the fauna of the Paradoxides beds. As the Brachiopoda in general have a far wider range in time than the Trilobites, it is not to be expected that the Brachiopod fauna of the Paradoxides beds will show so striking peculiarities as the Trilobite fauna, though the facts hitherto known tend to show that the Paradoxides beds contain many peculiar types also among the Brachiopoda. How far the differences in this respect extend between the Paradoxides beds and the overlying formations it is not, at present, possible to ascertain with full certainty, as the limits of many of the genera are still very uncertain, and probably many species ought to be referred to other genera than those to which they have hitherto been referred. In general, the Paradoxides beds are chiefly characterized by most of their Brachiopoda having a corneous shell, composed of

¹⁾ Sixth Annual Report of the United States Geological Survey of the Territories, 1873, p. 479.

²⁾ Trilobites, p. 195.

several thin laminae, while in the Lower Silurian strata the forms with a compact, calcareous shell have a great preponderance. Among the generic types *Kutorgina*, *Acrothele* and *Iphidea* seem to be the most characteristic, none of them being hitherto, with certainty, found in rocks of younger age than the Paradoxides period.

As hitherto no full account in one place has been given of the faunæ of the Swedish Primordial zone, I here subjoin a list of the species described up to this day from the Paradoxides beds of Sweden. Several undescribed species occur, but of these I will only refer to a few of the more important. The works in which the species have, under the names used in the list, been first described or mentioned as occurring in Sweden or any of the other Scandinavian countries are the following:

- ANG. 1851, 1854. ANGELIN, Palæontologia Scandinavica, fasc. I 1851, fasc. II 1854.
- BRONGN. 1822. BRONGNIART, Histoire naturelle des Crustacés fossiles.
- DALM. 1828. DALMAN, Årsberättelse etc., afgifven den 31 Mars 1828.
- LINRS. 1869. LINNARSSON, Om Vestergötlands Cambriska och Siluriska aflagringar (K. Vet. Akad. Handl. Bd 8, N:o 2).
- LINRS. 1872. LINNARSSON, Om några försteningar från Sveriges och Norges "Primordialzon" (Öfvers. af K. Vet. Akad. Förhandl. 1871, printed 1872).
- LINRS. 1875. LINNARSSON, Öfversigt af Nerikes öfvergångsbildningar (Öfvers. af K. Vet. Akad. Förhandl. 1875).
- NATH. 1869. NATHORST, Om lagerföljden inom kambriska formationen vid Andrarum i Skåne (Öfvers. af K. Vet. Akad. Förhandl. 1869).
- SJÖGR. 1872. SJÖGREN, Om några försteningar i Ölands kambryska lager (Geol. Fören. Förhandl., Bd 1, N:o 5).
- v. SEEB. 1865. v. SEEBACH, Beiträge zur Geologie der Insel Bornholm (Zeitschr. der Deutsch. geol. Gesellschaft., Bd XVII).
- TOR. 1870. TORELL, Petrificata Suecana Formationis Cambricæ (Acta Universitatis Lundensis for 1869, printed 1870).

List of the fossils of the Paradoxides beds of Sweden.	Parad. Kjerulfi.	Parad. Tessini.	Parad. Davidis.	Parad. ölandicus.	Forchhammeri.	Parad. Agnostus levi-gatus.	Strata with Agnostus levi-gatus.
Paradoxides Kjerulfi LINRS. 1872	*						
» Tessini BRONGN. 1822.....		*					
» Hicksi SALT. (TOR. 1870).....		*					
» Davidis SALT. (NATH. 1869).....			*				
» ölandicus SjöGR. 1872				*			
» Forchhammeri ANG. 1851.....					*		?
» Lovéni ANG. 1851					*		
Ellipsocephalus muticus ANG. sp. 1851, LINRS. 1875		*		*			
Arionellus difformis ANG. sp. 1851.....						*	
» aculeatus ANG. sp. 1851						*	
» acuminatus ANG. sp. 1851						*	
» sp. indet. LINRS. 1872	*						
Anomocare excavatum ANG. 1851						*	
» limbatum ANG. 1851.....						*	
» læve ANG. 1851.....						*	
Liostracus costatus ANG. 1854.....							*
» microphthalmus ANG. sp. 1851.....						*	
» ? aculeatus ANG. 1851.....		*					
Dolichometopus suecicus ANG. 1854.....						*	
Conocoryphe Dalmani ANG. 1854.....						*	
» glabrata ANG. 1854						*	
» sp. indet.			*				
Selenopleura holometopa ANG. 1851.....						*	
» canaliculata ANG. 1851.....						*	
» brachymetopa ANG. 1851						*	
» (?) stenometopa ANG. 1851 ¹⁾							?
Elyx laticeps ANG. 1851						*	
Harpides breviceps ANG. 1854 (Erinnys?).....						*	
Aneuacanthus acutangulus ANG. 1851						*	
Microdiscus sp. indet. NATH. 1869.....		*					

¹⁾ This species Professor Angelin cites from the regio Olenorum in Westrogothia and Öland. It is unknown to me, but I am inclined to think that it belongs to the strata with Paradoxides Forchhammeri. An identification is hardly possible from the description and figure given in Pal. Scand.

List of the fossils of the Paradoxides beds of Sweden.	Parad. Kjerulf.	Parad. Tessini.	Parad. Davids.	Parad. Ölandicus.	Parad. Forchhammeri.	Strata with Agnostus levigatus.
Corynexochus spinulosus ANG. 1854.....					*	
Agnostus gibbus LINRS. 1869.....		*				
» fallax LINRS. 1869.....		*				
» planicauda ANG. 1851.....					*	
» exsculptus ANG. 1851.....					*	
» punctuosus ANG. 1851.....			*			
» aculeatus ANG. 1851.....					*	
» parvifrons LINRS. 1869.....		*				
» brevifrons ANG. 1851.....					*	
» glandiformis ANG. 1851.....					*	
» bituberculatus ANG. 1851.....					*	
» lævigatus DALM. 1828.....					*	*
» regius SJÖGR. 1872.....				*		
Trilobites ænigma LINRS. 1869.....					*	
Leperditia primordialis LINRS. 1869.....						*
Hyalolithus socialis LINRS. 1872.....		*				
» tenuistriatus LINRS 1872.....					*	
» sp. indet. SJÖGR. 1872.....				*		
Orthis Lindströmi n. sp.....					*	
» exporrecta n. sp.....					*	*
» Hicksi (SALT.) DAV. aff.....					*	
Lingulella (?) Nathorsti n. sp.....	*					
» sp. indet.....		*			*	
Obolus ? sp. indet.....					*	
Obolella sagittalis (SALT.) DAV.....		?			*	
Acrotreta socialis v. SEEB. 1865.....				*	*	
Acrothele coriacea n. sp.....					*	
» granulata n. sp.....				?		
Kutorgina cingulata BILL., var. pusilla.....					*	*
Iphidea ornatella n. sp.....					*	
Protospongia sp. indet. NATH. 1869.....			*			

In the Olenus beds the Trilobites are still more prevalent, though not so many in number and only comprising, perhaps with one single exception, a few genera of the Olenide and Agnostide families. The only other fossils hitherto described from the Olenus beds are *Beyrichia Angelini* BARR.,¹⁾ *Orthis lenticularis* WAHLENB., *Dichograptus tenellus* LINRS. and *Dictyonema flabelliforme* EICHW.²⁾ Though the lastnamed species occurs together with an Olenide at Fågeisång in Scania, the genus *Dictyonema* is chiefly characteristic of a somewhat higher horizon, which I have, therefore, termed *Dictyonema schists*. In these schists it is associated with *Obolella Salteri* HOLL and a *Dichograptus*. The Ceratopyge limestone that follows above the *Dictyonema schists* has a distinctly Lower Silurian fauna.

¹⁾ This name Mr. BARRANDE, without a description, has given to a species figured by ANGELIN in an unpublished plate, and stated to occur in the alum schists of Scania. I have recently described and figured the species from specimens collected in Nerike.

²⁾ Among undescribed species there are some *Lingulidæ*.

Explanation of Plates.

PLATE I.

- Figs. 1—8. *Orthis Lindströmi* n. sp.
 1. Ventral valve, Lovened. 2. Interior of ventral valve, Kinnekulle. 3. Internal cast of ventral valve, Kinnekulle. 4, 5. Internal casts of ventral valve, Lovened. 6. Exterior of dorsal valve, Kinnekulle. 7. Interior of dorsal valve, Lillviken. 8. Internal cast of dorsal valve, Kinnekulle.

PLATE II.

- Figs. 9—12. *Orthis Lindströmi*, junior.
 9, 10. Ventral valves, Kinnekulle. 11, 12. Dorsal valves, Kinnekulle.

- Figs. 13—19. *Orthis exporrecta* n. sp.
 13. Ventral valve, Kinnekulle. 14—16. Internal casts of ventral valve, Lovened. 17. Dorsal valve, Kinnekulle. 18. Ditto, Lovened. 19. Internal cast of dorsal valve, Lovened.

PLATE III.

- Figs. 20, 21. *Orthis exporrecta*.
 Interiors of dorsal valve.
 Figs. 22, 23. *Orthis Hicksi* (SALT.) DAV. aff.
 22. Internal cast of ventral valve. 23. Internal cast of dorsal valve, Lovened.
 Figs. 24—28. *Lingulella* (?) sp. indet. (from the strata with *Paradoxides Forchhammeri*). 24. Exterior, somewhat exfoliated, Kinnekulle. 25. Interior, Bornholm (Museum of Copenhagen). 26, Exterior, Andrarum. 27. Ditto (Museum of Lund). 28. Exterior, Kinnekulle.
 Figs. 29, 30. *Lingulella* (?) *Nathorsti* n. sp.
 29. External cast, Andrarum (Museum of Lund), enlarged (2 diam.). 30. Internal cast, Andrarum, enlarged (2 diam.).
 Fig. 31. *Obolus* (?) sp. indet.
 Interior, partly exfoliated, Lillviken, enlarged (2 diam.).

- Figs. 32—35. *Acrotreta socialis* v. SEEBACH.
 32. Ventral valve, Kinnekulle, strata with Paradoxides Forchhammeri. 33. Ditto, Borgholm, strata with Paradoxides ölandicus (Coll. WALLIN). 34. Internal cast of ventral valve, Bornholm (Museum of Copenhagen). 35. Exterior of dorsal valve, Borgholm (Coll. WALLIN).
- Figs. 36—41. *Obolella sagittalis* (SALT.) DAV.
 36. Ventral valve, Bornholm (Museum of Copenhagen). 37, 38. Internal casts of ventral valve, Andrarum (Museum of Lund). 39. Interior of dorsal valve, Andrarum. 40. Interior of dorsal valve, Bornholm (Museum of Copenhagen). 41. Internal cast of dorsal valve, Bornholm (Museum of Copenhagen).
- Figs. 42, 43. *Iphidea ornatella* n. sp.
 42. Ventral valve, Bornholm (Museum of Copenhagen). 43. Dorsal valve, Lovened.

PLATE IV.

- Figs. 44—48. *Acrothele coriacea* n. sp.
 44. Ventral valve, Kinnekulle. 45. Interior of ventral valve, Kinnekulle, enlarged (4 diam.). 46. Internal cast of ventral valve, Kinnekulle. 47. Dorsal valve, Kinnekulle. 48. Interior of dorsal valve, Lovened.
- Figs. 49—50. *Acrothele coriacea*. ?
 49. Interior. 50. Internal cast of ventral valve, Andrarum, in the limestone band lying between the strata with Par. Kjerulfi and those with Par. Tessini (Museum of Lund).
- Fig. 51 (and 52?). *Acrothele granulata* n. sp.
 51. Ventral valve, Lillviken. 52. Dorsal valve (of the same?), Borgholm (Coll. WALLIN).
- Figs. 53, 54. *Kutorgina cingulata* BILL., var. *pusilla*.
 53. Exterior, Bornholm (Museum of Copenhagen). 54. Exterior, somewhat exfoliated.







