Investigations of the Lower Ordovician of the Siljan District, Sweden

V.

Notes on Swedish *Ahtiella* species

By

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Introduction.

In previous papers of the present series dealing with the Lower Ordovician of the Siljan District, Sweden, some of the groups of organisms occurring in an iron oolitic limestone have been described. Brachiopods form an important group in this stratal sequence, but a complete description of this fauna must be postponed. In this paper one species of *Ahtiella* is discussed, and those Swedish *Ahtiella* species which were earlier considered as *Strophomena jentzschi* GAGEL are revised in this connection.

Great importance was attached to *Strophomena jentzschi* by J. G. ANDERSSON in his work on lower Paleozoic phosphoritic rocks of Sweden

(1896). A special horizon called the *Strophomena jentzschi* conglomerate was distinguished by him.

I had the opportunity to study Prof. ANDERSSON's collection of this species and a few specimens from the type locality (Spittelhof in East Prussia). Both the ANDERSSON collection and the Spittelhof specimens belong to the Swedish State Museum.

Furthermore, I had at my disposal, in addition to the material collected by myself, specimens belonging to the Inst. of Palaeontology, Uppsala, collected by Prof. C. WIMAN, Dr ELSA WARBURG, Dr B. BOHLIN, and Mr H. MUTVEI.

Specimens reported as *Strophomena jentzschi* from Sweden.

ISLAND OF ÖLAND. A great many specimens were collected by J. G. ANDERSSON during his investigation of Swedish Paleozoic phosphorites (1896). They were not described nor figured.

Most of them derive from a drift boulder found at Stenåsa. The matrix of the boulder is a light-coloured limestone filled to a great extent with rounded quartz grains and phosphoritic nodules. The presence of the ostracod *Conchoides levis* HESSLAND indicates the boulder to be of *Raniceps* age. The mother rock is not known, but it is likely to be found on the bottom of the Baltic Sea since quartziferous limestones of this type do not seem to have been observed in Öland.

Rather many specimens were also found in the bed-rock at Hälludden, viz., in a light-coloured limestone rich in glauconite which belongs to the *Raniceps* Zone (acc. to oral communication by Mr H. MUTVEI). A few other specimens were found at Byerum (light-coloured *Raniceps* Limestone). A single specimen was also reported from Horn (not seen by me).

This material appeared to be heterogeneous. It is very questionable whether *Strophomena* = *Ahtiella jentzschi* is present. The main part consists of new species (*Ahtiella ölandica*, *A. jaanussoni*, and *A. plana*).

ISLANDS OF GOTLAND AND GOTSKA SANDÖN. The specimens were found by ANDERSSON in drift boulders (1896, p. 204 f.) obviously derived from the bottom of the Baltic Sea. Specimens from Källunge myr were placed at my disposal. They belong to the new species *A. ölandica*.

THE SUBMARINE AREA OF THE BOTHNIAN GULF. One specimen was briefly mentioned by WIMAN (1907, p. 103). It was found in a drift boulder just outside Uppsala. The specimen (figured in Pl. I. Fig. 5 of this paper) certainly belongs to the *Raniceps* Zone judging from the fact that *Glossopsis robusta* HESSLAND was found in the boulder. The specimen is *A. dalecarlica* n. sp.

THE SILJAN DISTRICT. One specimen (Pl. I, Fig. 3) was found by Dr ELSA WARBURG in 1908, but no account was ever published. The specimen is *A. dalecarlica* n. sp. and it derives from the Leskusänget limestone quarry in the parish of Orsa. I made some further finds of the species in this locality.

Specimens reported as *Strophomena jentzschi* from Estonia, Ingermanland, Norway, and N. German drift boulders.

ESTONIA. *S. jentzschi* is reported by ÖPIK (1927) from the so-called Rogö Sandstone which occurs mainly in the two Rogö Islands and the peninsula of Paldiski. The sandstone also appears on the Island of Odensholm; on the mainland it can be followed eastwards to Tallinn. The formation is rather calcareous and forms a thin layer tapering in thickness eastwards (from about 1.5 m to about 0.3—0.4 m). According to ÖPIK, phosphoritic nodules occur in the basal part of the sandstone.

Mr V. JAANUSSON has informed me that the *Expansus* Zone (*B III α*) is not represented in the Rogö Sandstone, as questioned by ÖPIK (1927, p. 56). In Paldiski and the Islands the main part belongs to the *Raniceps* Zone (*B III β*); only the uppermost part (about 10—25 cm) belongs to the *Eichwaldi* Zone (*B III γ*). The *B III β* and *B III γ* sections are parted by a discontinuity surface.

S. jentzschi is only reported from the peninsula of Paldiski. Judging from the fossils from this locality, as enumerated by ÖPIK, both the *Raniceps* and the *Eichwaldi* Zones occur there. It was not more definitely stated in what level the specimens were found. Most likely they were found in the *Raniceps* Zone which constitutes the main part of the Rogö Sandstone of Paldiski.

In later papers (1932 and 1933) ÖPIK erected two new *Ahtiella* species. One of them, *A. arenaria*, (1933, p. 20) was questioned to be identical with the specimen appointed by him (1932, p. 38) as lectotype of *A. jentzschi*. However, reasons against this supposition were, in fact, simultaneously alleged by himself. In the other paper, ÖPIK had assumed that *A. baltica* ÖPIK was identical with those specimens referred by ANDERSSON to *A. jentzschi* (1932, p. 43).

The material of *A. arenaria* was derived from the Lilla Rogö Island, that of *A. baltica* from the Rogö Islands and Paldiski.

As a matter of fact, definite statements as regards the identity of the Paldiski specimens referred to *Strophomena jentzschi* in 1927 were not given in these papers. Since they were neither pictured nor described, their identity is not ascertainable from the literature.

INGERMANLAND. LAMANSKY (1905, p. 177) mentioned that *S. jentzschi* occurs in the whole *B* stage at Wolchow. The species is said to be highly variable. Those specimens occurring at the transition between *B III α* and *B III β* are stated to be very similar to specimens from the *S. jentzschi*

conglomerate of the Island of Öland which he had received from Prof. ANDERSSON for comparison. The specimens of the *B III γ* zone are much smaller, more elongated, and have a finer sculpture.

The identity of these Ingermanland species is dubious.

NORWAY. HOLTEDAHL (1916, p. 46) reported two specimens from the Oslo District, viz. from the *Expansus* Slate; one was found at the transition between *3cβ* and *3cγ*. This species is very much reminiscent of *A. baltica* ÖPIK (cf. Pl. I, Fig. 8).

LAMANSKY's suggestion that the specimen denominated by BRÖGGER (1882, p. 50) as *Strophomena rhomboidalis* WILCKENS var. should be *Strophomena jentzschi* is untenable; in fact it belongs to another species, as shown by HOLTEDAHL (l. c.).

N. GERMAN DRIFT BOULDERS. The holotype was found in a drift boulder at Spittelhof in East Prussia. This boulder consists of a light-coloured limestone rich in quartz grains. Some other finds were made in a few other localities (cf. ANDERSSON 1896, p. 207 f). The boulders do not contain species indicating the age.

On the identity of *Strophomena jentzschi*. GAGEL.

There has been much uncertainty as regards the identity of this species owing to the fact that the description is scanty and the drawings are not very precise. In addition to this is the circumstance that GAGEL has drawn two specimens which have been interpreted to belong to different species or even different genera (ÖPIK 1932, p. 39). However, there may be no reason for the suspicion that they represent different genera. Both may, in fact, belong to *Ahtiella* ÖPIK, since they are elongatedly sinuate, though the sinus of the type designated lectotype by ÖPIK (1932, p. 38) is little pronounced judging from the drawing (GAGEL 1890, Pl. V, Fig. 26). The description mentions, moreover, that the species is sinuate.

It may also be questioned whether ÖPIK is right when suggesting the two specimens drawn as different species. The specimen shown in Fig. 26 *b* may be a mould of a ventral valve belonging to the same species as the specimen shown in Fig. 26 (cf. below).

GAGEL's collection may be in Königsberg (Ostpreussisches Provinzialmuseum), and not accessible for the time being, and a revision is thus not possible. However, I had the opportunity to study some specimens determined by GAGEL as *S. jentzschi*. They are included in a rock sample derived from the very same boulder as the holotype of *Ahtiella jentzschi*.

In this rock sample are many specimens, mainly moulds of ventral valves with fragments of the valves. One dorsal valve (partly damaged) is present. This valve and the moulds represent obviously the same species

(cf. p. 519). Furthermore, the characters of this species are practically perfectly coincident with those stated by GAGEL for *Ahtiella jentzschi*. Thus, the present specimens are certainly conspecific with this species.

Notes on the characters of presently known *Ahtiella* species.

Dimensional data (from ÖPIK 1932 and 1933, and the present material):

	Breath (B)	Length(L)	Ratio $\frac{B}{L}$	Ridges	Fine ridges between large	Con-marginal striae	Pseudo-punctae
A. jentzschi GAGEL	9.5—15	4—7	2.1—2.4	24—26	2—3	25	25
A. gemella (EICHW.)	7	2.5	2.8	—	—	—	—
A. lirata ÖPIK	19	12.5—15	1.3—1.5	8—18	5—10	15—20	20
A. baltica ÖPIK	18	9	2.0	24—30	2—3	25	25
A. sp. α aff. *baltica* ÖPIK	14	8	1.8	30	6—7	—	15—18
A. arenaria ÖPIK	18	7.8	2.3	30	4—6	—	—
A. ölandica n. sp.	9.5	6.5	1.5	30—35	5—6	25	15—35
A. jaanussoni n. sp.	15—28	8—16	1.7—2.1	23—28	2—4	20	15—20
A. plana n. sp.	9—10	4—5	2.0—2.4	27—30	4.5	15	25—30
A. dalecarlica n. sp.	6.5—10	3.5—5.0	2.0—2.2	30—34	4—5	25	30

Number of ridges referable to 5 mm.
Number of conmarginal striae referable to 1 mm.
Number of pseudo-punctae referable to 1 mm².

In the following only the external characters are considered.

A. gemella is not so accurately described and figured that the identity is certainly determinable.

Among the other species one may discern one group characterized by a high marginal surface. To this group are referable: *A. lirata*, *A.* sp. α aff. *baltica*, and *A. jaanussoni*. The main differences appear from the above table. *A. jaanussoni* is furthermore characterized by the fact that the radiating ridges of the marginal surface are squamose. *A. lirata* occurs additionally in a higher horizon than the other species.

A. dalecarlica takes a special position mainly on account of the fact that the corrugations of the face form a larger angle with the hinge margin than those of the remaining species; furthermore, the tapering ends of the corrugations are fairly short.

The remaining species (*A. baltica*, *A. arenaria*, *A. jentzschi*, *A. ölandica*, and *A. plana*) show minor differences as regards number of ridges, outline of face, appearance of sinus, and distinctness of corrugations. However, the

corrugations are identical in all the species in forming a very acute angle with the hinge margin and in the hinge end being elongatedly tapering.

Some special characters are mentioned below as regards these species.

A. baltica has a semicircular face which is slightly elevated; the sinus is shallow and ending at the anterior end of the face.

A. arenaria has a short face with indistinct corrugations; the sinus is extremely shallow and the cardinal extremities are acutely projecting.

A. jentzschi has a flat face and its anterior margin is not so rounded as in *A. baltica*, and the sinus is more shallow.

A. ölandica is similar to *A. baltica* as regards the appearance of the face, but the sinus is more pronounced and continues somewhat along the marginal surface.

A. plana is characterized by a plane face, very distinct corrugations and an angled transition from face to marginal surface.

Ahtiella from a stratigraphic point of view.

The renowned *Strophomena jentzschi* GAGEL which, in fact, is an *Ahtiella*, has appeared not to have the wide distribution as suggested earlier.

The comprehensive Öland and Gotland collection upon which ANDERSSON (1896) based his *Strophomena jentzschi* Zone is composed of other species distinguished for the first time in the present investigation.

ANDERSSON was aware of the fact that the material was heterogeneous. He pointed out (1896, p. 210) that the specimens "zeigen eine überaus stark hervortretende individuelle Variation".

The specimens reported as *Strophomena jentzschi* which have been found in Estonia, Ingermanland, and Norway seem to belong to other *Ahtiella* species.

As a matter of fact, *Ahtiella jentzschi* is known with certainty only in the East Prussian Spittelhof drift boulder, as reported by GAGEL 1890.

However, *Ahtiella* is an interesting genus from a stratigraphic point of view. It may occur in the *Expansus* period judging from a statement by LAMANSKY (1905, p. 177), but it is characteristic of the *Raniceps* Zone both in Estonia, Ingermanland, and Sweden. The Norwegian specimen reported by HOLTEDAHL (1916, p. 46) as *Strophomena ? jentzschi* but which seems to be conspecific with *A. baltica* ÖPIK may be of about similar age (transition from *3 c β* to *3 c γ* zones). In younger strata the genus seems to be less frequent. It has been reported from such layers in Ingermanland and Estonia (LAMANSKY 1905, p. 177: *Eichwaldi* Zone, and ÖPIK 1932, p. 39: lowermost part of the *C I* layers).

The age of *A. jentzschi* is not known. The boulder may be of *Raniceps* age judging from its great similarity to the Rogö Sandstone, but, as a matter of fact, this is by no means a reliable method of dating.

During the rise of the genus in the *Raniceps* period it seems to have been rapidly differentiated. Within the Siljan—Bothnian Gulf region one type (*A. dalecarlica* n. sp.) had developed which is fairly different from those occurring in the region of Estonia—Öland — (possibly the Oslo district).

The differences are referable not only to external characters but also to internal. The scars of the anterior adductor muscles are more square and distinct than those of the Öland species investigated; the lateral myophragmata are more distinct and directed about perpendicularly to the longitudinal axis of the valve (in the Öland species they form an acute angle with the longitudinal axis); finally, the main pallial truncs are curved and end anteriorly at the deepest part of the longitudinal myophragm (in the Öland species they run parallel to the longitudinal myophragm). The differences may be due to endemicity because of restricted communication. The fact that the communication between the Siljan district and the ocean was restricted during the *Expansus* and *Raniceps* periods is indicated by the development of the palaeohydrology and the ostracodal fauna (cf. parts I and IV of the present series).

However, a certain degree of endemicity may also be traced as regards the *Ahtiella* species within the Estonia—Öland region perhaps indicating that the communication was not very lively between the Estonia and Öland sections. The species which forms the majority of the *Ahtiella* species of Öland (*A. ölandica* n. sp.) is similar but not identical with the Estonian *A. baltica* Öpik. The same is the case as regards the Öland species *A. jaanussoni* n. sp. and the Estonian species *A.* sp. α aff. *baltica* Öpik (1932).

Until the *Ahtiella* species of the Oslo District have been further investigated it is of interest to note that the above-mentioned *Ahtiella* species reported by Holtedahl is very similar (probably conspecific) to *A. baltica*.

Description of species.

The casts of the internal anatomical details were made from internal moulds which had been prepared by removing the valves. Previously the fossils had been alternatively heated in a flame and cooled in water.

Number of ridges is invariably referable to 5 mm.

Abbreviations:

R. M. = Swedish State Museum
P. I. U. = Institute of Palaeontology, Uppsala
Length I = length perpendicularly projected
Length II = length measured along the surface.

Ahtiella jentzschi (GAGEL).

Pl. 1, Figs. 1, 2.

GAGEL 1890, p. 44.

The following description is based on the specimens included in the rock sample from the Spittelhof drift boulder as mentioned on p. 514.

Figures in brackets are referable to GAGEL, 1890 Fig. 26 (dorsal valve).

Material. One dorsal valve and 14 more or less completely preserved moulds of ventral valves with fragments of the valves themselves (1 practically complete; interior side).

Dimensions. Dorsal valve:

Breadth 13 mm (15) } Ratio 2.4 (2.1)
Length 5.5 mm (7) }

Length measured along the surface 7 mm (breadth: length = 1.9)

Ventral valve:

	Breadth (B)	Length (L)		Ratio $\frac{B}{L}$		Ridges
		I	II	I	II	
Specimen I	12.5	6.0	7.5	2.1	1.7	26—27
» II	10.0	4.5	5.5	2.2	1.8	27—28
» III	10.0	4.5	6.0	2.2	1.7	28—29
» IV	10.0	4.5	5.5	2.2	1.8	28—29
» V	10.0	4.5	5.0	2.2	2.0	25—26
» VI	10.0	4.5	5.5	2.2	1.8	27—28
» VII	10.0	4.5	5.0	2.2	2.0	25—26
» VIII	9.5	4.0	4.5	2.4	2.1	25
» IX	9.0	4.0	4.5	2.2	2.0	28—29
	9.0—12.5	4.0—6.0	4.5—7.5	2.1—2.4	1.7—2.0	25—29

Diagnosis. *Ahtiella* of fairly small size; face flat, anterior margin of face slightly rounded; marginal surface moderately high; transition from face to marginal surface forms a gentle curve; sinus very shallow; corrugations form an acute angle with the hinge margin, those of dorsal valve fairly little distinct, those of ventral valve as a rule more pronounced; radiating ridges rounded (about 25—29 per mm, 2—3 finer ridges between 2 more pronounced).

Affinities. The species is similar to *A. baltica* ÖPIK as regards corrugations, and number and arrangement of radiating ridges, but *A. baltica* is different, the face being practically semicircular.

Furthermore, it is similar to *A. ölandica* n. sp. which, however, has a practically semicircular face and a deeper sinus.

A. plana n. sp. has more distinct corrugations and the transition from face to marginal surface is angled.

Description.

Dorsal valve. The face is flat, and the transition to marginal zone which is moderately broad forms a gentle curve.

The angle between the hinge margin and the free margin is about 80°; in GAGEL's specimen it is about 85°.

The sinus forms a shallow depression, deepest just behind the hinge margin. The corrugations are low and not very distinct, 4—5 in number on each side; they form an acute angle with the hinge margin (about 30°).

The radiating ridges are low and rounded in transverse section; their number is 25—26 per 5 mm. Some of the ridges are more pronounced; between two such ridges are 2—3 (occasionally 4) fine ridges (GAGEL found 2—3).

Pseudo-punctae are partly fairly distinct; they occur in a number of about 25 per 1 mm².

The minute conmarginal striation is indistinct so that the frequence of the striae was not reliably measurable.

Interior anatomy was not observed.

Ventral valve. GAGEL mentioned that ventral valves were unknown to him which seems queer since the present rock sample of the Spittelhof boulder is, in fact, crowded with fragments and moulds of ventral valves. As anticipated, GAGEL's specimen in Fig. 26 *b* may possibly be such a valve or mould of a ventral valve.

The curve between the face and the marginal surface is somewhat more convex than that of the dorsal valve.

The angle between the hinge margin and the free margin is about 75° (in GAGEL's specimen about 80°).

The depression corresponding to the sinus is more pronounced than the sinus of the dorsal valve. The corrugations are similar to those of the dorsal valve but generally more distinct.

The radiating ridges are 25—29 per 5 mm; the number of fine ridges between more pronounced ones is generally 2—3.

The density of the minute conmarginal striae is 20—25 per 1 mm.

Tubercles corresponding to pseudo-punctae are distinct in the interior side of the valves. They are very small, slightly elongate, directed forwards, and arranged in rows; their number is 20—25 per 1 mm².

Occurrence. East Prussia, Spittelhof: drift boulder of unknown origin and age.

A. dalecarlica n. sp.

Pl. I, Figs. 3—5.

WIMAN 1907, p. 103.

Derivation of name. *dalecarlica* alludes to the Swedish province of Dalarna (or Dalecarlia) from where the holotype is derived.

Holotype. The type shown in Pl. I, Fig. 3 is the holotype (P. I. U. No. bp. 422).

Locality of holotype. Leskusänget limestone quarry, parish of Orsa, Dalarna, Sweden.

Stratum of holotype. Stratum corresponding to the *Raniceps* Zone of Estonia (about 3 m above the upper limit of *Limbata* Limestone).

Material. 4 dorsal valves from the Siljan District, and 1 dorsal valve from the submarine Bothnian Gulf District.

Dimensions. The specimens from the Siljan District are all 10.0 mm broad and 5.0 mm long; length measured along the surface is 6,0—8.0 mm. The ratio breadth: length is 2.0 and 1.3—1.7 resp. The specimen from the Bothnian Gulf is 6.5 mm broad and 3.5 mm long; along the surface it is 6.0 mm. The ratio is 1.9 and 1.1 resp.

Diagnosis. *Ahtiella* of fairly small size; face flat, its anterior margin practically parallel to hinge margin; sinus shallow and somewhat indistinct; corrugations distinct, in the main course forming a rather large angle with the hinge margin: radiating ridges exceeding 30 in number.

Affinities. The species is somewhat reminiscent of *A. jentzschi* in general shape, but it is distinctly different as regards the corrugations which form a greater angle with the hinge margin and as regards the radiating ridges which are more numerous than in *A. jentzschi.*

Description. The species is fairly small-sized. The face is flat, and the anterior margin of the face is practically parallel to the hinge margin. The marginal surface is moderately high and gently arched.

The transition between face and marginal surface is distinct, but forms a gentle curve.

The sinus is shallow and somewhat broadening forwards.

The corrugations are about 5 in number. Their main course forms a rather large angle with the hinge margin; the very ends are tapering and deviating sidewards.

The radiating ridges are rounded in transverse section. They are about 30—34 in number. Some are more pronounced; there are generally 4—6 finer ridges between two such more pronounced.

The conmarginal striae are about 25 per 1 mm. They are distinct and traverse the ridges.

The pseudo-punctae are about 25—30 per 1 mm^2.

The interior anatomy of the dorsal valve was studied in one specimen.

The cardinal process is fairly low and broad.

The brachial processes are rather low and of about moderate length (the ratio of the distance between the ends of the processes and the breadth of the valve is 2.1).

The scars of the adductor muscles are very distinct. They are short and about square. The lateral myophragmata parting anterior and posterior adductor muscles are very distinct and about perpendicular to the longitudinal axis of the valve.

The longitudinal myophragm is fairly high, especially in the anterior part.

The longitudinal main pallial truncs are short and curved so that they end at the highest part of the longitudinal myophragm.

Occurrence. Lower Ordovician. In the *Raniceps* Zone of the Siljan District (Leskusänget limestone quarry) and the submarine Cambro-Ordovician area of the Bothnian Gulf (drift boulder found just outside Uppsala).

Ahtiella ölandica n. sp.

Pl. II, Figs. 1, 3, 4—7.

Derivation of name. *ölandica* alludes to the Island of Öland from where the holotype and the remaining species present are derived.

Holotype. The specimen figured in Pl. II, Fig. 1 is holotype (R. M. No. Br. 16314).

Locality of holotype. Boulder found at Stenåsa, Öland, Sweden.

Stratum of holotype. Stratum corresponding to the *Raniceps* Zone of Estonia.

Material. 30 dorsal valves and 49 ventral valves and moulds with fragments of ventral valves.

Dimensions. The breadth is 11—14 mm in 2/3 of the specimens (max. 19 mm, min. 9 mm). The length is 6.5—9.5 mm in 4/5 of the cases (max. 11 mm, min. 5 mm); the length measured along the surface is 8—12 mm in 4/5 of the valves (max. 15 mm, min. 8 mm).

The ratio breadth : length is 1.7—2.1 in 4/5 of the cases (max. 2.2, min. 1.5); likewise in 4/5, the ratio breadth : length measured along the surface is 1.1—1.6 (max. 1.7, min. 1.1).

Diagnosis. *Ahtiella* of moderate size; face practically semicircular, slightly elevated in the median section; marginal surface fairly short for the most part; sinus increasing forwards in breadth and depth, continuing in the upper part of the marginal surface; radiating ridges often exceeding 30 per 5 mm; corrugations of face directed very obliquely to hinge margin.

Affinities. The species is very reminiscent of *A. baltica* ÖPIK. It is different mainly in the sinus being deeper and broader and continuing somewhat along the marginal surface. Furthermore, the number of the radiating ridges often exceeds 30; in *A. baltica* they are 24—30. However, it happens that the ridges are inferior to 30 also in the present species.

The species is also reminiscent of *A. jentzschi*, but in this species the anterior margin of the face is straighter, the sinus is shallower, and the number of the radiating ridges is only 24—26.

Description. The face is approximately semicircular; the median part is slightly elevated.

The marginal surface is fairly short and slightly arched.

The transition from face to marginal surface forms a gentle curve. The ventral valve is sometimes distinctly geniculated (cf. Pl. II, Fig. 7 *b*).

The sinus begins at the hinge margin as a small and shallow depression, but grows broader and deeper forwards; it continues somewhat along the marginal surface.

The corrugations of the face are generally 5—6 in number. They are distinct and directed very obliquely to the hinge margin. The hinge ends are elongatedly tapering.

The radiating ridges are generally 30—35 per 5 mm, but sometimes they are somewhat fewer. Some of them are more pronounced than the others. There is no strict regularity as regards the number of the ridges between two such ridges; in most cases they are about 4.

The conmarginal striae are about 25 per 1 mm.

Pseudo-punctae were observed in a number of 15—20 per 1 mm^2 on the outer side of the surface (visible in somewhat worn specimens), but in interior layers they are 30—35. In even more interior layers they are corresponded by tubercles (observed in ventral valves). They are arranged in rows, and they are somewhat elongated and pointing forwards. The very interior surface is smooth.

The interior anatomy of the dorsal valve was studied in two specimens.

The cardinal process is narrow, high, and long.

The brachial processes are moderately high and broad (the ratio of the distance between the ends of the processes and the breadth of the valve is 2.2).

The scars of the adductor muscles are rather distinct. The posterior ones are short and about square, the anterior are long and gently tapering forwards. The lateral myophragmata parting anterior and posterior adductor muscles are somewhat indistinct.

The longitudinal myophragm is long and moderately high, it is highest in the anterior part.

The longitudinal main pallial truncs are long and rather straight; they parallel the longitudinal myophragm.

Occurrence. Lower Ordovician. In drift boulders from Stenåsa, Öland, and Källunge myr, Gotland (cf. ANDERSSON 1896); both boulders of *Raniceps* age and certainly derived from the bottom of the Baltic Sea. Hälludden, Öland, *Raniceps* Zone.

Ahtiella jaanussoni n. sp.

Pl. I, Figs. 9, 10. Pl. II. Fig. 2.

Derivation of name. The species is named in honour of the Estonian geologist V. JAANUSSON who is now working in Sweden.

Holotype. The type shown in Pl. I, Fig. 9 is the holotype (P. I. U. No. bp. 6063).

Locality of holotype. Hälludden, Island of Öland.

Stratum of holotype. Stratum corresponding to the *Raniceps* Zone of Estonia.

Material. 6 dorsal valves and one mould of ventral valve.

Dimensions.

	Breadth (B)	Length (L)		Ratio $\frac{B}{L}$		Ridges
		I	II	I	II	
P. I. U. bp. 6064	28.0	16.0	25.0	1.8	1.1	27
P. I. U. bp. 6065	27.0	15.0	23.0	1.8	1.2	23—25
R. M. Br. 16366	26.0	12.5	28.0	2.1	1.0	24—25
Holotype P. I. U. bp. 6063	25.0	12.0	27.0	2.1	0.9	24—26
P. I. U. bp. 6060	24.0	12.0	23.0	2.0	1.0	25
P. I. U. bp. 6064[1]	20.0	12.0	—	1.7	—	26—28
R. M. Br. 16324	15.0	8.0	13.5	1.9	1.1	24—25
	15—28	8—16	13.5—28	1.7—2.8	0.9—1.2	23—28

[1] Ventral valve.

Diagnosis. *Ahtiella* of moderate size; face gently elevated; marginal surface high and gently pinched in the middle part; sinus shallow and gently broadening forwards; corrugations numerous (6—7), directed very obliquely to hinge margin; radiating ridges (23—28 per 5 mm) of variable distinctness, marginal surface ridges squamose, especially in the median part of the surface.

Affinities. The species is closest reminiscent of *A.* sp *α* aff. *baltica* ÖPIK (1932) especially as regards the general shape of the dorsal valve. However, the radiating ridges are somewhat fewer in the present species, but the corrugations are said to be fewer in ÖPIK's species (only two on each side). This species is furthermore considerably smaller. Whether the ridges of the marginal surface are squamose as is characteristic of the present species is not mentioned. But this is not likely since, if present, this feature should have been noticed, inasmuch as the specimen was not so worn that the squamose appearance of the ridges had been effaced.

Description. The species is of moderate size. The face is moderately long and its posterior margin forms a regular curve; the face is gently elevated in the central part.

The marginal surface is high and inconsiderably arched; in the median part it is slightly pinched.

The transition from face to marginal surface constitutes a regular curve. Planes through face and marginal surface form an acute angle.

The sinus is very shallow, increasing slightly in breadth forwards.

The corrugations are numerous, 6—7 on each side, and directed, in all their length, very obliquely to the hinge margin; hinge ends elongatedly tapering.

The radiating ridges are situated close together (23—28 per 5 mm; for the most part about 25); they are of varying breadth, some few are especially pronounced. Between two such ridges are generally 2—4 finer ridges. The ridges are squamose in the marginal surface.

The conmarginal striae occur mainly in the interspaces between the ridges; the small ridges are traversed but not the larger.

Pseudo-punctae are about 15—20 per 1 mm²; tubercles occur in the interior side of the valves.

The interior anatomy of the dorsal valve was studied in one specimen.

The cardinal process is fairly long and swollen in the posterior end (possibly fused with the chilidium).

The brachial processes are high and moderately long (the ratio of the distance between the ends of the processes and the breadth of the valve is 1.9).

The scars of the adductor muscles are shallow, especially the anterior ones. These are small and rounded, forming a longitudinally somewhat ovate spot. The lateral myophragmata are low; they form a very acute angle with the longitudinal axis of the valve. The longitudinal myophragm is fairly low and broad.

The longitudinal main pallial truncs are rather shallow and parallel to the longitudinal myophragm.

Occurrence. Lower Ordovician, in stratum corresponding to the Estonian *Raniceps* Zone. Hälludden and Hagudden, Island of Öland. (Hagudden: stratum *d* acc. to B. BOHLIN in The Asaphus Limestone of northernmost Öland. Bull. of the Geol. Inst. of Uppsala 1949).

Ahtiella plana n. sp.

Pl. I, Figs. 6, 7.

Derivation of name. *plana* alludes to the plane face.

Holotype. The specimen figured in Pl. I, Fig. 6 is holotype (R. M. Br. 16373).

Locality of holotype. Hälludden, Island of Öland.

Stratum of holotype. Stratum corresponding to the *Raniceps* Zone of Estonia.

Material. 3 dorsal valves and 2 ventral.

Dimensions.

	Breadth (B)	Length (L)		Ratio $\frac{B}{L}$		Ridges	
		I	II	I	II		
Holotype R. M. Br. 16373	10.0	5.0	7.5	2.0	1.3	30	Dorsal
» » » 16374	10.0	5.0	7.0	2.0	1.4	27—28	Ventral
» » » 16379	9.5	4.0	6.0	2.4	1.6	28—30	Ventral
» » » 16370	9.5	4.0	—	2.4	—	30	Dorsal
» » » 16369	9.0	4.5	6.5	2.0	1.4	30	Dorsal
	9.0–10.0	4.0–5.0	6.0–7.5	2.0–2.4	1.3–1.6	27–30	

Diagnosis. *Ahtiella* of fairly small size; face flat; transition from face to marginal surface angled; cardinal extremities acutely projecting; corrugations form a very acute angle with the hinge margin, they are very distinct and sometimes partly anastomosing; sinus shallow; radiating ridges about 27—30 per 5 mm.

Affinities. The species is somewhat reminiscent of *A. jentzschi* but is different, the corrugations being more distinct and the transition between face and marginal surface being angled.

A. arenaria ÖPIK which is of about the same shape and also has an extremely shallow sinus is different, the corrugations being fairly indistinct.

Description. The species is rather small-sized.

The face is flat, and its anterior margin is only slightly curved; the lateral ends are much acute.

The marginal surface is moderately high and inconsiderably arched.

The transition from face to marginal surface is angled; the angle is formed by a corrugation.

The sinus is extremely shallow.

The corrugations are sharp-ridged, very distinct, and partly anastomosing. They form a very acute angle with the hinge margin. Their number is 5 for the most part.

The radiating ridges are rounded in the transverse section and fairly low (27—30 per 5 mm). A few are somewhat more distinct; between two such ridges are 4—5 finer ones.

The conmarginal striation is fairly indistinct; about 15 striae were observed in 1 mm.

The pseudo-punctae are about 25—30 in number per 1 mm^2

The interior anatomy of the dorsal valve was studied in one specimen.

The cardinal process is low and short.

The brachial processes are moderately high and long (the ratio of the distance between the ends of the brachial processes and the breadth of the valve is 2.0).

The scars of the adductor muscles are fairly small; the posterior ones are distinct but the anterior are indistinct. The scars are indistinctly parted by the lateral myophragmata which are broad and low. They are directed about perpendicularly to the longitudinal axis of the valve.

The longitudinal myophragm is fairly low in the median part, but the ends are higher; the anterior end is, additionally, broadened like a V.

The longitudinal pallial truncs are broad and indistinct. They are curved, and the anterior ends reach the longitudinal myophragm just behind the V-shaped broadening.

Occurrence. Lower Ordovician, stratum corresponding to the *Raniceps* Zone of Estonia. Hälludden, Island of Öland.

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Explanation of plates.

Specimens whitened with ammonium chloride. Photographs taken by Mr N. HJORTH.

R. M. = Swedish State Museum.

P. I. U. = Institute of Palaeontology, Uppsala.

Plate I.

5 ×, except Fig. 8 (2.5 ×)

Fig. 1. *Ahtiella jentzschi* GAGEL. Dorsal valve, somewhat worn. From a rock sample of the Spittelhof drift boulder including the type described by GAGEL (lectotype according to ÖPIK 1932). R. M. Br. 21761.

Fig. 2. *Ahtiella jentzschi* GAGEL. Mould of ventral valve with fragments of the valve and the cardinal area. From the same rock sample as the specimen shown in Fig. 1.

Fig. 3. *Ahtiella dalecarlica* n. sp. Holotype. Dorsal valve. *a* Dorsal view. *b* Anterior view (part of mould of ventral valve visible). *c* Side view. P. I. U. bp. 422. Leskusänget, parish of Orsa, the Siljan District, Dalarna.

Fig. 4. *Ahtiella dalecarlica* n. sp. Dorsal valve, anterior view, showing pseudo-punctae (specimen somewhat worn). P. I. U. bp. 6062. Leskusänget, parish of Orsa, the Siljan District, Dalarna.

Fig. 5. *Ahtiella dalecarlica* n. sp. Dorsal valve. *a* Dorsal view. *b* Side view. P. I. U. bp. 3147. Ekeby at Uppsala, drift boulder from the submarine Cambro-Ordovician area in the Bothnian Gulf.

Fig. 6. *Ahtiella plana* n. sp. Holotype. Dorsal valve. *a* Dorsal view. *b* Side view. R. M. Br. 16373. Hälludden, Island of Öland.

Fig. 7. *Ahtiella plana* n. sp. Mould of ventral valve with fragments of the valve. R. M. Br. 16379. Hälludden, Island of Öland.

Fig. 8. *Ahtiella* aff. *baltica* ÖPIK. The same specimen figured by HOLTEDAHL 1916, Pl. VI, Fig. 1 under the name of *Strophomena ? jentzschi* GAGEL. Paleontologisk Museum, Oslo, No. I 674. Vækkerö near Oslo, transition from *3 c β*—*3 c γ*.

Fig. 9. *Ahtiella jaanussoni* n. sp. Holotype. Dorsal valve. *a* Dorsal view. *b* Anterior view. *c* Side view. P. I. U. bp. 6063. Hälludden, Island of Öland.

Fig. 10. *Ahtiella jaanussoni* n. sp. Dorsal valve, somewhat worn, showing pseudo-punctae. R. M. Br. 16337. Hälludden, Island of Öland.

Plate II.

5 ×, except Fig. 2 (2.5 ×).

Fig. 1. *Ahtiella ölandica* n. sp. Holotype. Dorsal valve, partly slightly worn. *a* Dorsal view. *b* Side view. R. M. Br. 16314. Stenåsa, Island of Öland (drift boulder).

Fig. 2. Interior anatomy of dorsal valve of *Ahtiella jaanussoni* n. sp.; cast of internal mould, showing cardinal process, brachial processes, scars of adductor muscles, longitudinal and lateral myophragmata, and longitudinal pallial truncs. P. I. U. bp. 6065. Hälludden, Island of Öland.

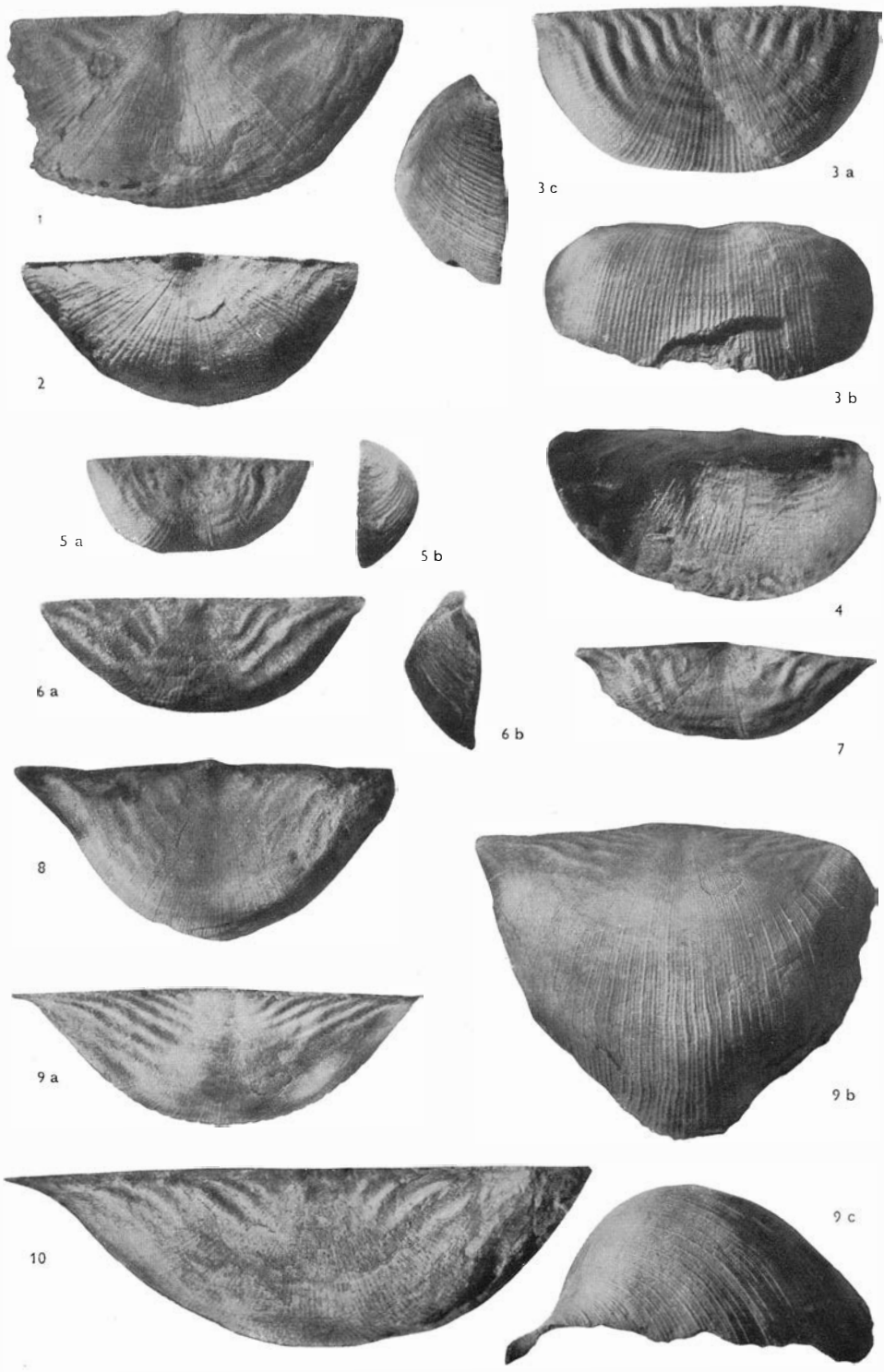
Fig. 3. *Ahtiella ölandica* n. sp. Dorsal valve, somewhat worn. R. M. Br. 16320. Stenåsa, Island of Öland.

Fig. 4. *Ahtiella ölandica* n. sp. Dorsal valve, slightly worn. R. M. Br. 14596. Källunge myr, Island of Gotland (drift boulder).

Fig. 5. *Ahtiella* cf. *ölandica* n. sp. Part of ventral valve, showing pseudo-punctae (valve seen from the interior side). R. M. Br. 14596. Källunge myr, Island of Gotland (drift boulder).

Fig. 6. *Ahtiella ölandica* n. sp. Ventral valve (interior part) showing tubercles corresponding to pseudo-punctae. Mould of outer side of the valve partly visible. R. M. Br. 16392. Stenåsa, Island of Öland (drift boulder).

Fig. 7. *Ahtiella ölandica* n. sp. *a* Ventral valve, showing innermost smooth layer and interior tuberculate strata. *b* Side view. R. M. Br. 16309. Stenåsa, Island of Öland (drift boulder).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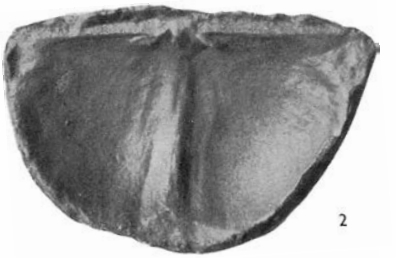
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