THE KUCKERS STAGE OF THE ORDOVICIAN ROCKS OF NE ESTONIA

BY

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WITH 12 PLATES, 1 MAP AND 12 FIGURES IN TEXT

Research work carried out in the
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Pt. I.

The Kuckers stage of the Ordovician Rocks of NE Estonia.

1. Introduction.

The Kuckers stage (C_2) near the village of Järve in Estonia now affords favourable opportunities for fossil-collecting, such as have never before existed, in the large Järve (or Kohtla-Järve) quarry (500 m. long and 250 m. wide) worked for fuel purposes, in the quarries of Vanamõisa near Kunda, and the village of Kukruse, and in the diggings near the Jõhvi estate.

The fauna of this stage is so abundant and frequently so well preserved that it is well worth detailed study.

Only a few classes have been entirely described: the Bryozoa by Bassler, the Ostracods by Bonnema, the Trilobites by F. Schmidt, and the Gastropods by Koken.

I have been enabled to make a detailed study of the bryozoa and brachiopoda, the former specially from the „kuckersite" beds, at first in the Geological Institution of the University of Tartu between October and December 1919 and later in the Geological Department of the Imperial College of Science and Technology in London, where I worked from January to July 1920. In September I collected further new material from the quarries of Vanamõisa, Järve, Jõhvi and near Tallinn (Reval), which I worked out partly in the Geological Institution of the University of Tartu and partly afterwards in the Imperial College.

I owe my best thanks to Prof. W. W. Watts, and Dr. A. Morley-Davies of the Imperial College, to Prof. J. G. Granö, Tartu, to the University Council of Tartu (Dorpat), who enabled me as a stipendiate of it to carry out the research work in the Imperial College, to the officers of the Geological Department of the British

Museum, to the Librarians of the Geological Society, the British Museum (Geol. Depart.) and the Science Library, to the Estonian Legation in London, to eng. F. Rosenberg, Director of the quarry of Järve, to the officers of the „oil shale" Department in Tallinn (Reval), and to the Librarians of the Natural History Society in Tartu and the Provincial Museum in Tallinn.

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The bituminous Kuckers beds were described for the first time by J. Georgi[1] in 1791. Engelhardt discovered the shale in 1789 near Kohala (Tolks) and sent specimens of it for investigation to the „Free economical Society“ in Petersbourg. Georgi[2] describes the Kuckers shale as „a brownish, laminated argillaceous or marly bituminous earth (Bergpecherde), which forms a considerable bed 3 feet thick, in the Rakvere (Wesenberg) District, near the Kohala estate (Tolks). The earth burns without an unpleasant smell. Ten ounces of this earth contains 4 ounces of tar and 25 grains of [ash] salt. Sheepherds burn this earth in piles. The darker sorts are used in place of umber.“

Later the shale seems to have been forgotten.

In the time of Helmersen the shales were rediscovered by accident. A stove, made near Kohala (Tolks) from shale slabs and bituminous limestone, began to burn.

Helmersen[3,4], who investigated the Vanamõisa and Kohala Region, divides the shale thus: 1) shale, more or less laminated, without limestone and 2) unlaminated, compact shale, containing a quantity of calcium carbonate and lying below the first sort. The thickness of the shale beds, pure or intercalated with limestone, was found to be 1.5—4 feet.

Data of one of the diggings near Vanamõisa (Helmersen):

1. Thin covering of earth.
2. Sand . . . . 3 feet.
3. Good quality shale . . . 2.5 „
4. Limestone . . . . 4.5 „
5. Shale . . . . 1.25 „

In 1861 F. Schmidt[8] furnishes detailed notes regarding the „Brandschiefer“.

Later F. Schmidt[11] establishes the *Kuckers* stage which he considers to be closely related by its fauna to the underlying *Echinosphaerite* limestone, but showing faunal as well as lithological peculiarities. *Chasmops odini*, nearly related to *Ch. conicophtalma* from Sweden, is very abundant in all localities in this stage. *C. odini* begins to appear in the „Echinosphaerite limestone“ (C_1). Bituminous marl, says F. Schmidt, is really a bituminous shale, in middle part of the Kuckers stage area, that is a little to north of the railroad between Jõhvi (Jeve) and Rakvere (Wesenberg). Here are the chief localities: Kukruse (Kuckers), Kohtla, Salla, Erra, Vanamõisa (Wanamois), Kohala (Tolks), where the red „Brandschiefer“ reaches a thickness of 1 f. West and east of these localities only thin partings of „Brandschiefer“ are found in marly limestones. The most eastern locality is the village Djatlitzy to south of Gostilitz (Petrograd Distr.) where in a quarry slightly bituminous grey limestone contains: *Chasmops odini*, *Siphonotreta unguiculata*, *Hybocrinus dipentus* etc. To the west of the last named locality the same rock is found near the village Uljatitzy to south of Koporje, but with definite intercalations of the „Brandschiefer" and with: *Orthis dorsata* His., *Clitambonites marginata* Pahlen, *Rafinesquina imbrex angusta*, all typical forms in C_2.

In american literature of the twentieth century notes on the Kuckers stage and a general description of other Ordovician stages in Estonia are found in Bassler's[18] work.

P. E. Raymond[21] gives some notes on the Kuckers formation (stage). According to P. E. Raymond (p. 198) „the base of this formation can be seen in the extensive quarries at Reval where the upper three or four feet are a bluish grey calcareous shale and thin-bedded shaly limestone containing numerous cystids, incl. *Echinosphaerites aurantium*, *Caryocystites balticus*, *C. aranea*". Among other fossils, common in this stage, P. E. Raymond names on the same page *Oxoplecia dorsata.* In my fairly large material of brachiopods I could find nothing, resembling an *Oxoplecia.*

To obtain fuller data on the thickness of the shale beds the Fuel Department Comission in Petrograd began special investigations in 1916, regarding the possibility of technical utilisation of the shale as a fuel.

The results of these investigations have been published by Pogrebov[26]. He (p. 24) estimates the thickness of pure shale to the north of the railroad between Jõhvi (Jeve) and Kohtla not less than 1 fath. (2.13 m.); he estimates the weight of a cubic fathom of undried shale at 1000 poud (16380 kg.) and the amount of shale on a square verst at the high figure of 250 millions of pouds (4095 mil. kg. or nearly 4 mil. tons). Locally, N of Jõhvi and Kohtla the shale is covered by thin moraine deposits and may be worked in open quarries. The thickness of the Kuckers stage is here approximately 7 fathoms [14.9 m.].

Pogrebov (p. 32) found in the sandy orthoceratite limestone near Järve thin partings of kuckersite with *Gloeocapsamorpha prisca,* and higher up, in the Jeve limestone, often a small amount of kuckersite.

F. Beyschlag and L. v. z. Mühlen[24] pointed out, that on account of the dip of strata varying from 2^0—5^0, the kuckersite can be worked in open quarries in a belt of considerable length but only 32.62—77.36 m. wide.

H. v. Winkler[31] (1920) estimates the amount of the superficial kuckersite seams in the district between Walgejõgi and Narova at the figure of 128.790.000 tons. He considers the kuckersite as a material of high economic value. It contains 65 % ash which lessens its value as fuel, in spite of its heating value of 2400 calories. It is valuable for the obtaining of gas and tar; lubricating oils free of paraffin are obtained by fractional distillation. These oils on account of their resistance to freezing are valuable for the motors of aeroplanes, whereas before only castor oil could be used. The gas-oil obtained from kuckersite is valuable for internal combustion engines. As by-products of the gas oil Winkler mentions methyl-alcohol, aceton, acetic acid, pyridin etc. The gas tar contains benzol and naphtalene. The kuckersite has been satisfactorily employed for fireing the revolving furnaces of cement factories.

3. Brief note on the strata underlying the Kuckers beds.

The strata underlying the Kuckers beds are exposed in North Estonia along cliffs (paekallas, Glint) on the shores of the Gulf of Finland.

a. Lower Cambrian.

At the base of the cliffs occurs the „Blue clay“ (sinisavi, blauer Ton). Interbedded with this clay are sandstone layers, especially its lowest and highest beds. The higher sandstone beds are correlated with the *Eophyton sandstone* of Sweden. Higher up comes an almost white unfossiliferous sandstone (correlated with the *Fucoid sandstone* of Sweden) and the lower part of the *Obolus sandstone* (Ungulitensand). Marcou[13a] named these beds in 1890 the *Esthonia formation.*

b. Ordovician.

The *upper beds* of *Obolus sandstone* (upper part of A_2 of Schmidt) begin with a bed of conglomerate. Raymond[21] (p. 186) describes this bed at Packerort as: „a bed of conglomerate, the matrix of which is an ironstained sandstone, which contains well-rounded boulders ranging from a few inches up to four feet in the greatest diameter . . . This conglomerate is very irregular, and only two or three feet thick . . . The conglomerate at the base of the formation was seen also along the river north of railroad bridge at Narva. The pebbles of that locality were all rather small, the largest seen being ten inches in diameter." This bed, undoubtedly a shore deposit, is the lowest bed of Ordovician age in Estonia. The conglomerate was described in 1842 by the Major A. v. Osersky[4a].

The Dictyonema (Dictyograptus) shale (A_3 — of Schmidt), next in succession, I regard as a shallow water deposit. This is a black or dark brown, bituminous shale, the lower part intercalated with sandstone layers, having an average thickness of 2.5—3 metres (pure shale without sandst. intercalations), but reaching 4.3—5 metres in the most western outcrop (Packerort) in Estonia. It dips (as do the overlying strata) SW. Its height above Sea level at Ontica is 35 m., at Packerort 8 m. Though it thins out to the east, at Narva, it is seen again in Russia still further east, while in Scandinavia on the west it reaches a greater thickness.

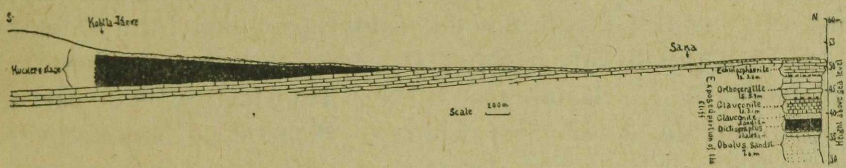
For the *upper beds* of the *Obolus sandstone* and the *Dictyonema shale* Raymond proposes the name *Packerort formation.*

The beds which follow 1) *Glauconite Sandstone* and 2) *Glauconite Limestone* (B_1 and B_2 — Glaukonitsand and Glaukonitkalk — of Schmidt, BI, BIIα, BIIβ, BIIγ and BIIIα of Lamansky, *Wolchow* formation of Raymond) have also been regarded as shallow water deposits. They stand out well in the exposures of the Sea cliff by reason of their green colour, often spotted with yellowish-red (Glauc. Limest.). The sandstone is almost entirely made up of glauconite grains, and while 3 m. thick at Packerort it thins to the East and disappears near Narva. The limestone which is poor in glauconite grains, on the other hand, thickens towards the East. Shallowing of the Sea at the end of the limestone period is proved by the presence of borings on its surface, often filled with sandy material, a few inches long and of the thickness of a finger. Lamansky[14] also records a conglomerate at the base of the succeeding limestone containing fragments of the glauconite limestone. (See t. f. 1).

Kunda stage (B_3 — *Vaginatenkalk* — of Schmidt, BIIIβ and BIIIγ of Lamansky, *Kunda* formation of Raymond) based on the —

Lower Linsenschicht — „soft clayey limestone 6—12 inches thick, full of small flattened grains of about the size, shape and colour of small Leperditias. These small „lenticles" have a concretionary form, . . . consist of clay containing iron oxides and calcium phosphate (Kupfer)" [Raymond, p. 193]. Raymond thinks „the lower „Linsenschicht" really represents a basal conglomerate of the Vaginatenkalk, for in places, as at Reval and Packerort, there is a real conglomerate, which replaces the „Lower Linsenschicht". To the East the limestone deposits of this stage are thicker.

The *Echinosphaerite* Limestone ($C_{1\alpha}$ — Upper „Linsenschicht" and lower part of the *Echinosphaerite* limestone of Schmidt, *Duboviki* formation of Raymond and $C_{1\beta}$ — upper part of *Echinosphaerite* limestone of Schmidt, *Reval* formation of Raymond) which follows begins with a similar deposit, the „Upper Linsenschicht". The *Duboviki* formation, according to Raymond, thins



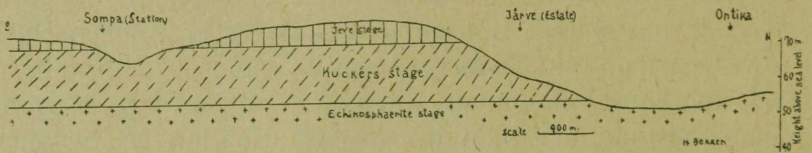
Text fig. I. Section: Kohtla-Järve — Saka.

out towards west: at Reval it is 1 f., at Baltishport 10 inches. To East in Russia on the River Wolchow near Duboviki it is probably 25—30 feet thick. Raymond says (p. 197) „a thin section shows that this rock is made up almost entirely of very small fragments of fossils". The „*Reval* formation" next in succession, lies from Wolchow — Reval upon the „Duboviki", westward from Reval upon the „Upper Linsenschicht". It is a compact, hard, often magnesian, greyish limestone 25—35 feet thick (largely quarried near Tallinn (Reval). Raymond describes the section of this limestone: „irregularly intergrown areas of very small crystals of calcite with irregular boundaries, and areas in which the crystals are of dolomite, about twice the size of those in the areas of calcite, and with definite crystal form. This rock is not made up of fragments of fossils, like that of the calcareous formations below."

The overlying Kuckers beds indicate a marked change in physical conditions; these beds are not exposed on the Sea cliff.

4. **Stratigraphy of the Kuckers stage** (C_2 of F. Schmidt).

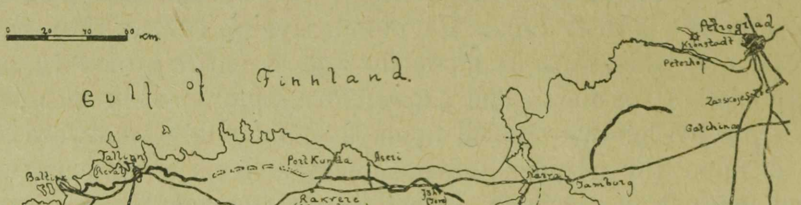
On the attached geological map of Northern Virumaa (Wierland), in the NE part of Estonia, which is identical with the map of J. Krutikov published in Pogrebov's paper[28], the outcrop of the Kuckers beds forms an irregular band, 4—10 klm. to south from the Sea shore, varying in width according to the extent to which the overlying Jeve limestone was removed by ice in the



Text fig. 2. Section: Sompa—Ontika.

Glacial Period. The comparatively thin moraine deposits do not completly conceal the terrace-like outcrops which form a feature of the topography from Jõhvi to Järve and in the vicinity of Vanamõisa to S of Kunda (see t. f. 2). This feature is in part the shoreline of the Joldia Sea, which in Pleistocene times covered the northern part of this region.

Near Vanamõisa, Vanaküla and Samma (64 m. above Sea level) the Kuckers stage may be approximately estimated at 11 m. Between Järve and Kukruse its thickness is 15—17 m., locally less.

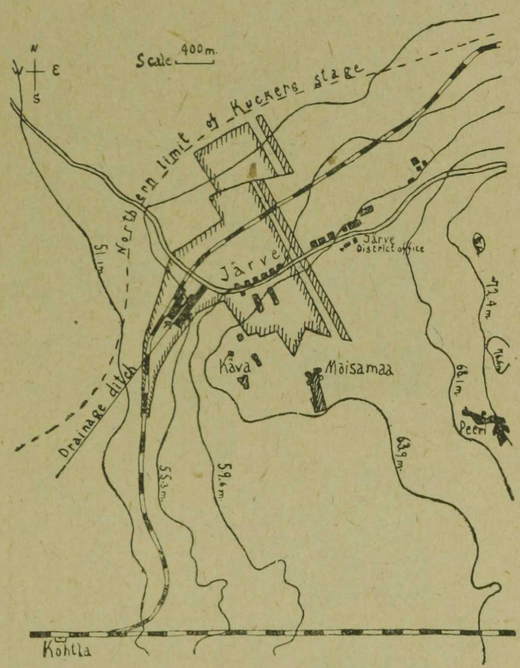


Text fig. 3. Northern limit of the Kuckers stage (The thick black line).

The beds of the Kuckers stage as partly also the *Echinosphaerite stage* have been denuded to east of Jõhvi and of Narva in the Narva District. A little to the west of Jambourg in Russia (Ingermanland) the beds of the Kuckers stage appear (t. fig. 3). The shale is worked in quarries near Veimarn in Russia. The morainic deposit is there thicker than in Estonia.

The pure bituminous intercalations of the Kuckers stage are not in the geological sense true „oilshales“ (Brandschiefer), which are made up of fissile argillaceous matter with a sufficient quantity of vegetable (or animal) matter to yield mineral oil on distillation. Pogrebov, Krutikov and Zalessky have proposed to call these deposits „Kuckersite“, a term which I am adopting in this paper.

Kuckersite is a saprocole [1]) (Zalessky) of Ordovician age. Its colour varies from different shades of light-brown to dark-brown, according to its oxidation. The colour is partly due to iron-oxides. After extraction of the mineral components by acids, there is left a light-yellow almost pure organic residue, which rapidly oxidises in the air and attains a dark-brown colour (Fokin). The specific gravity of the kuckersite varies from 1.2—1.8. Its hardness is not above 2. It burns with a luminous smoky flame and gives a specific odour of burning copra.



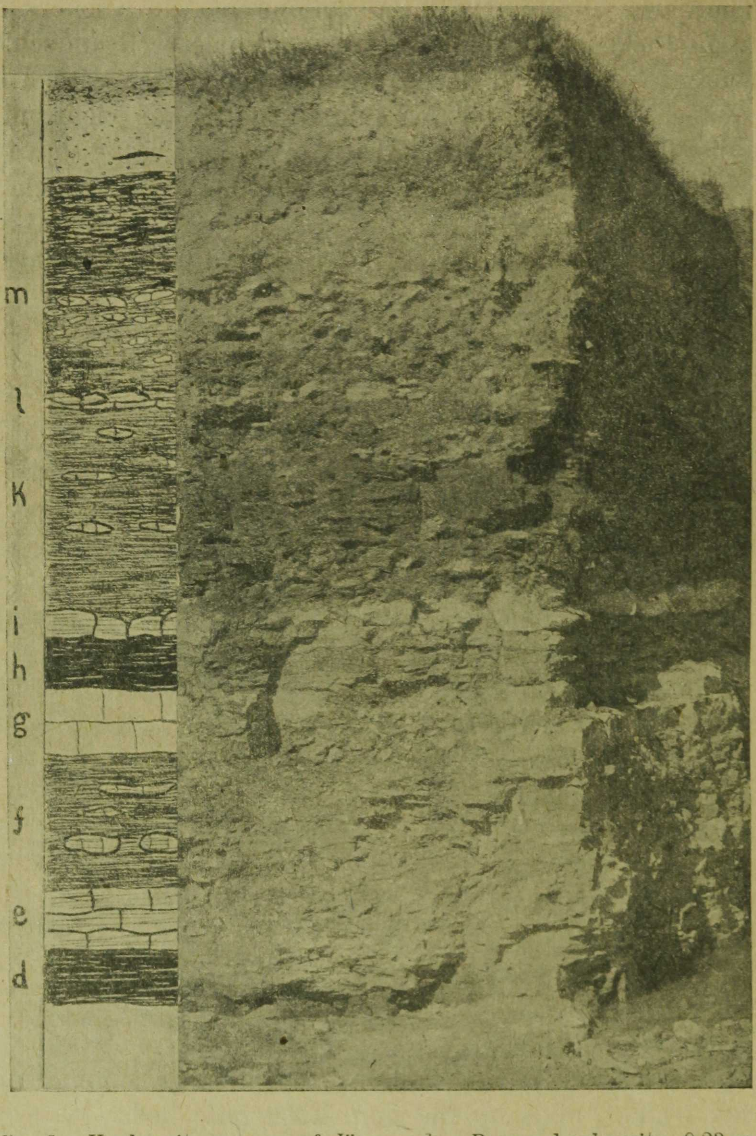
Text fig. 4. Sketch map of the kuckersite quarry of Järve. (After J. Ackerberg).

Marly - limestone beds of the Kuckers stage contain often a large amount of the material, which builds up the pure kuckersite beds.

The beds of the Kuckers stage are best developed and exposed in the large government quarry (see t. f. 4) of Kohtla-Järve (or Järve) and in the quarries beyond the Järve District office and the village Kukruse. (See t. f. 5).

a) Separated by a marly-limestone intercalation a com-

1) Saprocole according to Zalessky is a hardened sapropelite of any geological age, made up without a humic jelley.



Text fig. 5. Kuckersite quarry of Järve. *d* — Brown kuckersite, 0.23 m.; *e* — Grey-brown marly-limestone containing kuckersite, 0.22 m.; *f* — Light-brown kuckersite with marly-limestone concretions, 0.55 m.; *g* — Grey-blue compact limestone „Building Limestone", 0.26 m.; *h* — Light-brown kuckersite, 0.19 m.; *i* — Marly-limestone, containing kuckersite, 0.1 m.; *k* — Brown kuckersite with limestone concretions, 0.84 m.; *l* — Marly-limestone, often sandy, containing kuckersite, 0.06 m.; *m* — Dark-brown brittle kuckersite with limestone concretions in the lower portion and sand in the upper part, 0.85 m. The „Brittle kuckersite" is overlain by boulder-clay and sand, which in the Northern portion of the quarry is stratified, 0.4 m. Photogr. by Parikas.

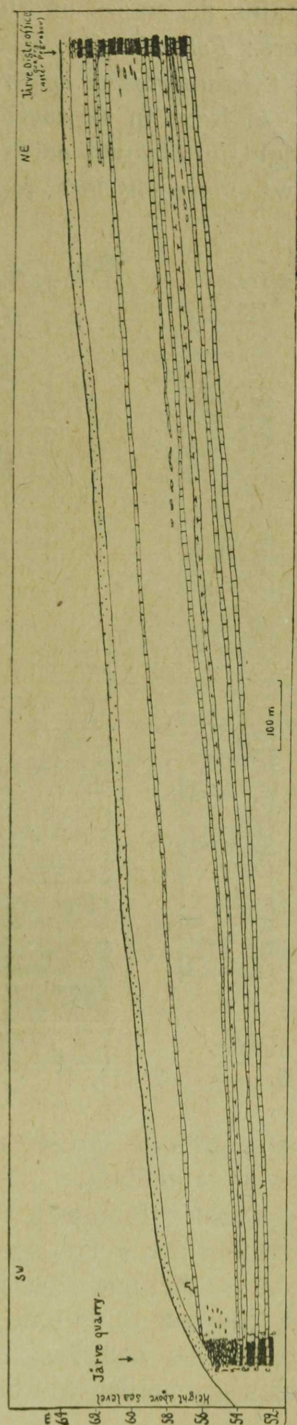
paratively thin kuckersite bed rests upon Echinosphaerite limestone at the north end of the drainage ditch in Järve quarry (52 m. above Sea level).

b) Then comes a pure kuckersite bed of 0.3 m. thickness with abundant worm tracks, *c*) a marly-limestone intercalation (0.15 m.) and *d*) a kuckersite bed of 0.4 m. thickness.

e) Upon this kuckersite bed rests a greyish-brown marly limestone, containing kuckersite (0.22 m. thick). On the top and below this calcareous bed are thin (1—2 cm.) layers of grey-blue clay.

f) Next comes a light-brown concretionary kuckersite bed (0.55 m. thick). The kuckersite of this bed splits irregularly. Of the fossils from this bed may be mentioned: *Protocrisina disposita* sp. n., *Nematopora ovalis*, Ulrich, *Nematotrypa gracilis* Bassler, *N. spiralis* sp. n., *Chasmatopora furcata* (Eichw.), *C. reticulata* (Hall), *C. punctata* sp. n. *Phylloporina granistriata* Ulrich, *Pseudohornea bifida* (Eichw.), *P. bassleri* sp. n., *Pachydictya elegans* Ulrich, *P. kuckersensis* Bekker, *P. irregularis* sp. n. *Eridotrypa aedilis* (Eichw.), — extremly abundant —, *Hemiphragma maculatum* Bassler, *Leptaena estonensis* sp. n.

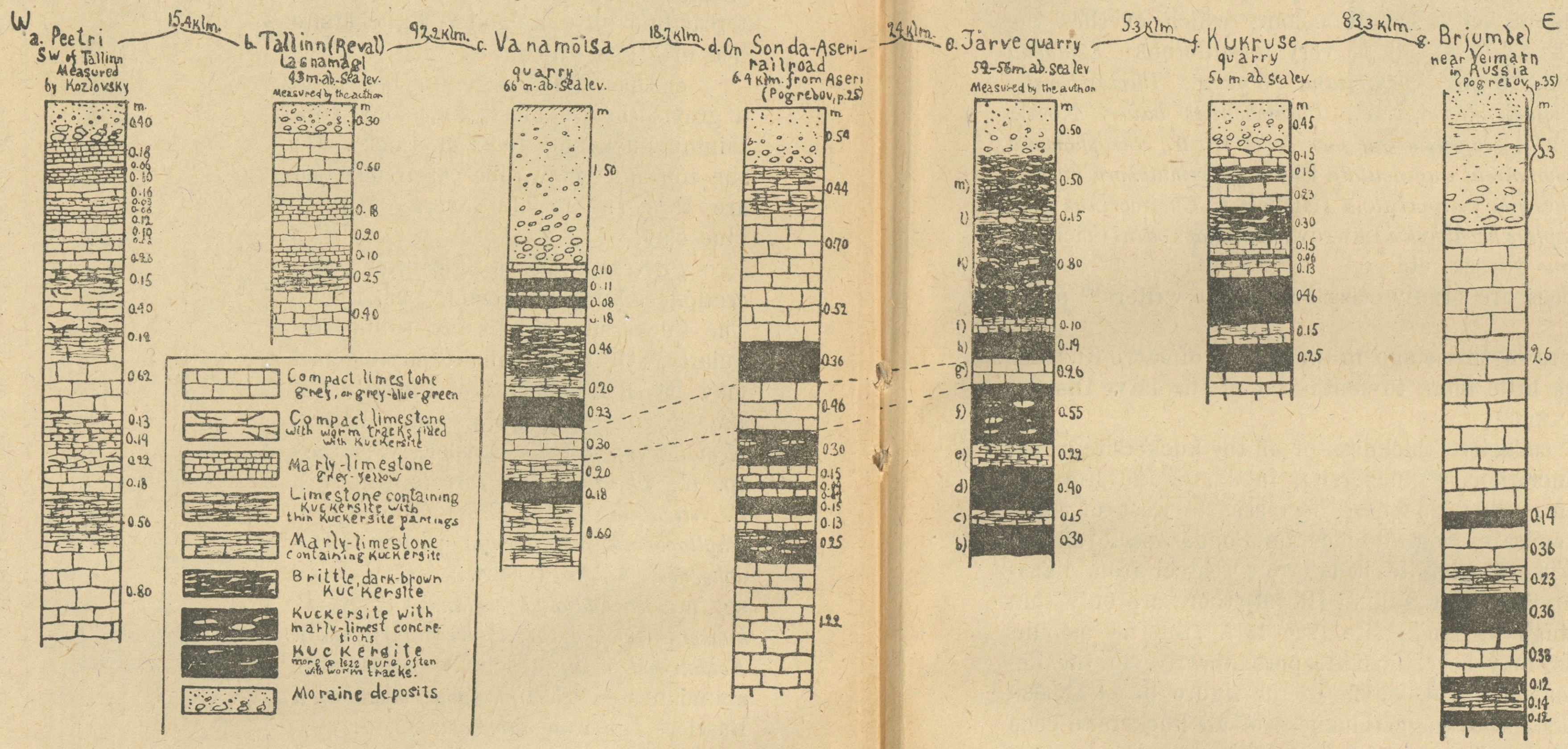
g) Upon this bed clearly marked in the section is a pure compact limestone of light grey-blue colour (0.26 m. thick) used for building and burning. This bed may be traced at a distance of 42 km. from Järve to Vanamõisa (see t. f. 7). Its name in the quarry is „Building limestone". It is a calcareous mud deposit with scanty fossils. It



Text fig. 6. Ideal section: Järve quarry — Järve District office.

contains no traces of kuckersite. In this bed are found among others: *Porambonites laticaudata* sp. n., *Ctenodonda* sp., *Cyclocrinus* sp., *Climacograptus* sp. (related to *C. antiquus* Lapw.).

h) Next in succession is a kuckersite bed 0.19—0.22 m. thick of light-nut brown colour; this bed contains no concretions. It shows more or less regular planes of lamination, indicated by



fossils. *Bryozoa*, *brachiopoda*, *trilobita* — usually in fragments — are very abundant.

i) Then follows a thin (0.1—0.2 m.) sandy marly-limestone, of grey-brown colour, containing kuckersite. In the large quarry of Järve the northern portion of the section (t. fig. 12) shows that this bed thins out.

k) This bed is succeeded by a kuckersite bed of 0.3 m. thickness, similar to the „brittle kuckersite“ layer to be imme-

diately described; it is slightly more compact and of a lighter-brown colour; this bed contains marly-limestone concretions (often sandy), not seldom of some continuity, generally small; the concretions contain kuckersite. In this bed are fairly well preserved fossils, such as: *Nematopora consueta* (Bassl.), *N. ovalis* Ulrich, *N. bogoljubovi* Bekker, *Pachydictya elegans* Ulr., *Eri-*

Text fig. 7.

Comparative thickness of the kuckersite beds in the Kuckers stage after data of diggings and exposures in quarries.

dotrypa aedilis minor (Ulr.), *Hallopora dybovsky* Bassl., *Lycophoria* sp. etc.

l) Then comes a thin, slightly disturbed, marly-limestone bed containing kuckersite with *Pseudohornea bifida* (Eichwald), *P. bassleri* sp. n., *Graptodictya bonnemai* Bassl., *jaervensis* var. n., *Chasmops odini* (Eichw.), *Cybele rex* Nieszk., *C. coronata* Schm., *Plectambonites sericea* (Sowerby), *Platystrophia biforata* Schloth. etc.

m) Next in succession, immediately below the ground moraine (in Järve quarry), rests the „brittle kuckersite" bed 0.5 m. thick. As result of oxidation this is of a dark-brown colour: it contains loose sand which is carried by the surface waters from the ground moraine. Of the fossils in this bed only scanty and brittle remains are left: *Rafinesquina dorsata* sp. n., *R. imbrex* (Pander), remains of bryozoa etc.

n) To the east of the Järve quarry exposed in a ditch, is a marly-limestone of yellow-white colour, which overlies the „brittle kuckersite" (T. f. 6). It is very fossiliferous: *Leptaena rhomboidalis* Wilck., *Orthis kuckersiana* Wysog., *Plectambonites schmidti* Törnqu. *leptelloides* var. n., *Porambonites baueri* Noetl., *P. aequirostris* (Schl.), *Rafinesquina jaervensis* sp. n., *Strophomena asmussi* Vern., *Siphonotreta unguiculata* Eichw., *Trematopora kuckersiana* Bassl., *Diplotrypa petropolitana* (Nichols.), *Cheirocrinus granulatus* Jaekel, *Asaphus kovalevskii* Lawrow, *Chasmops odini* (Eichw.), *Cheirurus spinulosus* Nieszk. etc.

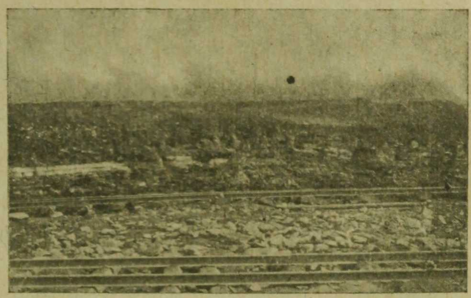
The upper beds are briefly described in the writers[29] paper of 1919.

The top layers of this stage in the Region of Järve-Kukruse should be found a little more to south-east of the Järve District office.

The average collective thickness of all the kuckersite layers including the concretionary kuckersite, in Järve and Kukruse quarry is 2.5—4 m. This thickness decreases to west of Järve (See t. f. 7), as appears from ditches on Sonda-Aseri railroad and Vanamõisa. The kuckersite beds grow scarcer from Vanamõisa to west, so that near Tallinn (Reval) there are only thin (1—1.5 cm.) partings of kuckersite (see t. f. 7). The amount of kuckersite beds may be estimated approximately, in the Region between Vanamõisa and Jõhvi, at the figure of 14.275.080 tons, if we take as the average thickness of all kuckersite beds in this Region 1.9 m., the area of this — unconcealed — kuckersite field equal to 368 □ klm. and the specific weight of kuckersite 1.2.

Near Tallinn on Lasnamägi (Laksberg) near the red lighthouse are trenches, 43 m. above Sea level and on a lower level, in the Kuckers beds. These compose a suite of more or less greyish-white compact limestones intercalated with yellow-brown marly limestone, with abundant crinoid stems. These, often shaly, marly-limestone beds contain thin kuckersite partings.

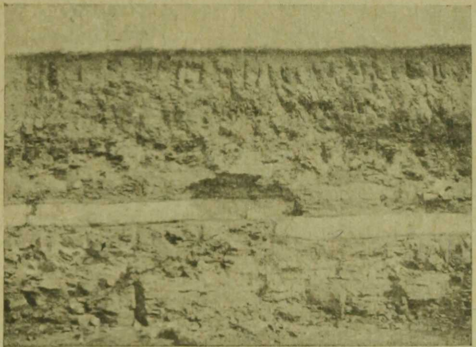
Of the fossils may be mentioned: *Anolotichia brevipora* Bassl., *Coeloclema laciniatus* (Eichw.), *Homotrypa subramosa* Ulrich, *Lioclema spineum vetustum* Bassl., *Trematopora cystata* Bassl., *Plectambonites schmidti leptelloides* var. n., *P. convexa* Pand., *Rafinesquina jaervensis* sp. n., *Cyrtometopus plautini* Schm., *Chasmops odini* (Eichw.).



Text fig. 8. Disturbance of limestone and kuckersite beds in the quarry of Kohtla-Järve. Photogr. by J. Ackerberg.

To the west of Tallinn at Peetri (Peterhof) the Kuckers stage (9 m.) consists according to Pogrebov[26] „of marly-limestone or limestone beds with thin partings of kuckersite or concretionary limestone containing kuckersite" (see t. f. 7, a).

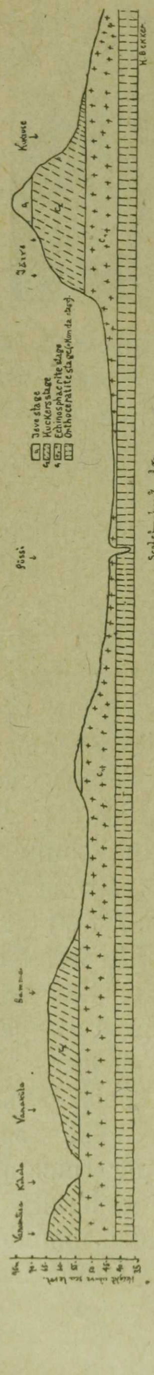
The kuckersite beds show slight disturbance in Järve quarry (see t. f. 8); the axis of the disturbance runs from W—E and is more apparent in the Järve District office quarry; its inclination is here nearly 25° to N and S. A thrust-fault in the Järve quarry was clearly shown by the shift of the „building limestone"; it runs from N—S. (See t. f. 9). The origin of this unimportant thrust-fault (shift — 0.26 m.) may be seen in the ice pressure during the Glacial period.



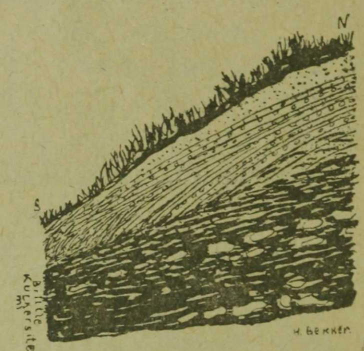
Text fig. 9. Thrust-Fault in the kuckersite quarry of Kohtla-Järve. Photogr. by J. Ackerberg.

As already mentioned the outcrops of the Kuckers beds are covered by ground moraine deposits of varying thickness (0.3—1.5 and more metres); these are composed generally of unstratified sand and gravel often with large rounded boulders which are of local origin or were brought over by the ice from

Finland. Often the ground moraine is clayey. On the northern side of Järve quarry the sand and gravel of the ground moraine above the brittle shale are stratified, with a well marked inclination of the strata from N—S in the lower portion, towards the surface the strata become horizontal. In the lower part of the inclined strata are fine bands of redeposited kuckersite (see t. fig. 10). These stratified beds have been formed very possibly by flowing water under the ice covering in the ice period. Water has denuded the superficial kuckersite and deposited it secondarily as fine intercalated bands in the sand and gravel.



Text fig. 11. Section: Vanamõisa-Püssi-Kukruse.



Text fig. 10. Stratified moraine deposits in the quarry of Kohtla-Järve.

The section of t. f. 11 shows the action of ice during the Glacial period upon the uppermost strata in Vanamõisa—Kukruse District. The upper Echinosphaerite limestone and all overlying beds are denuded between Samma and Järve, especially between Püssi and Järve. Near Vanamõisa, Vanaküla and Samma the upper Kuckers beds are carried away. The transported material is found in localities south of the places named. In the large åser of Rakvere, which is composed of sand and gravel, partly stratified, with a large number of rounded boulders, a considerable portion of these consist of kuckersite; they are rounded, ofttimes larger than one foot. Small kuckersite boulders have been found occasionally in more southern localities. A. Petzholdt [5, 6] in 1850 mentions bituminous shale near Rannapungerja (Rannapungern), north of

Lake Peipsi. The kuckersite boulders contain fossils as well preserved as those in the quarries.

The denudation of ice in the Glacial period is also shown on the Ideal section (see t. f. 5) from Järve quarry — Järve District office, with the results, that the concretionary kuckersite which in the District office quarry is 3 m. below surface is found in the Järve quarry directly under the ground moraine; the higher kuckersite and marly-limestone beds are absent in this quarry.

5. General remarks about Fossils of the Kuckers stage.

The good and often excellent preservation of Fossils of the Kuckers stage has been pointed out often before. The bulk of the fossils described in the present paper (II part) are from the quarry of Kohtla-Järve or Järve, 5—6 klm. to west from Kukruse (Kuckers). Fossils have not been recorded from this locality previously, for the quarry was only opened in 1916—17.

Text fig. 12. Lateral variation in the facies of the ancient sea bottom in the kuckersite quarry of Järve: The marly-limestone bed *i* (above the „Building Limestone *g*") changes into concretionary Kuckersite and — in the foreground of the photograph — into pure kuckersite. — Photogr. by J. Ackerberg.

The best preserved fossils are in the marly-limestone or limestone beds. Many brachiopods, trilobits, excellently preserved in these beds, are generally crushed and flattened in kuckersite beds.

The preservation of fossils depends naturally on the thickness of the valves, in the case of brachiopods. Well preserved brachiopods such as: different *Rafinesquinae*, *Clitambonites*, *Pseudocraniae*, *Plectambonites* and others are found abundantly in the kuckersite beds. Large *Porambonites*, as *P. laticaudatus*, *P. kuckersensis* are usually crushed and flattened, as often large species of *Rafinesquina* and *Leptaena* are.

The statement of A. Born[20] that *Clitambonites (Orthisina)*, *Porambonites* and *Plectambonites sericea* Sow. are almost entirely lacking in the kuckersite beds, is erraneous. *Clitambonites*, *Plect. sericea* are abundant in kuckersite beds. Bifoliate Bryozoas are generally more abundant in kuckersite beds than in the limestone. They are often well preserved.

The tests of trilobites in the kuckersite beds are extremely fragile. They seem to have lost their chitinous substance.

Small brachiopoda, like different sp. of *Pholidops*, *Pseudo-pholidops*, are well preserved in kuckersite beds.

Excellent fossils are usually collected from slightly weathered limestone or marly-limestone slabs.

The list of the Fauna of the Kuckers stage (p. 32—37) gives fossils of different localities of this stage in Estonia, the bulk of which are to be found in North-eastern Estonia (northern part of Virumaa). From the Kuckers stage near Tallinn only a few fossils are mentioned in the list.

Such fossils as: *Chasmatopora furcata* (Eichw.), *Diplotrypa petropolitana* (Nichols.), *Eridotrypa aedilis* (Eichw.), *Graptodictya bonnemai* Bassler, *Homotrypella instabilis* Ulrich, *Pseudohornea bifida* (Eichw.), *Clitambonites squamata, Platystrophia biforata* Schloth., *Plectambonites sericea* Sow., *Rafinesquina imbrex* (Pander), *Chasmops odini* (Eichw.), which have a wide horizontal distribution, are also abundantly represented vertically in different beds of the Kuckers stage and not only in this stage, but in underlying and overlying stages.

Provisionally the following may be regarded as more or less good characteristic fossils of the *Kuckers* stage: *Pterygometopus kuckersiana* Schm., *Cyrtometopus plautini* Schm., *Cybele coronata* Schm., *Acidaspis kuckersiana* Schm., *Pachydictya kuckersensis* Bekker, *Nematotrypa spiralis* sp. n., *Nematopora ramosa* sp. n., *Orthis kuckersiana* Wysog., *Porambonites laticaudatus* sp. n., *P. kuckersensis* sp. n., *Rafinesquina dorsata* sp. n., *R. jaervensis* sp. n., *Leptaena estonensis* sp. n., *L. triangulata* sp. n.

6. Origin of the kuckersite.

Helmersen[3] describes these beds as „une argile pénétrée de bitume".

Eichwald[7] considers that these beds „may be possibly formed by sea algae and similar plants".

F. Schmidt[11] defined these beds as „redbrown bituminous marls".

Chemical investigations of the „Brandschiefer" were published by Schamarin[10] in 1874, and a good deal of work has been done since.

L. F. Fokin[19] (1913) investigated this material not only chemically and technically but also petrographically and first proved the presence of algae in microscopic sections. He was led to this conclusion by the investigations of Renault and Bertrand, who found that Bogheads consists partly of algae. He describes in his sections: „oval-shaped light-yellow inclusions 0.01—0.07 mm. of diameter, often in grouplets." Fokin considers that „the material was deposited in shallow water in which lived a rich fauna and flora. As the organic matter contains a considerable amount of sulphur and nitrogen it may be of animal origin. The material was deposited as slime".

A. Born[18] failed to see algae in the „kuckersite". His conclusion is as follows: „Die organische Substanz bildet eine ziemlich grobkrystalline Grundmasse von hellbrauner Färbung."

Most important results were attained by M. D. Zalessky[22,30]. He draws attention to „Boghead", „Torbanite" and the „Cannel coals" called by Potonié sapantracones and considers the first two and probably the third to be organic mud or sapropel deposits from the bottom of lakes; all these consist generally of algae. Zalessky describes recent sapropel deposits from lakes Balahash and Beloje (Tver gov.), in the latter of which the sapropel deposit reaches a thickness of 9 m. and is composed generally of Cyanophycean algae, including species of the genera: *Microcystis*, *Aphanocapsa*, *Aphanothece*, *Chroococcus*, *Gloeothece*, *Synechococcus*, and of green algae such as: *Scenidium obliquus*, *S. bijugatus* and *Pleurococcus vulgaris*. He says (p. 5): „It has proved that the ‚bituminous oil shale of kuckers' long known in geological literature, is a sapropelite formed in sea water."

Zalessky describes in sections irregular-oval or rounded amber yellow coloured particles from 0.01—0.08 mm. in diameter, which contain 20—30 or more irregular ovoid or beanshaped brownish corpuscles 5 μ. long and 3.5 μ. broad" (p. 9). These brownish corpuscles remind one vividly of colonial forms of algae belonging to *Chroococcaceae*, the colonies of which are made up of cells embedded in slime, and especially do they recall recent algae of the gen. *Gloeocapsa* (Pl. I^A f. 2). Zalessky found that moistened particles of kuckersite expand in volume; this is to be expected if the yellow matrix and the other ground mass of the kuckersite is slime.

In diluted chloralhydrate the colonies of algae in the kuckersite become more clearly defined and „the cells, although a little lighter coloured, are clearly to be seen in the slime mass." (Pl. I^A, f. 3).

Zalessky says (on p. 14): „Recent forms of *Gloeocapsa* live on moist earth and stones or on rocks in water and form slimy coverings of different colours; as we have seen the kuckersite makes up beds of 3 feet; therefore the algae, which could originate such thick deposits, must have been planctonic or nectonic forms like the recent species of the genera: *Microcystis*, *Aphanocapsa*, *Aphanothece*" etc.

For the fossil alga Zalessky proposes the name *Gloeocapsamorpha* to indicate its morphological resemblance to *Gloeocapsa*.

Further Zalessky considers that *Gloeocapsamorpha prisca* Zalessky, which compose the kuckersite, lived freely in the water and temporarily covered its surface. „Periodically all this living covering with the other plankton sinks downwards; at the bottom it may continue to grow and live, until covered by next years growth; but the fresh covering will stop the free access of oxygen; and so decomposition of the lower deposits will begin and the accumulation of the algae and other forms of life made up the organic slime, named by Potonié ‚sapropel'."

Zalessky thinks that the kuckersite has been deposited in shallow sea lagoons. The origin of thin kuckersite layers between limestones may be explained by transported algal slime taken by the waves from the shallower and deposited in deeper parts, where the limestone was formed. Lastly he considers that the kuckersite beds might even be formed from algae growing on submerged rocks. Vast quantities of these algae would be torn by the waves from the rocks during the more stormy period of the year and deposited in tranquil waters.

In order to follow up this important investigation of Zalessky I have studied thin sections from different beds and localities: from Järve quarry, and from the trenches of Lasnamägi near Tallinn (Reval). While I have reached nearly the same conclusions as Zalessky (Pl. I, f. 4) I am able to make few additions to his observations. Zalessky says (on p. 8): „the beds in the pure kuckersite are made up only of algae without mineral particles of clay and marl . . .“ I found however, that thin sections of the purest kuckersite under polarized light show minute irregularly shaped fragments (in very small number it is true) of different minerals, generally quartz. A few of these grains are comparatively large. In larger number than these mineral grains there are minute calcite particles — fragments of fossils. The pureer the shale the smaller is the number of particles. The section of kuckersite from Tallinn is much more calcified; nearly half of the matrix of the section appears to be calcareous fragments and grains.

None of the organic material, the umber-yellow ground matrix with the dark-brown grouplets gives any reaction with polarized light. A considerable portion of the grouplets represent the alga described by Zalessky: *Gloeocapsamorpha prisca.* But my own observations show that a considerable number of other forms are present, and that a phytoplanctonist could describe a whole flora from the kuckersite. Frequently I found in my sections a form, which resembles very closely a recent *Myconostoc* (Pl. I, f. 4[6]), which at the present day lives in rotting mud or slime deposits. There can also be found forms very much resembling *Aphanocapsa*, *Chroococcus*, *Gloeothece*, forms resembling Diatomacean algae and forms like bacteria.

For comparison with the kuckersite section on Pl. I, f. 5 and 6, I have given drawings of sections from the Dictiograptus shale of Estonia (f. 5) and from the typical oil shale of Pumpherstone in Scotland.

7. Conditions of deposition of kuckersite.

I have referred to the considerations of Zalessky. These can be extended by detailed stratigraphical observations.

As evidence of a planctonic mode of life for *Gloeocapsamorpha prisca* Z. points out, that comparatively thick bituminous marly-limestone beds, deposited in deeper water than the kuckersite beds, contain a considerable quantity of the kuckersite matter or of algae. Such deposits could only be formed when the algae were continually sinking down to the other material which composes the marly-limestone.

The kuckersite beds, which contain small limestone concretions are very turbulent and therefore comparatively shallow water deposits. Such beds are irregularly laminated or show no lamination planes at all. Instead they often have an irregular-conchoidal fracture. Their fossils are generally broken, the fragments are irregularly distributed in the kuckersite, and a single concretion may contain fragments of several different fossils. Worm tracks are often common in these beds as well as in the pure kuckersite beds.

The pure kuckersite beds (without limestone concretions) show a more regular bedding, which is indicated by the fossils, which lie on this plane. The deposition must have taken place under calmer conditions than those of the concretionary kuckersite.

The pure limestone, called the „Building Limestone" appears to have formed as the result of a sudden deepening of the Sea floor.

In the quarry of Järve we see not only different types or facies of deposits superimposed, but alongside the exposure (from N—S) of the quarry, which together with the ditch has the length about 1 klm., we see corresponding lateral variation in the facies of the ancient sea bottom, as shown on the photograph, t. fig. 12. It shows (above the „Building limestone") a more or less pure, slightly bituminous marly limestone, which changes into concretionary kuckersite and then (in the foreground of the photogr.) into pure kuckersite bed.

Zalessky thinks that the kuckersite may be compared with a tertiary saprocole from Brazil which is called the „Turf of Marahu". It is a bedded light-yellow material of clay-like aspect; it is very light and burns in a candle flame.

„To the same group of sapropelites", says Zalessky, „may belong a tertiary saprocole from Kiev District (village Novoselizo); this is yellow, but in KOH it takes a red-brown colour, while kuckersite, even after boiling in KOH, gives only gold-yellow colouring. KOH after boiling with the algal slime from lake

Beloje attains the same colour. It follows, that the saprocole of tertiary age of the Kiev District is more advanced in decomposition, than the silurian saprocole".

8. Correlation of the Kuckers stage.

As pointed out previously *Chasmops conicophtalmus* of Sweden is nearly related to *Ch. odini* from Kuckers stage; this stage and *Chasmops* or *Macrurus* limestone of Sweden, with *Ch. conicopht.*, *Ch. macrurus*, which in Öland, Westrogothia and Dalecarlia (Dalarne) rests upon the Cystidean or Echinosphaerite limestone, are regarded as equivalent in time.

In Norway the lower portion of the stage 4, containing Chasmops, is equivalent to our Kuckers stage. Holtedahl[4, pt. II.] (p. 10—11) correlates the Kuckers stage with shales 4 b α containing *C. conicophtalma* and limestones 4 b β in Asker-Baerum and Bundefjord; in Skien-Langesund District are shales and limestones in the lower portion of 4 b with *Ch. conicophtalma.* In the Ringerike District Lower Chasmops shale and limestone occur (4 b α and 4 b β).

From 16 different brachiopods of the Strophomenidae recorded by Holtedahl from the above named districts, 6 species are common with those from the Kuckers stage. These are: *Leptaena rhomboidalis* Wilckens, *Plectambonites quinquecostata* M'Coy, *P. convexa* Pander, *P. sericea* Sow., *Rafinesquina imbrex* Pander, *Strophomena asmussi* Vern.

There is more difficulty in finding equivalent beds in the British islands. As pointed out by J. E. Marr[13] „the Cystidean limestone (of Sweden) containing Cystideans, such as *Echinosphaerites aurantium* and Phacops of the subgen. *Chasmops*, which are found in somewhat earlier beds in Russia, but first occur in Wales in Middle-Bala beds, whilst, as I have before pointed out, the Cystideans did not reach the Lake-District until Upper-Bala times; for there are no shallow water forms of Arenig age, and very few of Lower-Bala age, in the Southern parts of Britain."

Most interesting is the occurrence of some typical Kuckers stage fossils in the Glensaul District recorded by Gardiner and Reynolds[17]. Table III given by these authors contains fossils from the Shangort and Tourmakeady Beds. In ashy and gritty limestons by foot bridge a quarter of a mile SSW of Garranagerra the following fossils are common or nearly related with those of Kuckers stage: *Plectambonites quinquecostata* M'Coy, *P. sericea* Sow., *Rafinesquina imbrex*, var. *semiglobosina* Dav., *Chasmops aff. odini* Eichw. From others, the species not determined, may be possibly common *Porambonites* sp., *Siphonotreta*? sp., *Cybele* sp., *Remopleurides* sp., *Echinosphaera* sp. etc.

The occurrence of forms which in Scandinavia and Estonia occur in lower stages is most remarkable; thus associated with *Chasmops aff. odini* Eichw. from these beds are recorded *Megalaspis* sp., *Nileus armadillo* Dalm., *Niobe* sp. Quite unknown forms for Europe from these beds are: *Bathyurellus, Bathyurus.*

Cowper Reed (In Gardiner and Reynolds) gives to the occurrence of *Chasmops* in Ireland the following explanation: „we can explain its occurrence by regarding the Swedish Orthoceras Limestone fauna, or a certain portion of it, as having lived on later in the West of Ireland, just as, for instance, the Lower Devonian fauna did in the Hamilton Beds of N. America; or we may interpret the fact as an indicating that *Chasmops* appeared at an earlier date in the western than in the eastern parts of its faunal province . . . But there can be no doubt that the general faunastic facies of the Glensaul, Tormakeady and Shangort Beds is Scandinavian, and the whole assemblage of species indicates the lower part of Ordovician“.

R. S. Bassler[18] describes 46 species of bryozoa from the Kuckers stage in Estonia; 14 species are common to this stage in Estonia and the Black River group in America. He says (p. 18): „Beginning with the invading Glauconite sandstone and continuing until the close of the Vesenberg, the faunas are uniformly of Middle Ordovician age and represent the Black River and earliest Trenton formations of the American section.“

P. E. Raymond[21] has placed in his paper a table in which he gives his „interpretation of the sections and correlation of subdivisions of the Ordovician of Estonia and Scandinavia with those of certain localities in North America“. He correlates with the Kuckers stage:

Leray and Lorette subdivisions from . . Champlain valley.
Leray and Echinosphaerites subdivisions
from . . . . Bellefonte.

Part of Echinosphaerites and Ottosee subdivisions from	S. W. Virginia.
Upper part of Plattville and Lower Decorah subdivisions from	Minnesota.
Leray and Rockland subdivisions from .	Ottawa and Ontario.
Leray and Lorette subdivisions from . .	Central New-York.

Of great interest are the records by F. R. Cowper Reed of typical european, especially scandinavian and estonian, fossils from Burma and Jun Nan province in China. Strict correlation is naturally not possible; most of the recorded fossils are in Estonia also common in other stages. F. R. Cowper Reed[15] describes from different localities of Burma as follows:

	Localities:	Plate and fig. in the work of Cowper Reed
Plectambonites sericea (Sow.) . . .	Nankat, Nannjun	IV, 36. 37
Rafinesquina imbrex (Pander) . . .	Tanomawgan . .	V, 9—12
Clitambonites aff. squamata (Pahlen),	Kunlein	V, 14
Porambonites intercedens (Pander),	Sedaw	V, 15 a. b.

The first three of these brachiopods are extremely abundant in the Kuckers stage of Estonia.

The fauna described by Reed[23] from Jun-Nan of the beds at Shih-Tien contains generally local species and says Reed (p. 69): „the Echinosphaerite limestone of Dalecarlia may be especially mentioned in connection with the abundance of cystideans in rock types g and h". These rock types are:

(g) — Dark greyish-green massive limestone, tough and more or less crystalline.

(h) — Tough pale pinkish or greenish-yellow limestones or calcareous mudstone, sometimes cleaved or crushed.

From the list of Fossils I call attention to: *Endoceras wahlenbergi* Foord, *Orthoceras regulare* Schl., found also from Kuckers stage in Estonia. F. Reed indicates: „all of them (fossils) indicate the Ordovician and especially suggest stages B and C, the Orthoceras, Cystidean and Chasmops Limestones, of the Baltic Provinces of Russia and Scandinavia".

9. List of the Fauna of Kuckers stage in Estonia.

	Kuckers stage.							
	Vanamõisa quarry 61—63 m. above sea level.	Kohtla-Järve quarry 52—56 m. above sea level: kuckersite.	Kohtla-Järve quarry 52—56 m. above sea level: marly-limest.	Järve quarry near the District office 60—64 m. above sea level.	Kukruse quarry 53—56 m. above sea level.	Estate Kukruse (Kuckers). (Bryozoa after Bassler).	Jõhvi (Jeve) (Between rail-road and estate Jõhvi). 52—55 m. above sea level.	Tallinn (Reval) Lasnamägi Trenches near S. Light-house. 42—43 m. ab. sea lev.
Spongiae.								
Hazelia cf. *palmata* Walcott. n. r. 1)	—	×	—	—	—	—	—	—
Cystoidea.								
Cystoblastus kokeni Jaekel.	—	—	×	—	—	—	—	—
Echinosphaerites aurantium His. .	—	—	×	—	—	—	—	×
Caryocystites balticus	—	—	—	—	—	—	—	—
„ *aranea*	—	—	—	—	—	—	—	—
Protocrinites sp.	—	—	—	—	×	—	—	—
Crinoidea.								
Chirocrinus granulatus Jaekel . .	—	×	×	—	—	—	—	—
Hybocrinus dipentus Lindström . .	—	—	—	—	—	—	—	—
Polyptychella estona Jaekel. . . .	—	×	—	—	—	—	—	—
Bryozoa.								
Anolotichia brevipora Bassler . .	—	—	—	—	—	—	—	×
„ *impolita* (Ulrich) . . .	—	—	—	—	—	×	—	—
„ *sacculus* Bassler . . .	—	—	—	—	—	×	—	—
Chasmatopora furcata (Eichw.) . .	—	×	×	×	×	×	×	—
„ *punctata* sp. n. . . .	—	×	—	—	—	—	—	—
„ *reticulata*(Hall.) n. r.	—	×	—	—	—	—	—	—
Coeloclema laciniatus (Eichw.) . .	—	—	—	—	—	—	—	×
Corynotrypa delicatula (James) . .	—	—	—	—	—	×	—	—
Dekayella praenuntia Ulrich . . .	—	—	—	—	—	—	—	×
Dianulites petropolitana Dybowski	—	×	—	—	—	×	—	×
Diplotrypa bicornis (Eichw.) . . .	—	—	—	—	—	×	—	—
„ *hennigi* Bassler	—	—	—	—	—	×	—	—
„ *lamellaris* sp. n.	—	×	—	—	—	—	—	—
„ *moniliformis* Bassler n. r.	—	—	—	—	×	—	—	—
„ *petropolitana*(Nicholson)	×	×	×	×	×	×	×	×
„ *westoni* Ulrich n. r. . .	—	—	—	—	×	—	—	—
Dittopora colliculata (Eichw.) . . .	—	—	—	—	—	×	—	—
„ *magnipora* sp. n. . . .	—	×	—	—	—	—	—	—
Eridotrypa aedilis (Eichw.) n. r. . .	—	×	×	—	—	—	×	×
„ „ *minor*(Ulrich) n. r.	×	×	—	—	—	—	—	—
Estoniopora communis Bassler . .	—	—	—	—	—	×	—	—
„ *curvata* Bassler . . .	—	—	—	—	—	×	—	—
Favositella exserta Bassler	—	—	—	—	—	×	—	—

1) n. r. = new record.

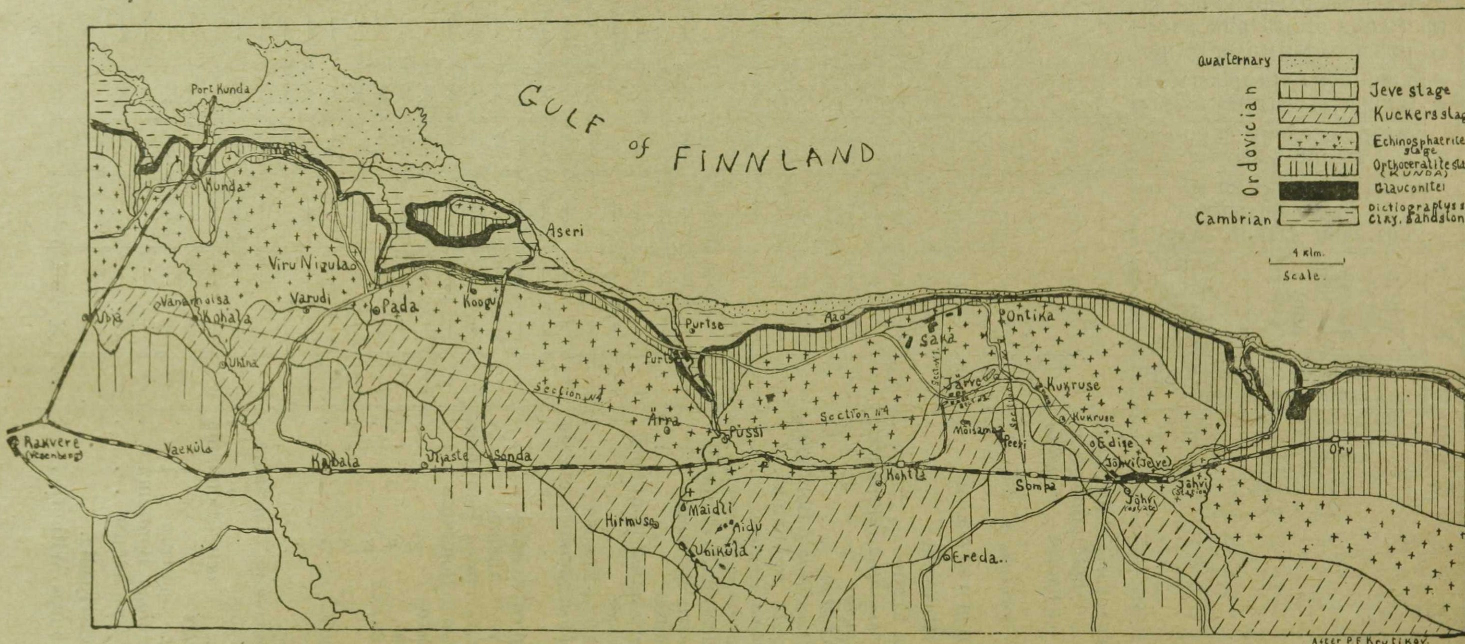
	Kuckers stage.							
	Vanamõisa quarry 61—63 m. above sea level.	Kohtla-Järve quarry 52—56 m. above sea level		Järve quarry near the District office 60—64 m. above sea level.	Kukruse quarry 53—56 m. above sea level.	Estate Kukruse (Kuckers). (Bryozoa after Bassler).	Jõhvi (Jeve) (Between railroad and estate Jõhvi). 52—55 m. above sea level.	Tallinn (Reval) Lasnamägi Trenches near S. Lighthouse. 4?—43 m. ab. sea lev.
		kuckersite.	marly-limest.					
Graptodictya bonnemai Bassler	×	×	×	×	×	×	×	×
„ „ *jaervensis* var. n.	—	×	×	—	—	—	×	—
„ *minima* sp. n.	—	—	×	—	×	—	—	—
Hallopora tolli Bassler	—	—	—	—	—	×	—	×
„ *dumalis* (Ulrich)	—	×′	—	—	—	—	—	×
„ *dybovski* Bassler	—	—	—	—	—	×	—	—
Helopora divaricata Ulrich	—	—	—	—	—	×	—	—
Hemiphragma panderi (Dybovski)	—	×	—	—	×	—	—	—
„ *maculatum* Bassler	—	—	—	—	×	×	—	×
„ *multiporatum* Bassler	—	—	—	—	—	×	—	—
„ *rotundatum* Bassler	—	—	—	—	—	×	—	×
Homotrypa subramosa Ulrich	—	—	—	—	—	—	—	×
Homotrypella instabilis Ulrich	—	×	×	×	×	×	—	×
Leptotrypa hexagonalis Ulrich	—	—	—	—	×	×	—	—
Lioclema spineum Bassler	—	—	—	—	—	×	—	—
„ „ *ramosum* var. n.	—	×	—	—	—	—	—	—
„ „ *vetustum* Bassler	—	—	—	—	—	—	—	×
Mesotrypa expressa Bassler	—	—	—	—	—	—	—	×
„ *milleporacea* Bassler	—	—	—	—	—	×	—	—
„ „ *parva* Bassler	—	—	—	—	—	×	—	—
Mitoclema (?) *mundulum* (Ulrich)	—	—	—	—	—	×	—	—
Nematopora consueta (Bassler)	—	×	—	—	—	×	—	—
„ *lineata* (Billings)	—	×	—	—	—	—	—	—
„ *ovalis* Ulrich	—	×	—	—	—	×	—	—
„ *ramosa* sp. n.	—	×	—	—	—	—	—	—
„ *bogoljubovi* Bekker	—	—	—	—	×	—	—	—
„ *granosa* Ulrich	—	×	—	—	—	—	—	—
Nematotrypa gracilis Bassler	—	×	—	—	×	×	—	—
„ *spiralis* sp. n.	—	×	—	—	—	—	—	—
Orbipora distincta (Eichw.)	—	—	—	—	×	—	—	—
Pachydictya bifurcata (Hall)	—	—	—	—	×	—	—	—
„ *crassa* Hall	—	—	—	—	×	—	—	—
„ *cyclostomoides* (Eichw.)	—	—	—	—	—	—	—	—
„ *flabellum* (Leuchtenb.)	—	—	—	—	—	—	—	—
„ *elegans* Ulrich	—	×	—	—	×	—	×	—
„ *irregularis* sp. n.	—	—	—	—	×	—	—	—
„ *kuckersensis* Bekker	—	×	—	×	×	—	—	—
Phylloporina granistriata Ulrich	—	×	—	—	—	—	—	—
„ *papillosa* sp. n.	—	×	—	—	—	—	—	—
Polypora quadrata sp. n.	—	—	—	—	×	—	—	—
Protocrisina disposita sp. n.	—	×	—	—	—	—	—	—
„ *ulrichi* Bassler	—	—	—	—	—	×	—	—
„ *exigua* Ulrich	—	—	—	—	×	—	—	—
Pseudohornea bassleri sp. n.	—	×	×	—	—	—	—	—
„ *bifida* (Eichw.)	—	×	—	×	×	×	×	—

	Kuckers stage.							
	Vanamõisa quarry 61—63 m. above sea level.	Kohtla-Järve quarry 52—56 m. above sea level		Järve quarry near the District office 60—64 m. above sea level.	Kukruse quarry 53—56 m. above sea level.	Estate Kukruse (Kuckers). (Bryozoa after Bassler).	Jõhvi (Jeve) (Between rail-road and estate Jõhvi). 52—55 m. above sea level.	Tallinn (Reval) Lasnamägi Trenches near S. Light-house. 42—43 m. ab. sealev.
		kuckersite.	marly-limest.					
Rhinidictya exserta (Eichw.) . . .	—	×	—	—	×	—	—	—
Stellipora revalensis Dybowski . .	—	—	—	—	—	×	—	×
Stigmatella foordii (Nicholson) . .	—	—	—	—	—	×	—	—
Stomatopora arachnoidea (Hall) . .	—	—	—	—	—	—	—	—
Trematopora cystata Bassler . . .	—	—	—	—	—	—	—	×
„ *kuckersiana* Bassler .	—	—	×	—	×	—	—	×
Brachiopoda.								
Clitambonites marginata Pahlen . .	—	×	×	—	—	—	—	—
„ *pyramidalis* „ . .	—	×	×	—	×	×	—	—
„ *pyron* „ . .	—	—	—	—	—	—	—	—
„ *schmidti* „ . .	—	×	×	—	×	—	—	—
„ *squamata* „ . .	—	×	×	×	×	—	—	×
„ *trigonula* „ . .	—	—	—	—	—	—	—	—
Leptaena estonensis sp. n.	—	—	×	—	—	—	—	—
„ *rhomboidalis* Wilkens n. r.	—	—	×	—	—	—	—	—
Lingula ovata M'Coy n. r.	—	×	—	—	×	—	—	—
Orthis concava F. Schmidt	—	—	×	—	—	—	—	—
„ *frechi* Wysogorski	—	—	—	—	—	—	—	—
„ *inostrantzefi* „	—	—	—	—	—	—	—	—
„ *kuckersiana* „	×	×	×	×	×	—	—	—
„ *moneta* (Eichw.)	—	—	—	—	—	—	—	—
„ *umbo* Lindstr.	—	×	—	—	—	—	—	—
„ *sp.* (sp. n. ?)	—	×	—	—	—	—	—	—
Philedra baltica Koken	—	—	×	—	—	—	—	—
„ *rivuloso*	—	×	×	—	—	—	—	—
Pholidops infrasilurica Huene . .	×	×	×	—	—	×	×	—
„ *curvata* sp. n.	—	×	—	—	—	—	—	—
„ *elegans* sp. n.	—	×	—	—	—	—	—	—
„ *estona* sp. n.	—	×	—	—	—	—	—	—
„ *obtusa* sp. n.	—	×	—	—	—	—	—	—
Pseudopholidops complicata gn. & sp. n.	—	×	—	—	—	—	—	—
„ *pseudocranoides* sp. n.	—	×	—	—	—	—	—	—
„ *scutellata* sp. n. . . .	—	×	—	—	—	—	—	—
Platystrophia biforata Schloth . .	×	×	×	×	×	—	×	×
Plectambonites sericea (Sowerby) . .	×	×	×	×	×	—	×	×
„ *schmidti* Törnquist var. . *leptelloides*, n. var. . . .	—	×	×	×	×	—	—	×
„ *quinquecostata* M'Coy n. r.	—	×	—	—	—	—	—	×
„ *convexa* Pander	—	—	—	—	—	—	—	×
Porambonites aequirostris (Schl.) .	—	×	×	×	×	—	—	×
„ *laticaudatus* sp. n. .	—	—	×	—	—	—	—	—
„ *kuckersensis* sp. n. .	—	×	×	—	—	—	×	×
„ *baueri* Noetling . . .	—	—	×	—	—	—	—	—

	Kuckers stage.							
	Vanamõisa quarry 61—63 m. above sea level.	Kohtla Järve quarry 52—56 m. above sea level: kuckersite.	Kohtla Järve quarry 52—56 m. above sea level: marly-limest.	Järve quarry near the District office 60—64 m. above sea level.	Kukruse quarry 53—56 m. above sea level.	Estate Kukruse (Kuckers).	Jõhvi (Jeve) (Between rail-road and estate Jõhvi). 52—55 m. above sea level.	Tallinn (Reval) Lasnamägi Trenches near S. Light-house. 42—43 m. ab. sealev.
Pseudocrania depressa Eichw. . . .	—	×	×	—	—	—	×	×
„ *planissima* „ . . .	—	×	—	—	—	—	—	—
Pseudometoptoma orbiculiforme Huene	—	—	—	—	—	—	—	—
Rafinesquina dorsata sp. n.	—	×	×	×	×	—	×	—
„ *imbrex* (Pander) . . .	—	×	×	×	×	—	×	—
„ *jaervensis* sp. n. . . .	—	×	—	×	×	—	—	×
Strophomena asmussi Vern.	—	—	×	—	—	—	—	—
„ cf. *corrugatella* Dav. .	—	×	×	—	—	—	—	—
Siphonotreta unguiculata Eichw. .	—	—	×	—	—	—	—	—
Lycophoria sp.	—	×	—	—	—	—	—	—
Pelecypoda.								
Aristerella nitiduloides sp. n. . . .	—	—	—	—	×	—	—	—
Cyrtodonta ? *rotundata* sp. n. . .	—	—	—	—	×	—	—	—
Ctenodonta logani Salter	—	—	—	—	×	—	—	—
Clionychia cf. *lamellosa* Hall. . . .	—	—	×	—	—	—	—	—
Modiolopsis aff. concentrica Hall. .	—	—	—	—	×	—	—	—
Nucula aedilis Eichw.	—	—	—	—	—	—	—	—
„ *macromya* Eichw.	—	—	—	—	—	—	—	—
Gastropoda.								
Bucania radiata (Eichw.)	—	—	—	—	—	—	—	—
Bucaniella jugata Koken	—	—	—	—	—	—	—	—
Cymbularia galeata Koken	—	—	×	—	×	—	—	—
Eccyliopteris increscens (Eichw.) .	—	—	—	—	—	—	—	—
„ *tolli* Koken	—	—	—	—	—	—	—	—
Euomphalus devexus Eichw. . . .	—	—	—	—	×	—	—	—
Haplospira variabilis Koken n. r. .	—	—	—	—	×	—	—	—
Pleurotomaria elliptica (His.) . . .	—	—	—	—	—	—	—	—
„ *inflata* Koken . . .	—	—	—	—	—	—	—	—
„ *notabilis* (Eichw.) .	—	—	—	—	—	—	—	—
„ *rossica* Koken . . .	—	—	—	—	—	—	—	—
Raphistoma acutangulum Koken . .	—	—	—	—	×	—	—	—
„ *marginale* Eichw. mut.	—	—	—	—	—	—	—	—
Salpingostoma compressum (Eichw.)	—	—	—	—	—	—	—	—
Sinuites rugulosus Koken	—	—	—	—	—	—	—	—
Subulites peregrinus Schl. sp. . . .	—	—	—	—	×	—	—	—
Worthenia estona Koken	—	—	—	—	—	—	—	—
„ *mickwitzi* „	—	—	—	—	—	—	—	—
„ *sibirica* (Eichw.) . . .	—	—	—	—	—	—	—	—
Cephalopoda.								
Endoceras wahlenbergi Foord. . . .	—	—	×	—	×	—	—	—
Orthoceras regulare Schloth. n.r. .	—	—	×	—	—	—	—	—
„ sp.	—	×	—	—	—	—	—	—

	Kuckers stage.							
	Vanamõisa quarry 61—63 m. above sea level.	Kohtla Järve quarry 52—56 m. above sea level		Järve quarry near the District office 60—64 m. above sea level.	Kukruse quarry 53—56 m. above sea level.	Estate Kukruse (Kuckers).	Jõhvi (Jeve) (Between railroad and estate Jõhvi). 52—55 m. above sea level.	Tallinn (Reval) Lasnamägi Trenches near S. Lighthouse. 42—43 m. ab. sea lev.
		kuckersite.	marly-limest.					
Pteropoda.								
Hyolithes striatus Eichw.	—	—	—	—	—	—	—	—
Crustacea.								
A. - Trilobita.								
Acidaspis kuckersiana Schmidt . .	—	—	—	—	—	×	—	—
Ampyx rostratus Dalman	—	×	—	—	—	×	×	—
Asaphus kovalevskii Lawrow n. r. .	—	×	×	—	—	—	—	—
„ *nieszkowskii* cf. *lepidus* Törn.	—	—	—	—	—	—	—	—
„ *ornatus Pompeckj* n. r. . . .	—	—	×	—	—	—	—	—
„ *platyurus laticauda* Schm. n. r.	—	—	—	—	×	—	—	—
„ sp.	×	×	×	×	×	—	×	—
Basilicus kuckersiana Schmidt . .	—	×	—	×	—	×	—	—
Ceratolichas inexpectatus „ . .	—	—	—	—	—	—	—	—
Chasmops odini (Eichw.)	×	×	×	—	×	×	×	×
„ *praecurrens* Schmidt n. r.	—	—	—	×	×	—	—	—
Cheirurus macrophtalmus Kutorga n. r.	—	×	—	×	—	—	—	—
„ *spinulosus* Nieszkowski .	—	×	×	—	—	—	×	—
Cybele coronata Schmidt	—	—	—	—	—	×	—	—
„ *kutorgae* „ n. r.	—	×	—	—	—	—	—	—
„ *rex* Nieszkowski	—	×	—	—	—	—	×	—
Cyphaspis planifrons Eichw. . . .	—	×	—	—	—	×	—	—
Cyrtometopus plautini Schmidt . .	—	—	—	—	—	—	—	×
„ *pseudohemicranium dolichocephala* (Schmidt)	—	—	—	—	—	—	—	—
Homolichas depressus (Angelin) . .	—	×	—	—	—	—	×	—
Hoplolichas conicotuberculatus (Nieszkowski)	—	×	—	—	—	×	×	—
„ *tricuspidatus longispina* Schmidt	—	—	—	—	—	×	—	—
Illaenus crassicauda	—	—	—	—	—	—	—	—
„ *linnarsoni* Holm	—	×	—	—	—	—	—	—
„ *oblongatus* Angelin . . .	—	—	—	—	—	×	—	—
„ *sphaericus* Holm	—	×	—	—	—	—	—	—
Lichas kuckersiana Schmidt . . .	—	×	—	—	×	—	—	—
Menocephalus minutus (Nieszk.) . .	×	—	—	—	—	—	—	—
Metopias kuckersiana Schmidt . .	—	—	—	—	—	—	—	—
Nieszkowskia cephaloceras Nieszk. .	—	—	—	×	—	×	—	—
„ *variolaris* (Linn.) . .	—	×	—	—	—	×	—	—
Ogygia dilatata panderi Schmidt .	—	—	—	—	—	×	—	—
Pharostoma nieszkowskia „ .	—	×	—	—	—	—	—	—
Pseudasaphus tecticaudatus Steinh. .	—	×	—	—	—	×	—	—
Pterygometopus exilis Eichw. . . .	—	—	—	—	—	×	—	—
„ *kuckersiana* Schmidt	—	×	—	—	—	×	—	—

	Kuckers stage.							
	Vanamõisa quarry 61—63 m. above sea level.	Kohtla Järve quarry 52—56 m. above sea level: kuckersite.	Kohtla Järve quarry 52—56 m. above sea level: marly-limest.	Järve quarry near the District office 60—64 m. above sea level.	Kukruse quarry 53—56 m. above sea level.	Estate Kukruse (Kuckers). (Ostracoda after Bonnema)	Jõhvi (Jeve) (Between rail-road and estate Jõhvi). 52—55 m. above sea level.	Tallinn (Reval) Lasnamägi Trenches near S. Light-house. 42—43 m. ab. sea lev.
Pterygometopus panderi Schmidt n. r.	-	×	—	—	—	—	—	—
„ *sclerops* Dalman n. r.	—	×	—	—	—	×	—	—
Remopleurides elongatus elongata Schm.	—	—	—	—	—	—	—	—
Sphaerocoryphe cranium Kutorga	—	—	—	—	—	×	—	—
B. Entomostraca.								
1. Ostracoda.								
Bollia granulosa Krause	—	—	—	—	—	×	—	—
„ *minor kuckersiana* Bonnema	—	—	—	-	—	×	—	—
„ „ *robusta* „	—	—	—	—	—	×	—	—
„ *ornata* Krause	—	—	—	—	—	×	—	—
„ „ *latimarginata* Bonnema	—	—	—	—	—	×	—	—
Ceratopsis schmidti Bonnema	—	—	—	—	—	×	—	—
„ *cornuta* Krause	—	—	—	—	—	×	—	—
Ctenobolbina carinata Krause	—	—	—	—	—	×	—	—
„ *kuckersiana* Bonnema	—	—	—	—	—	×	—	—
Cytherellina jonesii Bonnema	—	—	—	—	—	×	—	—
„ *krausei* „	—	—	—	—	—	×	—	—
„ *ruedemanni* Bonnema	—	—	—	—	—	×	—	—
„ *ulrichi* „	—	—	—	—	—	×	—	—
Entomis flabellifera Krause	—	—	—	—	—	×	—	—
„ *obliqua kuckersiana* Bonnema	—	—	—	—	—	×	—	—
„ *oblonga* „ „	—	—	—	—	—	×	—	—
„ *quadrispira* Krause	—	—	—	—	—	×	—	—
„ *variolaris* Bonnema	—	—	—	—	—	×	—	—
Macronotella kuckersiana Bonnema	—	—	—	—	—	×	—	—
Primitia decumana Bonnema	—	—	—	—	—	×	—	—
„ *dentifera* „	—	—	—	—	—	×	—	—
„ *estonia* „	—	—	—	—	—	×	—	—
„ *kuckersiana* „	—	—	—	—	—	×	—	—
„ *molli* „	—	—	—	—	—	×	—	—
„ *kapteyni* „	—	—	—	—	—	×	—	—
„ *tolli* „	—	—	—	—	—	×	—	—
„ *rossica* „	—	—	—	—	—	×	—	—
Primitiella kuckersiana Bonnema	—	—	—	—	—	×	—	—
Strepula kuckersiana „	—	—	—	—	—	×	—	—
„ „ *acuta* Bonnema	—	—	—	—	—	×	—	—
Tetradella calkeri „	—	—	—	—	—	×	—	—
„ „ *convexa* „	—	—	—	—	—	×	—	—
Ulrichia kuckersiana Bonnema	—	—	—	—	—	×	—	—
„ cf. *bidens* Krause	—	—	—	—	—	×	—	—
2. Cirripedia.								
Plumulites estonicus Withers	—	×	—	—	—	—	—	—



Geological map of NE Estonia, of the district between Jôhvi (Jeve) and Rakvere (Wesenberg).

Pt. II.

New and newly recorded fossils from the Kuckers stage[1]).

Spongiae.

Gen. *Hazelia* Walcott.

Walcott, 1920 Cambr. Geol. and Paleontol. N 6, Middle Cambrian Spongiae, p. 281, Smiths. Miscell. Coll. vol. 67, N 6.

Hazelia cf. *palmata*, Walcott (Pl. I, f. 17. Pl. III, f. 20).

Hazelia palmata Walcott, 1920, Smiths. Miscell. Coll. Vol. 67, N 6 p. 282, pl. 69, f. 1, 1a—e, pl. 67, f. 2.

Material: 1 specimen in the Geological Museum of the University Tartu (Dorpat)[2]).

Locality and Horizon: Järve, kuckersite quarry, Estonia, Kuckers stage (C_2)[3]). Middle-Ordovician[4]).

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1) The material I collected in the summers of 1917 and 1919 from the uppermost shale and marly limestone beds, 1—3 metres from the surface in the kuckersite quarries in the Kuckers District.

4—5 tons of shale from the oil-shale quarries in Järve, from a depth of 2—3 metres from the surface, was transported at the end of 1919 to London for chemical investigation. It was kept at the Esthonian Legation and there I was able to split up nearly 2 tons of the shale. Many new species and records I got in this way such as: new species of *Pholidops, Pseudopholidops, Strophomena, Nematotrypa spiralis, Diplotrypa lamellaris,* the sponge *Hazelia* cf. *palmata, Plumulites* (named by T. Mc. Withers *P. estonicus* W.) etc.

In September 1920 I collected abundant additional material from the quarries of Järve and Vanamôisa, as also near Jôhvi (Jeve) and near Tallinn (Reval).

2) In the following descriptions G. M. U. Tartu or Geol. Mus. Univ. Tartu.

3) „ „ „ „ Kuckers stage = C_2 (of F. Schmidt).

4) „ „ „ „ M. Ordovic = Middle Ordovician.

Measurements: Diameter of strands 0.2 mm. Diameter of the frond 11 and 21 mm.

Description: The skeleton is a flattened layer on the shale surface (Pl. III, f. 20); the irregular, undulating fibrous strands form something like a meshwork, with more or less elongated interspaces (Pl. 1, f. 17). Near the border on the side of the frond in the delicate meshwork of the sponge seems to lie the pointed basal portion.

The spicules are not preserved in this species from the Kuckers stage, but the frond closely resembles Walcott's species.

Bryozoa.

Gen. *Protocrisina* Ulrich.

Protocrisina Ulrich, 1890, Geol. Surv. Illinois, vol. VIII, p. 369.
" " 1911, R. S. Bassler, The early Paleoz. bryozoa of the Baltic Prov., 77 Bull. U. St. Nat. Mus., p. 71.

Protocrisina disposita sp. n. (Pl. VIII, f. 16, 17, 18).

Diagnosis: Four rows of zooecial apertures: two on the front, one on each of the borders. Each of the zooecial apertures on the lateral sides of the stem has on its lower end one small aperture. On the noncelluliferous side is a regular row of small elliptical apertures.

Material: Holotype (fragment of a branch) in authors collection. Geol. Mus. Univ. Tartu.

Locality and Horizon: Järve, kuckersite quarry, Estonia. In the kuckersite bed *h.* Kuckers stage. M. Ordovic.

Measurements:	Fragmentary branch.
Diameter	0.5 mm.
Longitudinally zooecial apert. in 1 mm.	2.

Description: There is only a fragment of a stem, but in its essential features it shows so characteristic a structure, that we may be sure we have here an undescribed species. The cross section of the branch is rounded quadrangular. The elliptical, often ovoidshaped, zooecial apertures are in 4 characteristically disposed rows. Two rows on the front of the branch stand close to each other (Pl. VIII, f. 17). On each of the borders is one row of zooecial apertures; each of these apertures has near the lower end a small aperture. It is natural to suppose that above these small apertures have been avicular appendages. (Pl. VIII, f. 16). On the back of the branch in a hollow sulcus are small apertures, of the same size as those described (Pl. VIII, f. 18).

Relations: *P. ulrichi* Bassler described by R. S. Bassler from the Kuckers stage differs as it has only 2 rows of zooecial apertures. *P. exigua* Ulrich, from Borkholm limestone (F_2), shows small pores also on the front of the stem, which are more or less irregularly dispersed as also on the noncelluliferous side.

Gen. *Lioclema* Ulrich.

Lioclema Ulrich, Geol. surv. Illinois, vol. 8, 1890, pp. 376, 425.

Lioclema spineum ramosum, var. n. (Pl. VI, f. 14—18).

Lioclema spineum Bassler, 1911, Early Paleoz. Br. of the Balt. Prov. 77, Bull. U. St. Nat. Mus. p. 248, f. 142.

Diagnosis: Zoarium pointed, branching. Zooecial apertures multiangular; large mesopores less angular. Acanthopores 3—4 to each zooecium, comparatively small, elevated.

Material: Holotype in G. M. U. Tartu.

Locality and Horizon: Järve; kuckersite quarry, Estonia. C_2. M.-Ordovic. In the kuckersite.

Measurements:

Diameter of the circular pointed end of zoarium . 2 mm.
„ „ „ compressed portion of the zoarium higher up . . . . 3—11 „

In 2 mm. longitudinally 5—6 zooecial apertures.

Description: This variety of *Lioclema spineum* bears a very spiny surface, as the acanthopores project fairly high. The acanthopores with circular or quadrangular openings, are usually in the junction between the polygonal zooecia. The large mesopores are usually penta- or sixangular (Pl. VI, f. 14).

A vertical section (Pl. VI, f. 18), for which I had to sacrifice the pointed end of the zoarium, shows the mode of growth and the arrangement of the zooecial tubes from the first growth stages of the zoarium. The zooecial tubes have become filled with matrix in this part of the zoarium. The thread-like axis is well seen in the lower portion; higher up the zoarium is found the usual construction of mature zone of the species: tabulated tubes. In the younger portion of the zoarium diaphragms are met only occasionally. The strong acanthopores are well developed in this portion of zoarium.

Vertical section (Pl. VI, f. 16) from the mature zone of zoarium shows more or less closely tabulated mesopores, sparsely tabulated zooecial tubes near the surface (the actual immature zone of the living specimen) and the more or less equally tabulated central tubes (actual mature zone). The section (Pl. VI, f. 17) has cut a few acanthopores near the surface.

The tangential section (Pl. VI, f. 15) is not successful on account of its obliquity.

Relations: I am disposed to regard this described specimen as an intermediate form between *Lioclema spineum* Bassler and *Lioclemella clava* Bassler. The acanthopores of my specimen agree much more with those of *Lioclemella*, but the habit of growth (*Lioclemella clava* — clubshaped) separates them. *Lioclema spineum* has much larger acanthopores and larger apertures.

Gen. ***Hallopora*** Hall.

For Synonyms see *Hallopora* Bassler, 1915, R. S. Bassler, Bibliogr. Index of amer. Ordovic. and Silurian Fossils. Vol. 2, 92 Bull. U. St. Nat. Mus. p. 1021.

Hallopora dybovsky Bassler (Pl. IX, f. 1—4).

Hallopora dybovsky Bassler, 1911, „Early Paleoz. Br. of the Balt. Prov." 77, Bull. U. St. Nat. Mus., p. 335, pl. 5, f. 1-1e, t. f. 211, 212.

Material: My collection in Geol. Mus. Univ. Tartu.

Locality and Horizon: Kukruse, Estonia. C_2. M.-Ordovic. In the kuckersite.

Description: As an addition to Bassler's description of this species I give the figures of one specimen, which has not the usual hemisphaeric or dome-shaped zoarium of the species, but has a zoarium like a stout branch (Pl. IX, f. 1). The figures (Pl. IX, f. 2—4) of the zoarial surface, tangential and vertical thin sections may be compared by the reader with the figures given by Bassler, and need therefore no further explanation.

Hallopora dumalis Ulrich (Pl. VI, f. 9—13).

See Synonyms in Bassler monogr.: „Early Paleoz. Br. of the Balt. Pr." etc. p. 331, t. f. 207.

Material: G. M. U. Tartu.

Locality and Horizon: Järve, kuckersite quarry, Estonia. C_2. M. Ordovic. In the kuckersite.

Measurements: Length of the fragmentary zoarium 22 mm.
Width „ „ „ „ 2 „

In 2 mm. 4—5 zooecial apertures.

There is no need for a new description of this species. I have been compelled to give the figures and to direct the attention to the two vertical sections (Pl. VI, f. 9, 11) taken from different parts of the zoarium. As we see there are slight differences. In the section from the younger portion of the zoarium the walls of the central zooecial tubes are irregularly flexible (Pl. VI, f. 9); in the older portion the walls of the zooecial tubes are straighter (Pl. VI, f. 11). The mesopores are well-developed (Pl. VI, f. 10).

Gen. ***Diplotrypa*** Nicholson.

For Synonyms see *Diplotrypa* Nicholson, 1915, R. S. Bassler, 92 Bull. U. St. Nat. Mus. v. I, p. 456.

Diplotrypa moniliformis Bassler (Pl. IX, f. 7—9).

Diplotrypa moniliformis Bassler, 1911, Early Paleoz. Br. etc. 77, Bull. U. S. Nat. Mus., p. 321, t. f. 199.

Material: My collection, Tartu, Estonia.

Locality and Horizon: Kukruse, Estonia. Kuckers stage (C_2). M. Ordovic. According to Bassler the species is apparently rare in Jeve limestone (D_1).

Description: The irregularity of the zooecial walls figured and described by Bassler is not so marked in the Kuckers specimen but the tabulation makes me believe that it belongs to the named species. The diaphragms are uniformly distributed in the zooecial tubes and mesopores and stand nearly at equal distances from each other (Pl. IX, f. 7).

In the lower part of the vertical thin section through the centre of the Kuckers specimen (a half of the zoarium I used for the section) we see initial budding stages of the colony (Pl. IX, f. 8). The zooecial tubes, which are growing in different directions (in the centre nearly straight), similar to recent *Lichenopora* of the Cyclostomata, are cut transversely (the rounded apertures on the section) and vertically (the prolonged tubes of the section). The walls of this part of the zoarium are thick. Then in a more advanced growth stage the walls of the zooecial tubes, as we see in the section higher up, become the characteristic structure of the Trepostomata and in the tubes are developed diaphragms, which in some of the tubes are sparsely developed in this portion of the zoarium. The vertical section (Pl. IX, f. 7) is from the mature zone of the zoarium. Fig. 9, pl. IX shows the tangential section of this species.

Diplotrypa westoni Ulrich (Pl. IX, f. 6).

Diplotrypa westoni Ulrich, Bassler, 1911, Early Paleoz. Br. of the Balt. Prov. 77, Bull. U. S. Nat. Mus. p. 323, t. f. 201.

Material: My collection, Tartu (Specimen and thin section).

Locality and Horizon: Kukruse, Estonia. Kuckers stage (C_2). M.-Ordovic.

According to Bassler this species is „Apparently common in the Chasmops limestone at Nittsjö, Rättvik, Dalarne, Sweden and South Bödahamn, island of Oeland".

To recognize the identity of the Kuckers specimen with this species compare Bassler's text fig. 201 f., with the fig. of my vert. section (Pl. IX, f. 6) of the Kuckers specimen, which shows the characteristic angularity of the zooecial walls, also the sparse diaphragms in the zooecial tubes.

Diplotrypa petropolitana Nicholson (Pl. X, f. 1—11).

See Synonyms in Bassler's: 1911 Early Paleoz. Br. of the Balt. Prov. 77, Bull. U. S. Nat. Mus., p. 313, t. f. 192—195.

Material: In the G. M. U. Tartu and my collection.

Locality and Horizon: Kukruse, Järve, Estonia. Kuckers stage (C_2). M. Ordovic. In the kuckersite and marly limestone, abundant.

Description: To show the great variability of this species it seems to me useful to give the figures of vertical and tangential thin sections on Pl. X.

Fig. 1. represents a specimen with unusual mode of growth. The epitheca, concentrically striated, measures 8 cm.; higher up the zoarium grows larger and the diameter of the flattened top is 12 cm. The top of the zoarium bears traces of weathering, possibly on the sea floor, of Ordovician age. There are on the top of the zoarium deep hollows filled up by marly limestone. The height of the specimen is 4 cm.

The vertically cut zoarium of same specimen (f. 1) shows a secondary growth zone.

The vertical and tangential thin sections are from the upper border (mature zone) of same (f. 1) zoarium (Pl. X, f. 2—4). In this portion of the zoarium the mesopores are very closely tabulated, 3—4 diaphragms in the space of a mesopore diameter. The zooecial tubes are sparsely tabulated.

The zoaria of the other specimens for the sections on Pl. X. are hemispherical, often conical. Sometimes the lower portion of the zoarium is slightly narrower, with a hemispherically expanded upper portion. The average diameter of all these specimens is 1—2 cm. Often 3—5 cm.

Vertical thin sections through the centre of the zoarium of two specimens (Pl. X, f. 5 and 9) as also the second growth zone (Pl. X, f. 6), give some idea of the initial growth stages of the zoarium. There are the prolonged young zooecial tubes, without diaphragms, thick walled, as we see on the figures 9 and 6; the mesopores are developed very early (Pl. X, f. 9 and 5).

The zooecial tubes never grow straight up, except in large zoaria in the mature zone, usually they bend in a different manner and on account of this the vertical sections rarely show a zooecial tube in its full length. The same is to be said about mesopores.

The mesopores are less densely tabulated in the young portion of the zoarium (Pl. X, f. 5 and 9). The vertical section (Pl. X, f. 6) from the same zoarium as f. 5. shows clearly bordered two growth zones. In the mature part of the first zone the mesopores are much closer tabulated than in the younger portion or the beginning of the second growth zone of the zoarium (Pl. X, f. 5).

The zooecial tubes have sometimes nearly straight walls, but the angularity of the mesopores is usually more constant and deflects also the walls of the zooecial tubes.

In tangential sections we see usually the polygonal apertures of the zooecial tubes; often the tubes are attached, but usually separated by the mesopores of very irregular size and shape (Pl. X, f. 4. 8). Often the angularity of the zooecial tubes increases to such extent that the apertures of the tubes appear in tangential section almost circular or elliptical (Pl. X, f. 11.).

Diplotrypa lamellaris, sp. n. (Pl. IX f., 10, 11).

Diagnosis. Zoarium irregularly expanded, lamellose. In the expanded portions, more or less evidently growing in two superimposed layers. The central portion of zoarium thickened, stem-like rounded in transverse section. Zooecial walls thick, mesopores closely tabulated.

Material: Fragmentary specimens in Geol. Mus. Univ. Tartu. Authors collection.

Locality and Horizon. Järve, kuckersite quarry; Estonia. Kuckers stage (C_2). M. Ordovic. In the kuckersite bed *h*.

Measurements:

Thickness of the central portion of zoarium . . . . 1 cm.
„ „ „ lamellose expansion . . . . . . 1—3 „
In 2 mm. . . . 5—6 zooecial apertures.

Description: The zooecial apertures on the surface of zoarium are usually sixangular. Two zooecial tubes are rarely in contact. The dividing dark line in the walls of zooecia and mesopores appears distinctly on the tangential section (Pl. IX, f. 11). The apertures of the mesopores of the same section appear more or less uniformly small; most of them are quadrangular, but there are 3-, 5- and 6-angular mesopores.

The vertical section (Pl. IX, f. 10) shows closely tabulated mesopores, 2—3 in the space of a diameter of the mesopore. The zooecial tubes are without diaphragms or have these in the upper part of the zooecium. The same section shows the biserial mode of growth of the zoarium in its expanded lamellose portion.

Gen. ***Dittopora*** Dybovsky.

Dittopora Dybovsky, 1877, Die Chaetetiden der Ostbalt. Silur-Formation, p. 84.
„ „ , 1911, The early Paleoz. Br. of the Balt. Prov., 77 Bull., U. St. Nat. Mus., p. 301.

Dittopora magnipora, sp. n. (Pl. VI, f. 1—8).

Diagnosis: Zooecial apertures irregularly shaped, often with rounded lobes, rarely oval. Peristomes of the apertures on the surface of zoarium more or less distinct. Large acanthopores surround the zooecial apertures and are in the interspaces in the angles of the mesopores; the walls of the mesopores are not seen on the surface.

Material: Holotype in the G. M. U. Tartu. Authors collection.

Locality and Horizon: Järve, kuckersite quarry, Estonia. Kuckers stage (C_2). M. Ordovic. In the kuckersite.

Measurements:	1-st spec. (Pl.VI, f. 1)	2-nd spec.
Length	25 mm.	10 mm.
Width at the base of zoarium	1 „	4 „
„ „ „ top „ „	2.5 „	5 „
Zooecial apertures, longitudinally in 2 mm.	5—6	5
„ „ transversally „ „	2—3	

Description: Two well preserved fragmentary specimens, one with the pointed basal portion (Pl. VI, F. 1. 2) found in the kuckersite. The end of the zoarium (Pl. VI, F. 1) is incurved. The basal portion is an upturned cone (Pl. VI, f. 2) with irregularly scattered acanthopores; some of these are inconspicuously larger then others. Regular zooecial apertures appear 3—4 mm. from the end.

The surface of the zoarium appears rough by presence of the considerably elevated large acanthopores, which surround the zooecial apertures, 2—4 to each zooecium. The acanthopores often separate the approached zooecial apertures. The interspaces on the surface are solid, no visible mesopore walls (Pl. VI, f. 4).

The zooecial apertures are rarely rounded-oval, common are irregularly shaped apertures.

Internal structure is similar to that of *Dittopora colliculata* (Eichwald). Vertical section (Pl. VI, f. 5) from the basal portion of zoarium, shows the large acanthopores, usually not filled by calcite; the zooecial tubes are without diaphragms, filled by calcite. In this part of the zoarium mesopores are wanting. The right half of this well-preserved thin section shows the method of growth of the zooecial tubes. Vertical section from the upper part of the same zoarium (Pl. VI, f. 3) exhibits closely tabulated mesopores; their diameter is nearly equal to that of the zooecia. The zooecial tubes have only a few diaphragms in this part where they bend from the axial region outwards. In the axial region the walls of the zooecial tubes are flexuous, but less than in the young or basal portion of the zoarium; diaphragms are wanting in the axial portion. A vertical section of another specimen (Pl. VI, f. 8.) shows similar structure; on the left side of the figure are two acanthopores. In the axial portion the walls of the zooecial tubes are not preserved; it is filled by calcite. This zoarium shows a false hollow of the stem, which we often meet with in the branches of *Homotrypella instabilis* Ulrich from the same stage.

The tangential section (Pl. VI, f. 6) shows the angular network formed by the walls of the mesopores. The acanthopores are in close contact with the zooecial apertures; walls of these and of the acanthopores are clearly seen in the section; they are thicker than the walls of the mesopores. Other acanthopores are in the interspaces in the angles of the mesopores. A tangential section of the other specimen (Pl. VI, f. 7.) taken close to the surface of the zoarium, shows no mesopore walls; these are concealed by solid tissue.

Relations: There is the fact that the two sets of acanthopores, seen in the Gen. *Dittopora*, in this species are almost obscured. But it is interesting to remark, that the described species has acanthopores of three or more sizes, but there is no distinctly marked difference in the size of them. Among large and conspicuous acanthopores are those of medium and of still smaller size.

The similarity of the vertical sections of *Dittopora colliculata* (Eichw.), (Bassler, Early Paleoz. Br. Balt. Prov. etc., p. 307, f. 189 b) and of my species (Pl. VI, f. 3) must be noted. The hemisepta in Bassler's figures (Bassler, Early Pal. etc. t. f. 189 b. and 190 c.) are, as I believe, broken fragments of diaphragms.

It is interesting to note the similarity of the vertical sections from the basal portion of the described species (Pl. VI, f. 5) and of *Lioclema spineum ramosum* (Pl. VI, f. 18).

Gen. *Chasmatopora* Eichwald.

Chasmatopora Eichwald, 1860, Lethea Rossica, vol. I, p. 370.
„ „ 1911, R. S. Bassler, The early Paleoz. Bryozoa of the Balt. Prov., 77 Bull., U. St. Nat. Mus., p. 169.

This gen. of the Fam. *Phylloporinidae* as many other requires special study.

In the material, I have at my disposal, may be noticed two types. Seen in transverse sections one type has the zooecial tubes more or less regularly disposed on one side of the zoarial rounded branch; this type could include all species of the gen. *Chasmatopora*.

The other type is with zooecial tubes irregularly disposed throughout the whole branch of zoarium. This type could include the species of the gen. *Phylloporina* Ulrich.

As it proves the shape of fenestrules is the most constant of the specific characters.

The character of the surface in immature and mature zones of the zoarium differs often considerably.

Chasmatopora furcata Eichwald (Pl. VII, f. 1--6, pl. XII, f. 4).

Polypora furcata Eichwald, 1860, Lethaea Rossica, vol. 1, p. 378, pl. 23, f. 11 a. b.
Chasmatopora furcata (Eichwald), 1911, Bassler, Early Paleoz. Br. of the Balt. Prov., 77. Bull. U. S. Nat. Mus. pl. 12, t. f. 87.

Material: In the G. M. U. Tartu.

Locality and Horizon: Järve, Kukruse, kuckersite quarries, Estonia.

Kuckers stage: (C_2) M.-Ordovic. In the kuckersite abundant.

Measurements:

Diameter of the branches	0.5	mm.
Width of anastomoses. .	0.1—0.3	„
Length of fenestrules . .	1—5	„
Width „ „ . .	0.5—1	„

In 1 cm. are usually 3—5 fenestrules.

In 2 mm. longitudinally 8--9 zooecial apertures.

Description: The fenestrules are prolonged elliptical or triangular or prolonged angular; their size varies greatly. The zooecial apertures are in the mature zone of zoarium (Pl. VII, f. 1) of variable size and often more or less angular; the celluliferous side of zoarium bears 4 or more rows of zooecial apertures. In the younger part of zoarium the apertures are elliptical, and on the surface between the apertures there are often fine ridges. In the younger part of the zoarium the noncelluliferous side bears parallel fine grooves (Pl. VII, f. 4), between which are longitudinal rows of elevated granules with minute apertures in the centre; they are often confused with regular ridges. In the more mature zone also (Pl. VII, f. 3) the granules are in more or less regular parallel rows, but the grooves are wanting.

The transverse section of a branch from a well-preserved part of zoarium, (Pl. VII, f. 5, 6) shows 4 spaces of the zooecial tubes disposed regularly on one side of the zoarial branch: well preserved specimens show on other side of the transverse section a group of fine pores, which are transversly cut tubules of the pores of the noncelluliferous side.

Sometimes (Pl. VII, f. 1) on the celluliferous side of the branches are small pores in the interspaces of the zooecial apertures, often near the lateral borders of these; they suggest the places of attachment of avicularia of recent bryozoa. The noncelluliferous side of such a specimen is shown on Pl. VII, f. 3.

Chasmatopora punctata, sp. n. (Pl. VII, f. 7—11).

Diagnosis: The fragmentary zoarium is a reticulate expansion. The fenestrules are rhomboidal in outline. The zooecial apertures are surrounded by numerous pores. On the noncelluliferous face are pores distributed irregularly or in longitudinal rows.

Material: Holotype in Geol. Mus. Univer. Tartu.

Locality and Horizon: Järve, kuckersite quarry, Estonia. Kuckers stage (C_2); M.-Ordovic. In the kuckersite.

Measurements: Length of fenestrules 1.5—2 mm.
In 2 mm. longitudinally 10 zooecial apertures.

Description: The zoarium builds a flattened reticulate expansion on the surface of the shale. Most of the fenestrules are rhomboidal (Pl. VII, f. 7). The fine branches of the zoarium are circular, often slightly compressed. The elliptical zooecial apertures are in 3 more or less regular longitudinal rows. The zooecial apertures are encircled by numerous minute pores, about 9 or 10 to each aperture, pores are also in the interspaces (Pl. VII, f. 9). The peristome of the zooecial aperture is poorly developed.

The noncelluliferous side of the zoarial branches is covered with irregularly distributed granules (Pl. VII, f. 8); often the granules or pores are in longitudinal rows.

On the transverse section (Pl. VII, f. 10, 11) we see zooecial tubes in cross section, in well preserved parts of zoarium of very regular disposition (Pl. VII, f. 11): 2 large transversly cut tubes, with small tubes between these. A other figure is a section from a slightly compressed branch (Pl. VII, f. 10).

Comparison with other Estonian species of *Chasmatopora*. The fenestrules are similar to those of *Ch. tenella*, but the noncelluliferous side of *Ch. tenella* is longitudinally striated and this species has no pores regularly encircling the apertures on the celluliferous side. *Ch. reticulata* has smaller fenestrules and the noncelluliferous side is also longitudinally striated. *Ch. furcata* differs in the shape of the fenestrules, and the absence of the minute encircling pores around the apertures.

Gen. *Phylloporina* Ulrich.

Phylloporina (Ulrich) Foerste, 1887, Bull Sc. Lab. Denison Univers. vol. 2, p. 150.
„ Ulrich, 1890, Geol. Surv. Illinois, vol. 8 pp. 399, 639.

Genotype: *Phylloporina granistriata* Ulrich.

Phylloporina granistriata Ulrich (Pl. VII, f. 12—15, Pl. XII, f. 3).

Phylloporina granistriata Ulrich, 1890, Pal. of Illinois, P. 639, pl. XXIX, f. 3—3 a.

The original description of Ulrich: „Zoarium an undulating expansion, consisting of more than ordinarily rigid, slender branches, from 0.3—0.5 mm. in width, that inosculate at rather long but irregular intervals. Fenestrules narrow, with an average length of about 4 mm. but varying from 2—6 mm. Width from 0.2—0.7 mm. Reverse side with fine, granulose, longitudinal striae. Celluliferous side not seen. Zooecia (in section) tubular, arranged in 3 rows. Apertures circular, with a small peristome, 0.09 mm. in diameter. 10—11 in 2 mm. Rows of cells separated by slightly elevated carinae, bearing 1 small acanthopore to each zooecium."

Material: G. M. U. Tartu.

Locality and Horizon: Järve, kuckersite quarry, Estonia, Kuckers stage (C_2) M.-Ordovic. In the kuckersite.

Measurements: Width of fragmentary zoarium 25 mm.
Length „ „ „ 10—11 „
Width of the basal stem of zoarium 1.5 „
Length of fenestrules . . . . 0.5—2.5 „
Width „ „ . . . . 0.5—1 „

In 2 mm. longitudinally 8—9 zooecial apertures.

In 1 cm. in the average 5 fenestrules.

Description: The fenestrules are prolonged multiangular more or less like those of *Ch. furcata*, but much smaller (Pl. VII, f. 12, Pl. XII, f. 3).

The celluliferous side of the branches (Pl. VII, f. 13) bears flexuous ridges. The central ridge is stronger than the others. Between the ridges are four longitudinal rows of elliptical or circular zooecial apertures, with poorly developed peristome. Some of the ridges on the sides of the zoarium branch up from the central ridge. In the interspaces are a few acanthopores.

The noncelluliferous side of the zoarium (Pl. VII, f. 14) bears longitudinal grooves, which give the striated character. In the grooves are often acanthopores.

In a transversally cut branch of a zoarium we see (Pl. VII, f. 15) the zooecial tubes in the whole space of the branch. The zooecial tubes show often in tang thin sections diaphragms.

Phylloporina papillosa, sp. n. (Pl. VIII, f. 23, 24, 25).

Diagnosis: Zoarium a reticulate expansion. The comparatively small fenestrules elongated angular of rather regular outlines. The branches are rounded triangular. The zooecial apertures in rather regular 4 longitudinal rows. In the middle portion of the branch, separating at each side 2 rows of zooecial apertures, is a slightly elevated ridge with papillae at regular intervals. The reverse side is longitudinally striated.

Material: Holotype in authors collection, Geol. Mus. Univ. Tartu.

Locality and Horizon: Kohtla-Järve, kuckersite quarry. Estonia. In the kuckersite. Kuckers stage (C_2). M. Ordovic.

Measurements: Length of fenestrules . . 1.5—2 mm.
Width „ „ . . 0.5—1 „

In 1 mm. longitudinally 4 zooecial apertures.

Description: The fenestrules of the fragmentary zoarium are generally elongated elliptical, but there are often more irregular, slightly angular fenestrules. The zooecial apertures of the triangular branches (in cross section) are elliptical, with a slightly raised epistome. In the centre, between two associated zooecial rows is a ridge with prominent papillae at same distance from each other as the zooecial apertures (Pl. VIII, f. 23). In the direction of the longitudinal axis of the branch the slopes of the papillae are gentle, laterally they are abrupt. The reverse side is striated, on better preserved portions of zoarium the striae are subparallel; they bear also small papillae (Pl. VIII, f. 24). No small pores (acanthopores) are seen, as are usually seen in *Chasmatopora*.

In transverse section (Pl. VIII, f. 25) of a branch we see transversly cut zooecial tubes distributed irregularly.

As distinction from *P. granistriata* Ulrich may be mentioned the papillose ridge on celluliferous side as also the smaller size of fenestrules.

Gen. *Polypora* M'Coy.

For Synonyms see *Polypora* M'Coy, 1915, R. S. Bassler, 92 Bull., U. St. Nat. Mus., p. 1021.

Polypora quadrata, sp. n. (Pl. VII, f. 16—20, Pl. XII, f. 4).

Diagnosis: The fenestrules are quadrangular. The branches of zoarium more or less parallel. The celluliferous side with 4 rows of zooecial apertures, the circular apertures have a peristome. The reverse side often has a central ridge.

Material: Holotype in my collection.

Locality and Horizon: Kukruse, Estonia. Kuckers stage (C_2). M.-Ordovic. Rare in the kuckersite.

Measurements:

Width of the fragmentary zoarium	10	mm.
Length „ „ „	18	„
„ of the fenestrules	1—2	„
Width „ „ „	0,5—1	„
Diameter of the zoarial branches	0,5—0,75	„
„ „ „ anastomoses	0,1	„

In 1 mm. longitudinally 4 zooecial apertures.

Description: It is difficult to determine the complete shape from the fragmentary zoarium (Pl. XII, f. 4): it may have been funnel-shaped or a flabellate expansion. The branches are more or less parallel, they are united by numerous anastomoses at right angles, forming quadrangular prolonged fenestrules. The convex celluliferous face bears circular zooecial apertures (Pl. VII, f. 16) in more or less regular rows. The apertures have an elevated peristome. Reverse side is less convex (Pl. VII, f. 19); in the middle of this side, longitudinally to the axis, is a carina or ridge. On some parts of the branches the ridge is wanting (Pl. VII, f. 18). The transverse section of a branch (Pl. VII, f. 20) shows that the zooecial tubes in the branches are close to the noncelluliferous side from where they bend outwards (not figured in section).

Comparison with related species. The shape of the zoarium resembles the zoarium of a *Fenestella;* but the described species has no carina between the two zooecial rows, as *Fenestella.* Near by related to the described species is *Polypora incepta* Hall. (See: Bassler[11]); the shape of zoarium is similar, but on the noncelluliferous face of *Polypora incepta* we see striated structure, which, except the central ridge, is wanting in my species. On the fig. of Dr. Bassler we see no peristomes; the described species has distinct peristomes.

The general shape of zoarium separates this species from *Chasmatopora* and *Phylloporina.*

Gen. ***Pseudohornea*** Roemer.

For Synonyms see *Pseudohornea* Roemer, 1915, R. S. Bassler, 92 Bull., U. St. Nat. Mus., p. 1054.

Pseudohornea bassleri sp. n. (Pl. VII, f. 21—24, Pl. XII, f. 1).

Diagnosis: The zoarium is bush-like, dichotomously branching, growing as other Pseudohorneas from a flat basal expansion. The oblique zooecial apertures are arranged in 5 longitudinal rows. The noncelluliferous side is covered with irregularly distributed small papillae, which have minute apertures in the centre.

Material: Holotype in the Geol. Mus. Univ. Tartu.

Locality and Horizon: Järwe kuckersite quarry, Estonia. Kuckers stage (C_2). M.-Ordovic. In the kuckersite bed *f.*

Measurements:

Length of nearly complete zoarium . . .	6 cm.
Width „ „ „ „ . . .	4 cm.
Diameter of the basal portion of the stem.	1,5 mm.
Average diameter of the branches . . .	0,25—1 mm.
Distance between the bifurcations . . .	4—5 mm.
Longitudinally in 2 mm.	6 zooecial apertures.

Description: The nearly complete zoarium (Pl. XII, f. 1) is an expanded bush, dichotomously branching at regular intervals. The branches are more or less circular in cross section.

On the celluliferous side of zoarium (Pl. VII, f. 22) are rows of oblique zooecial apertures. The walls between the apertures are not very thick. The shape of apertures is often elliptical.

The noncelluliferous side of zoarial branches (Pl. VII, f. 21) is covered with irregularly scattered papillae (on some parts of zoarium they are in flexuous rows); the papillae are usually elliptical, with gentle slopes and apertures on the top in the centre. On some parts of the noncelluliferous face may be found single or double zooecial apertures of the usual size (Pl. VII, f. 21).

On a rough vertical section (Pl. VII, f. 23) we see zooecial tubes spreading from a thin lamina; this and the walls of zooecial tubes are white in the greyish calcite mass, which has filled the zoarium. The other side of the vertical section shows minute white tubules in the grey calcite; some of the tubules are communicating. The usual direction of the tubules is the direction of the long axis of zoarium, except where they bend outwards and open on the papillae.

On the transverse section (Pl. VII, f. 24) we see zooecial tubes in cross section; the shape is rounded-irregular.

Comparison with other Estonian species of Pseudohornea:

Pseudohornea orosa (see Bassler's: Early Paleoz. etc. 1911, p. 174) differs in all from the described species.

For comparison of *P. bifida* and *P. bassleri* I have figured the noncelluliferous face of *P. bifida* (Pl. VII, f. 27), the celluliferous side (Pl. VII, f. 26) and the cross section of a zoarial stem (Pl. VII, f. 28).

Gen. ***Nematopora*** Ulrich.

For Synonyms see *Nematopora* Ulrich, 1915, R. S. Bassler, Bibliogr. index of american Ordovic. and Silurian Fossils, 92 Bull., U. St. Nat. Mus., p. 850.

Nematopora ramosa, sp. n. (Pl. VII, f. 29, 30, 31).

Diagnosis: The branching of the zoarium is distichous. The rows of zooecial apertures are separated by striated interspaces. The zooecial apertures are far remote (longitudinally) from each other.

Material: Holotype in G. M. U. Tartu.

Locality and Horizon: Kukruse; kuckersite quarry, Estonia. Kuckers stage (C_2). M.-Ordovic. Rare in the kuckersite.

Measurements:

Length of the fragmentary zoarium	6,5 mm.
Diameter of the main stem of zoarium	0,5 „
„ „ „ „ „ of branches . . .	0,25 „
Distance of the branches from each other . .	0,75—1,0 „

Angle of branching rarely 90°, usually 58°—60°.

In 2 mm. longitudinally 3—3,5 zooecial apertures.

Description: The branching of the zoarium is distichous. The zooecial apertures are elliptical; they are in 7 longitudinal rows around the stem (Pl. VII, f. 29). The rows of zooecial apertures are between linear ridges.

On the transverse section (Pl. VII, f. 31) we see 7 transversely cut zooecial tubes; from the same section is clearly shown the ridged surface of zoarium.

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Comparison with other Estonian species of Nematopora: The described species differs from all other species in Estonia by its mode of branching. The zooecial apertures, too, are more remote from each other (longitudinally) than in the other species. The grooves between the zooecial apertures relate this species to *N. bogoljubovi* mihi (H. Bekker, pt. I, 29), but it differs by the absence of transverse ridges in the grooves and by the far more remote zooecial apertures longitudinally.

Nematopora granosa Ulrich (Pl. VIII, f. 19—22).

Nematopora granosa Ulrich, 1890, Journ. Cinc. Soc. Nat. Hist. vol. XII, p. 196.
" " " 1895, Geol. of Minnes., Paleont., vol. III, pt. I, p. 205, pl. III, f. 17—20.

Material: Fragmentary specimen in authors collection; Geol. Mus. Univ. Tartu.

Locality and Horizon: Järve; kuckersite quarry; Estonia. Kuckers stage (C_2). M.-Ordovic. In the kuckersite.

Measurements: Diameter of zoarium . . 0,2 mm.
Longitudinally in 1 mm. 3 zooecial apertures.

Original description of Ulrich: „Zoarium ramose; branches bifurcating at rather long intervals, from 0.25—0.38 mm. in diameter, the smallest quadrangular in cross section and with only four rows of zooecia; those of the average size, pentagonal, and with five rows of cells. Zooecial apertures small, narrow, about seven in each range in 2.5 mm., enclosed by a series of minute granules. Longitudinal interspaces with a small number of similar granules. Rows of apertures separated by more or less well-developed straight or slightly flexuous granulose ridges.

Form. and Local.: Galena shales, near Cannon Fall, Minnesota."

Description: The estonian specimen is rounded quadrangular (in cross section) with four rows of zooecial apertures (Pl. VIII, f. 22): in the longitudinal interspaces are 2 rows of granules; the elongated elliptical zooecial apertures are encircled by minute elongated granules (Pl. VIII, f. 20. 21).

This species seems to be related with *N. consueta* Bassler (pt. l, 18, p. 155, f. 76 c. d.) but it is smaller, differs by its more elongated zooecial apertures and the surface ornamentation.

Gen. *Nematotrypa* Bassler.

Nematotrypa Bassler, 1911, Early Paleoz. Br. of the Balt. Prov. 77, Bull., U. St. Nat. M., p. 164.

Nematotrypa spiralis, sp. n. (Pl. VII, f. 32—37).

Diagnosis: The pointed zoarium has a continous elevation in zigzag line around the stem; on this elevation are arranged the zooecial apertures, forming a more or less spirally winding band of zooecial apertures on the zoarium. In the zooecial interspaces and the depressions on the sides of zoarium, are numerous small apertures of angular mesopores.

Material: Holotype in Geol. Mus. Univ. Tartu.

Locality and Horizon: Järve, kuckersite quarry; Estonia. Kuckers stage (C_2), Middle-Ordovic. In the kuckersite.

Measurements:

Length of nearly complete zoarium	103 mm.
Width of the base of complete zoarium	2,5 „
„ „ other parts of zoarium	4—9 „
„ „ the depressions (no apertures) of zoarium	0,5—1 „
„ „ „ band with zooecial apertures . . .	1 „

In 2 mm. 6—7 zooecial apertures.

Description: The appearance of this fine specimen is unique. The zoarium is slightly flattened, possibly compressed, and the elevations on the borders are highest. The lower part of the zoarium is broken, but the general shape of the portion left from the end leaves no doubt that it has been pointed (Pl. VII, f. 32). The bands of zooecial apertures on the elevations of the spire (Pl. VII, f. 36) are connected by bands of zooecial apertures in front and on the back of the zoarium. The irregularly scattered ovoidal zooecial apertures (Pl. VII, f. 34) are separated by numerous small angular mesopores. The walls of the zooecial tubes are thin, on the surface of the zoarium they give the appearance of low peristomes. The spaces in the depressions on the sides of the zoarium contain small angular mesopores, often larger than the mesopores in the interzooecial spaces. In small fragments of paratypes, there are in the depressions between the mesopores longitudinal ridges. This feature may be of specific value, but is more probably an individual variation, caused by the arrangement of the mesopores in more regular rows. Near the base the zoarium of the described species is striated (Pl. VII, f. 37). In this portion the zooecial apertures are sparsely distributed.

The vertical section (Pl. VII, f. 33) shows the bending zooecial tubes, which spread from a thread-like axis. In the immature zone of the zooecial tubes are blunt, often clubshaped, hemisepta. The interzooecial spaces seem to be filled by vesicular tissue, produced by closely and irregularly tabulated mesopores. Very similar is the vertical section (Pl. VII, f. 35) of a paratype, mentioned before.

Comparison of the vertical sections of this species with the vertical section of *Nematotrypa gracilis* Bassler (Early Paleoz., Br. Balt. Prov. p. 165, f. 83 e) leaves no doubt that my species belongs to the named genus. More, there is the external similarity (compare Bassler's figure 83 b, c with my figures 36 on pl. VII).

But there are sufficient strong specific characters for the described specimen as: nonbranching zoarium, arrangement of zooecial apertures, more abruptly bending (internally) zooecial tubes. I have found no pores in the walls of my specimen.

Gen. ***Graptodictya*** Ulrich.

For Synonyms see *Graptodictya* Ulrich, 1915, R. S. Bassler, Bibliogr. index etc., 92 Bull., U. St. Nat. Mus., p. 567.

Graptodictya bonnemai jaervensis var. n. (Pl. VIII, f. 1—4).

Graptodictya bonnemai Bassler, 1911, Early Paleoz. Bryozoa of the Balt. Prov. 77, Bull., U. S. Nat. Mus., p. 123, pl. 8, f. 3; t.-f. 48.

Diagnosis: The bifoliate zoarium, dichotomously branching at irregular intervals has ovoidal zooecial apertures. The pointed ends of the apertures are directed downwards. The zoarial margins are very narrow.

Material: Geol. Mus. Univ. Tartu.

Locality and Horizon: Järve, kuckersite quarry, Estonia. Kuckers stage (C_2). M.-Ordovic. In the kuckersite.

Measurements:

Length of fragmentary zoarium	2,5 cm.
Width of branches	1,75—2 mm.
Thickness of branches (shorter diameter of cross section)	0,75 mm.
In 2 mm. — longitudinally	5—5,5 zooec. apert.
Transversly in 1 mm.	7 rows of zooec. aper.

Description: The zooecial apertures are distinctly ovoid, directed with the pointed end downwards. The zooecial apertures are quite close to each other, leaving very narrow interspaces (Pl. VIII, f. 2).

Striking is the regularity of the diagonal zooecial rows; each of such diagonal row contains 7—11 zooecia. The margins of the zoarium are very narrow, striated. The vertical section is a typical section of very regular structure, of *Graptodictya bonnemai* (Pl. VIII, f. 4).

Comparison with related species. I have examined a large number of typical *G. bonnemai*, nearly one of the commonest bryozoa in the kuckersite, and found that its zooecial apertures are pointed at both ends, sometimes nearly hexagonal, or if the one end is pointed, it is turned upwards (see Bassler „Early Paleoz. Br. etc.“, Pl. VIII, f. 3).

Graptodictya minima sp. n. (Pl. VIII, f. 5—8).

Diagnosis: The bifoliate minute zoarium dichotomously branching bears on each side 5—6 rows of zooecial apertures. The zoarium branches at moderately long intervals.

Material: Holotype in Geol. Mus. U. Tartu.

Locality and Horizon: Järve and Kukruse, kuckersite quarries, Estonia, Kuckers stage (C_2). M.-Ordovic. In kuckersite and marly limestone.

Measurements: Length of zoarial fragments	5—15	mm.
Diameter of zoarium . . .	0,3—0,5	„
In 1 mm. longitudinally . .	4	zooec. apert.

Description: The minute zoarium may easily be taken for a *Nematopora*, but closer study will show that it belongs to the gen. *Graptodictya*. To be sure of this it is only necessary to compare the vert. section of my specimen (Pl. VIII, f. 8) with Bassler's figure (Bassler's „Early Paleoz. Br. of the Balt. Prov.“, p. 123, f. 48 b — right part of the figure).

The surface of the zoarium has 5—6 longitudinally arranged rows of zooecial elliptical apertures, with peristomes. The sharpened ends of the apertures are connected by ridges on the surface and in the interspaces are ridges (Pl. VIII, f. 5). The margins are developed in the zoaria but very narrow (Pl. VIII, f. 6); the shape of the zoarium in transverse section is seen on Pl. VIII, f. 7.

Gen. ***Pachydictya*** Ulrich.

Pachydictya E. O. Ulrich, 1882, Journ. Cinc. Soc. Nat. Hist., vol. V, p. 152.

„ „ 1890, „Paleoz. Bryozoa“ Geol. Surv. Illinois, vol. VIII, pt. 2.

„ „ 1915, R. S. Bassler, 92 Bull., U. St. Nat. Mus., p. 928.

Pachydictya irregularis, sp. n. (Pl. VIII, f. 9—15).

Diagnosis: The bifoliate, transversly cut elliptical zoarium has irregularly distributed zooecial apertures on both sides. The transverse and vertical sections are of a typical *Pachydictya.*

Material: G. M. U. Tartu.

Locality and Horizon: Kukruse, Estonia; Kuckers stage (C_2). M.-Ordovic. In the kuckersite.

Measurements:

Width of fragmentary zoarial branches . 2,5—3 mm.
In 2 mm. longitudinally . . . . 5—6 zooec. apertures.

Description: The fragmentary zoarium is figured on Pl. VIII, f. 9. From one of the branches springs off a young branch. This branch (Pl. VIII, f. 13), enlarged, is grooved. In the grooves are elliptical zooecial apertures in longitudinal rows. Between the grooves on the elevations are often some apertures. On the mature zone (Pl. VIII, f. 10) we see the zooecial apertures distributed irregularly on the surface of the zoarium. A few of the apertures are very close to the margin of the zoarium. The shape of the zooecial apertures has become nearly circular, with a slightly elevated peristome. The interspaces are finely punctured.

The transverse section is with a median lamina, the tubules in this lamina are not visible (Pl. VIII, f. 11).

A vertical thin section (Pl. VIII, f. 15) shows fine pores in the walls of the zooecia. The structure of walls is laminated, composed of horizontal laminae.

Pl. VIII, f. 14 tang. thin section shows the zooecial apertures more elliptical shaped, with walls and the pores.

By the irregularly disposed zooecial apertures this species differs from all other species of *Pachydictya* in Estonia.

Most related to this species is *Pachydictya kuckersensis* Bekker (see H. Bekker[29], pt. I, p. 329, pl. VII, f. 1—6). It differs from *P. kuckersensis* by its irregularly scattered zooecial apertures; by zooecial apertures which are often on the margins.

The surface of the described species is similar to *Euspilopora ? barrisi* Ulrich[12], but the internal structure differs.

Brachiopoda.

Gen. ***Lingula*** Bruguière.

Lingula ovata M'Coy.

Lingula ovata M'Coy, 1864—5, Davidson, Brit. Foss. Brachiop., p. 38, pl. 11, f. 19—23.

Material: 1 Spec. in Geol. Mus. Univ. Tartu.

Locality and Horizon: Järve, kuckersite quarry, Estonia. Kukers stage (C_2). M.-Ordovic. In marly-limestone.

Gen. ***Pholidops*** Hall.

Hall and Clarke, 1892, Paleontol., Geol. Surv. of New-York, vol. VIII, pt. I, p. 155.

Pholidops infrasilurica Huene (Pl. II, f. 1—3).

Pholidops infrasilurica Huene, 1899, Verh. d. russ. K. Mineral-Gesellchaft St. Petersb., II. Ser., 36. Bd., p. 268, pl. II (X), f. 18 a, b.

Material: Geol. Mus. Univ. Tartu.

Locality and Horizon: Järve, kuckersite quarry. Kuckers stage (C_2). Fairly abundant in kuckersite. M.-Ordovic.

		Dors. v.	Ventr. v.
Measurements:	Length . . .	2,25 mm.	(fragm.)
	Width	1,5 „	1,5 mm.

Description: The specimens which I referred to this species agree nearly with the descriptions and figures of v. Huene, except the position of the posterior adductor scars of dorsal valve, which in my specimens are not so high up in the apical cavity as figured by Hyene. Further, in my specimens (Pl. II, f. 2) the elongate median scars separate also the posterior adductors, which Huene has found close together.

The *ventral* valve is almost as figured by Huene (Pl. II, f. 3). In my specimen the muscular area is more angular. The anterior adductors are confused, clearly marked are the posterior adductors, but of different shape from those figured by Huene.

Pholidops estona sp. n. (Pl. II, f. 4, 5).

Diagnosis: Muscular area rounded quadrangular. The scars elongated eliptical. From the united ends of the anterior adductors proceeds a short rostellum.

Material: Geol. Mus. Univ. Tartu.

Locality and Horizon: Järve, kuckersite quarry, Estonia. Kuckers stage (C_2). M.-Ordovic. In the kuckersite; well preserved specimens rare.

		Dors. v.	Ventr. v.
Measurements:	Length . . .	2,25 mm.	2,25 mm.
	Width	1,3 „	1,3 „

Description: The muscular area of *ventral* valve (Pl. II, f. 4) is rounded quadrangular. The posterior adductor scars are elongated elliptical. The central adductors are not developed, or more probably not preserved. The anterior adductors have left an elongated mark with uniting ends in the centre of the valve; from the united ends a short rostellum is directed towards the anterior end. Near the anterior end we find a central mark: two rib like processes, of obscure meaning.

The *dorsal* valve shows a tendency (Pl. II, f. 5) for the anterior and posterior adductor scars to become separate; the continuous band, slightly or more abruptly bent, which unites the mentioned scars, loses here its continuous character. The muscular area is less sharply defined. The eliptical marks of anterior adductors stand separated nearly in the centre of the valve. The posterior adductor scars are visible as elongated, club shaped marks above the anterior adductors. The elongate median scars are not preserved or are wanting.

The valves in the kuckersite specimen were close together, as figured for *Ph. elegans* (Pl. II, f. 8); this is often the only more or less sure indication that the unarticulate valves belong to the same species.

Pholidops elegans sp. n. (Pl. II, f. 6—9).

Diagnosis: Valves with slender apical portion. Large anterior adductors of dorsal valve united with the small posterior adductors by slightly curved parietal bands.

Material: Geol. Mus. Univ. Tartu.

Locality and Horizon: Järve, kuckersite quarry, Estonia. Kuckers stage (C_2). M.-Ordovic. In the kuckersite.

		Dors. v. (f. 6)	Dors. v. (f. 8)	Ventr. v. (fragm.)
Measurements:	Length	3 mm.	1 mm.	—
	Width	2 „	0,5 „	1,5 mm.

Description: The *dorsal* valve (Pl. II, f. 7, 8) shows in the apical cavity two closely opposed posterior adductor scars, which are united by two fine bands (parietal?) with the larger anterior adductors, nearly in the middle of the valve. The elongated median scar we see in the smaller specimen (Pl. II, f. 8).

The exterior of the valve is concentrically striated; at the apex the striae or growth lines are naturally more crowded (Pl. II, f. 6). The posterior end of the valve is more or less sharply pointed, the apical angle is 50—55°.

The supposed *ventral* valve (Pl. II, f. 9) shows in the muscular area a rhomboidal mark, bordered by the parietal band; $^1/_3$ of shell length from the beak are the anterior adductor scars, from these two bands proceed to the beak and may touch in the apical cavity the posterior adductor scars, these are not preserved in the specimen.

The interior of dorsal valve is similar to that of *P. infrasilurica*, but the slender shape differs considerably.

Pholidops obtusa sp. n. (Pl. II, f. 10, 11).

Diagnosis: Apex of valves obtuse, broadly trapezoidal. Rostrum of ventral valve comparatively strong.

Material: Holotype in Geol. Mus. Univ. Tartu.

Locality and Horizon: Järve, kuckersite quarry, Estonia. Kuckers stage (C_2). M.-Ordovic. In the kuckersite.

		Dors. v.	Ventr. v.
Measurements:	Length . . .	2 mm.	2,25 mm.
	Width . . .	1,5 „	1,75 „

Description: Ventral valve (Pl. II, f. 10). Shell ellipsoidal, beak very obtuse, broad, with rounded edges. The central adductor scars must have been strong; they have left in the centre of the valve two deep circular depressions. The posterior scars are not preserved in the described specimen. From the central marks proceed towards the beak, two slightly curved bands (parietal), broader just above the central scars and with small depressions there; these are possibly marks of the anterior adductors. Below the central adductor scars is a comparatively strong rostrum.

Dorsal valve (supposed). Shell ellipsoidal, beak broad, lower than the beak of the ventral valve. The anterior and posterior adductor scars are connected by a band as in *Ph. elegans*, only the scar marks are smaller. The mark of the linear median scar proceeds from the centre of the valve nearly to the border of the beak; anteriorly this mark does not traverse the elevated strong anterior margin of the muscular area.

Pholidops curvata sp. n. (Pl. II, f. 12, 13).

Diagnosis: Upper margin of central border, below the beak curved. Besides 2 pairs of anterior and posterior adductor scars, there are marks of central adductors.

Material: Holotype in Geol. Mus. Univ. Tartu.

Locality and Horizon: Järve, kuckersite quarry, Estonia. Kuckers stage (C_2). M.-Ordovic. In kuckersite.

		Dors. v.	Ventr. v.
Measurements:	Length . . .	2,3 mm.	2,25 mm.
	Width	1,5 „	1,5 „

Description: Ventral valve (Pl. II, f. 12). Shell ellipsoidal; beak broadly triangular. The contact border below the beak slightly curved towards the anterior end. Nearly about the middle of the valve are two central adductors. The posterior adductor scars are in the apical cavity below the contact border. Between these scars, in the middle of the connecting band are 2 marks, possibly the anterior adductors. The anterior parietal scar connects the central scar, with a curve towards the anterior end. Outside the muscular area, in the anterior part of the valve, are concentric striae, indicating, that the valve is externally striated. The concentric striae are crossed by a few coarser radial striae (palleal marks?).

Dorsal valve (Pl. II, f. 13). The central border below the beak is curved similar to the opposite valve. There seems to be a pedicle furrow (also in the opposite valve), but it is really a shell fissure. The anterior and central scars are widely divergent, from the anterior scars two bands proceed towards the apical cavity where the posterior scars are not visible. Between the central scars are two elongated median scars.

Gen. ***Pseudopholidops*** Gen. n.

Genotype: *Pseudopholidops scutellata* sp. n.

Diagnosis: The valves generally of the shape and size of *Pholidops:* ellipsoidal, with a terminal sharpened or obtuse beak. In dorsal valves occurs a pair of muscular scars, the obliqui interni, as in *Pseudocrania.* The muscular scars are usually separated. There is no strongly limited muscular area, as often in *Pholidops*.

Pseudopholidops scutellata sp. n. (Pl. II, f. 14, 15).

Diagnosis: Valves ellipsoidal, obtuse beak. Muscular marks separated. Single and double growth lines on surface alternate.

Material: Holotype in Geol. Mus. Univ. Tartu.

Locality and Horizon: Järve, kuckersite quarry, Estonia. Kuckers stage (C_2). M.-Ordovic. In the kuckersite.

		Dors. v.	Ventr. v.
Measurements:	Length . . .	3 mm.	—
	Width	2 „	—

Description: Dorsal valve: Shell most convex near the apex. Beak terminal, trapezoidal. The border of contact is strongly developed posteriorly in the apical region. Towards front of the shell it gently slopes and disappears in the anterior part of valve. Outlines of valve ellipsoidal, beak obtuse.

The surface is marked by concentric striae (Pl. II, f. 15) in this order: a slightly elevated growth line (or stria) is followed by a smooth (but seen under microscope it is minutely striated) interspace, then a double growth line, again the smooth interspace followed by single growth line etc. The surface is as seen different from the surface of *Pholidops*.

The interior shows separated muscle scars; there is no connecting parietal band as in *Pholidops*. The anterior adductor scars are nearly in centre of the shell; they are separated by elongated median scars. The posterior adductors are in the apical cavity below the beak. Between these scars is a heartshaped callosity (as in some species of Obolus) and just above the ant. add. scars a pair of strong marks, possibly marks of *obliqui interni* (on fig. 14, Pl. II o. i.) as in *Pseudocrania antiquissima* Eichw. (See v. Huene, op. 1), pushed only in the described species more to the centre of valve. Between the post. adductors in the centre is a small mark possibly the mesenteric, as in *Pseudocrania divaricata* (See: Davidson, op. 2).

Ventral valve unknown.

Pseudopholidops complicata sp. n. (Pl. II, f. 16, 17).

Diagnosis: Valves elliptical, more or less acuminate beaks. Ventral valve with triangular muscular area. Anterior adductors elongated; contact border encircles the valves. Muscular scars in dorsal valve separated.

Material: Geol. Mus. Univ. Tartu.

Locality and Horizon: Järve, kuckersite quarry, Estonia. Kuckers stage (C_2). M.-Ordovic. In kuckersite.

		Dors. v.	Ventr. v. 1. specim.	Ventr. v. 2. specim.
Measurements:	Length . . .	2 mm.	3 mm.	2 mm.
	Width . . .	1,3 „	1,75 „	1 „

Description: Ventral valve (Pl. II, f. 16): The interior is marked by a triangular muscular area. Anterior adductors of elongated shape, nearly in centre of valve. Posterior adductors in the apical cavity near the contact borders, which here encircle the valve. Just below the beak, from the apical cavity proceeds to the anterior end a divergent then uniting mark of obscure meaning. *Dorsal* valve (supposed) (Pl. II, f. 17) has anterior adductors nearly in centre of valve. The separated posterior adductors are clubshaped turned with the finer ends to the beak. From a median callosity just below the anterior adductors two bands proceed towards anterior end and nearly reach the contact border. These are possibly traces of pallial sinuses.

Pseudopholidops pseudocranoides sp. n. (Pl. II, f. 18).

Diagnosis: Valves elliptical. Contact border very narrow. Anterior adductors separated by upper part of rostrum.

Locality and Horizon: Järve, kuckersite quarry, Estonia. Kuckers stage (C_2). M.-Ordovic. In kuckersite.

		Fragm. dors. v.
Measurements:	Length . . .	2 mm.
	Width	1 „

Description: The ellipsoidal *dorsal* valve has a marginal beak. The contact border is very narrow and anteriorly not expressed.

The anterior adductors, nearly in middle of the valve, are separated by upper part of rostrum; just on the end of this rostral process are two scars, possibly *obliqui interni*.

In the apical region are faint marks of posterior adductors. For the general resemblance of the arrangement of muscular scars with *Pseudocrania divaricata Davidson* (see: Davidson, op. 2) is given expression in the trivial name.

Gen. ***Orthis*** Dalman (s. str.).

Orthis sp. (Pl. II, f. 19—25).

Material: Geol. Mus. Univ. Tartu.

Locality and Horizon: Järve, kuckersite quarry, Estonia. Kuckers stage (C_2). M.-Ordovic. In kuckersite.

Measurements:		Dors. v.	Ventr. v.
	Length . . .	8 mm.	13 (?) mm.
	Width. . . .	13 „	24 „

Description: *Dorsal valve* (Pl. II, f. 19—21). Valve convex. Near the apex convexity strongest. Widest at the slightly curved hinge line. The area very narrow and covers only about $^1/_3$ of width of shell (Pl. II, f. 19, 21). The delthyrium obscured by the median callosity between the strong crural plates (Pl. II, f. 21). This callosity extends like a process over the cardinal area (Pl. II, f. 20). It seems to fit in the delthyrium of ventral valve. No muscle marks are visible below the crural plates.

The surface of one remarkably well preserved fragmentary specimen (Pl. II, f. 20, 24) shows on the apex of the valve the protegulum, which has the shape of a broad Obolus and is concentrically striated like many of the Atremata. Further down begin radial corrugations and then strong rounded ribs, crossed transversly by continuous growth lines.

Ventral valve (fragment) (Pl. II, f. 22, 23). There is a half from the similarly convex ventral valve. The hinge line is more or less straight. The cardinal angle of the valve is worn. The apex is slightly curved and higher than the apex of the opposite valve. Below the apex is a triangular slightly concave, primitive area. The delthyrium is possibly elongated (judging from the callosity of opposite valve) like an split. The tooth is trilobed and is supported by an outgrowth of the inner shell layer; this supporting lamina slightly curved, extends nearly to one third of length of valve towards anterior margin of the valve.

Relations: The described specimen resembles slightly the gen. *Plectorthis* Hall, but it seems to belong to a more primitive group as the primitive area shows.

I could not find relatives from the *Eoorthis* and *Protorthis* of Walcott.

Gen. *Platystrophia* King.

Platystrophia lynx Eichw.

Material: 3 specimens in authors collection. Geol. Mus. Univ. Tartu.

Locality and Horizon: Ülemiste, nr. Tallinn (Reval), Jôhvi, Estonia. Kuckers stage (C_2). M.-Ordovic. In marly limestone.

Gen. *Plectambonites* Pander.

Plectambonites schmidti Törnquist, var. *leptelloides*, n. var. (Pl. III, f. 16; Pl. IV, f. 12; Pl. V, f. 9—13).

Diagnosis: The valves concavo convex, the lateral angles auriculate. Outlines of margins rounded triangular. The line from beak about the highest portion of the valve towards anterior margin is hemisphaerical. Widest near the straight or slightly incurved hinge line. Beak incurved. The triangular delthyrium covered by the cardinal process of dorsal valve. The surface transversly striated with stronger ribs at intervals of 1 mm. average. Between two coarser ribs are 9—15 finer, sometimes less than 9. Irregular concentric growth lines are visible specially in anterior part of valves. Very faint concentric wrinkles are often present anteriorly.

Material: Geol. Mus. Univ. Tartu authors collection; Imper. College, London.

Locality and Horizon: Järve, Kukruse; in kuckersite quarries, Estonia. Kuckers stage (C_2). M.-Ordovic. Abundant in kuckersite.

		Specim. on Pl. V, f. 9, 10
Measurements:	Width at hinge line . . .	11 mm.
	Greatest width	13 „
	Length	10,5 „
	Height	6 „
	Thickness	3 „

Description: The area of the *ventral* valve is slightly concave (Pl. V, f. 11); the edges of valve rounded, often slightly auriculate. The incurved beak proceeds 0,5—1 mm. above the area. The triangular delthyrium is 1,5 mm. wide. On angles of the area and delthyrium are small prominent hinge teeth (Pl. IV, f. 12; Pl. V, f. 11).

They are supported by spondylial-like lamellae which enclose the muscular area. These lamellae or dental plates with a curvature to the sides proceed to one third of length anteriorly, then they turn up, become united, then diverging, they enclose the area of adductors. From the muscular area enclosed by the outer lamella, rediate fine striae, often strongly expressed.

The greatest width of valve is 1—2 mm. from area towards anterior margin. The valve is highest nearly in its middle portion. In a great number of specimens the interior of ventral valves is found as figured on Pl. V, f. 11. I found a valve with much more elongated muscular area, figured on Pl. V, f. 11a.

Dorsal valve is concave, with a straight or slightly curved linear hinge line. The cardinal process is broad, triangular, slightly contracted about the hinge line, proceeding towards the anterior margin of the visceral field. The muscular area is not clearly expressed. A prominent feature are the broad, flabellate, strongly elevated on the valve, visceral fields. On the visceral fields are fine striae. To the sides of the cardinal process are well developed dental sockets (Pl. V, f. 11b).

Of interest is the resemblance of the visceral area of dorsal valve with that of *Leptella sordida* Billings (Hall and Clarke, op. 3).

Plectambonites sericea (Sowerby) (Pl. III, f. 21).

Plectambonites sericea (Sowerby), 1892, Hall and Clarke, Brachiop. pl. XV, f. 25—29.

Material: Geol. Mus. Univ. Tartu.

Locality and Horizon: Järve; Kukruse, kuckersite quarry, Estonia. Kuckers stage (C_2). M.-Ordovic. In kuckersite and marly limestone. The commonest of brachiopods in C_2.

Plectambonites quinquecostata M'Coy (Pl. III, f. 14, 15).

Leptaena quinquecostata M'Coy, Davidson, 1864—65, Fossil-Brachiop., p. 322.
Plectambonites quinquecostata M'Coy, O. Holtedahl, 1916, The Strophomenidae of the Kristiana Region, p. 78, p. XV, f. 9.

Material: Geol. Mus. Univ. Tartu.

Locality and Horizon: Järve, kuckersite quarry, Estonia. Kuckers stage (C_2). M.-Ordovic. In kuckersite; not very common.

Plectambonites convexa Pander (Pl. I, f. 16).

Plectambonites convexa Pander, 1830, Beitr. zur Geogn. Russl., p. 91, pl. 19, f. 5.
Leptaena convexa Gagel, 1890, Brachiop. d. cambr. und silurischen Geschichte im Diluv. Ost- u. Westpr., p. 49, pl. III, f. 24.
Plectamb. convexa Pander, 1915, O. Holtedahl, The Strophom. of the Krist. Reg., M. N. Kl. N. 12, p. 78, pl. XIV, f. 9.

Material: 2 specim., authors collection, Geol. Mus. Univ. Tartu.

Locality and Horizon: Ülemiste, near Reval; Kuckers stage (C_2).

Measurements:

	Ventr. v.
Width	10 mm.
Length	8 „
Height	4.5 „

Description: This species from the Kuckers stage near Tallinn (Reval) has nearly rhomboidal outlines; lateral slopes of the convex ventral valve are considerably abrupt. On the preserved portion of surface, on lateral slopes, are seen between 2 stronger striae 5—7 finer striae which are shallowly pitted.

Interior of valve not exposed.

This species closely resembles the species figured by Holtedahl. Closely related to the small forms of *P. schmidti* var. *leptelloides* (abundant in the Kuckers stage), it differs by its more pointed, rounded triangular, apical portion.

Gen. ***Leptaena*** Dalman.

Leptaena rhomboidalis Wilckens (Pl. IV, f. 9).

Leptaena rhomboidalis Wilckens, Hall and Clarke, 1892, Geol. Sur. New-York, Paleontol., vol. VIII, p. 676, pl. VIII, f. 17—31.
Leptaena rhomboidalis Wilckens, O. Holtedahl, 1915, The Strophom. of the Krist. Region, M. N. Kl. N. 12, p. 69, pl. XII, f. 1—12.

Synonyms see:

Strophomena rhomboidalis (Wilck.), Davidson, Brit. Sil. Brachiop., p. 281.
Leptaena rhomboidalis (Wilck.), Schuchert, Synopsis of American Fossil Brachiop., p. 240.

Material: 2 valves (dors. and ventr.) in authors collection, Geol. Mus. Univ. Tartu.

Locality and Horizon: Järve, kuckersite quarry, Estonia. In uppermost marly-limestone. Kuckers stage (C_2). M.-Ordovic.

Measurements:

	Dorsal v.	Ventr. v.
Width	19.5 mm.	21 mm.
Length	13.5 „	13 „

Description: The convex *ventral* valve is posteriorly flattened-convex, bent anteriorly at one third of length from hinge. Corrugations strongly developed. The muscular field is bordered by a lamella, the width of which is more than its length (Pl. IV, f. 9).

The *dorsal* valve shows the exterior. The corrugations are most strong in the middle portion of valve. The surface striae are nearly of uniform size. In posterior portion are some striae stronger with 2—3 finer intercalated.

Relation: The described specimens correspond nearly in size and externally with the specimen from stage 4 of Kristiania Region figured on pl. XII, f. 8 by Holtedahl (see Holtedahl, referred above). Compare also with Hall's figure of a ventral valve (op. 3, pl. VIII, f. 25).

Leptaena estonensis sp. n.
(Pl. I, f. 7, 8; Pl. III, f. 17; Pl. IV, f. 8 and 10).

Diagnosis: Valves normally concavo-convex. The size large. Hinge line nearly straight. Area of the ventral and dorsal valves well developed. Hinge teeth strong, supported by elevated lamellae, which limite laterally the muscular area. More or less continuous corrugations are developed in posterior portion and especially on the lateral borders of the valves.

Material: 3 ventr. v. (exterior), 2 fragm. ventr. v. (interior), 2 dorsal valves (interior) in authors collection; Geol. Mus. Univ. Tartu.

Measurements:

	Ventr. v. (exterior)	Ventr. v. (exter.)	Fragm. ventr. v. (inter.)	Dors. v. (inter.)
Width . .	55 mm.	42.5 mm.	48 mm.	55 mm.
Length . .	40 „	39 „	39 „	39 „

Locality and Horizon: Järve, Kukruse; kuckersite quarries; Estonia. Kuckers stage (C_2). M.-Ordovic. In uppermost marly-limestone and kuckersite.

Description: The material is in the kuckersite usually broken; it is better preserved in the marly-limestone. The shells have been very thin and fragile.

Ventral valve: The posterior portion is nearly flat, slightly raised in apical region. Nearly at one third of length of valve from the anterior end it bends at an angle of 100°—130°. The flat posterior portion shows more or less concentric corrugations, in apical region only very faintly marked. (Pl. IV, f. 10).

The surface is marked by strong striae, which are crossed by fine growth lines. Towards apical region and posterior portion of lateral borders striation is nearly uniform, in 1 mm. there are 4 striae. At anterior end a number of striae becomes much stronger; they stand at 1 mm. or a little more from each other; between stronger striae are intercalated, in middle of anterior end of valve, 7—14 finer. Towards lateral borders the stronger striae may stand from each other 1.5—2 mm. with 6—9 intercalated finer striae.

Dorsal valve: A dorsal valve shows the bifid cardinal process and the straight narrow area. The muscular area is posteriorly limited by a slightly raised lamella. In the central portion of the muscular field a thin septum-like ridge extends over half the length of the valve. The adductors show fine borders. In the middle portion of the central disc the continuity of some of the corrugations is interrupted (Pl. III, f. 17).

So far as external features go, this species appears to be closely related to *Strophomena schmidti*, Gagel, of which the interior has not been described; but the outlines of this species is nearly hemisphaerical, while *L. estonensis* shows more or less triangular outlines.

In internal structure it shows relations to *Leptaena rhomboidalis*. The muscular field of the ventral valve is bordered as in latter species, by an elevated margin; the area is also high, at the deltidial opening 3.5 mm. and with longitudinal striae (Pl. I, f. 8). It differs in having not so strong corrugations and by its geniculation.

As a relative may be regarded *L. kjerulfi* Holtedahl (see op. 4) from stage 4bβ, of Gaasø, Baerum, Snarøsund, South of Volden, Asker. But the corrugation of the Kuckers species is less sharply developed while its geniculation is more sharp, than that of *L. kjerulfi*.

Gen. ***Rafinesquina*** Hall and Clarke.

Rafinesquina imbrex (Pander), new descr.

Plectambonites imbrex Pander, 1830, „Beitr. z. geogn. russ. R. St. Petersb." p. 91, pl. XIX, f. 12.

Leptaena imbrex Pander, 1846, S. Kutorga, Dritter Beitr. zur Paleont. Russlands, Aus den Verhandl. d. Mineral. Ges. zu St. Petersb. für d. J. 1845—46, besond. abgedr., p. 32, pl. V, f. 3.

Pander's original description: „Dieselbe äussere Gestalt wie bei den vorigen (*Pl. triangularis:* die Wölbung der oberen Schale so stark, dass sie gleichsam einen Winkel bildet, unter Schale fast ebenso concav.), nur herrscht der Längendurchmesser sehr vor".

Material: Geol. Mus. Univ. Tartu.

Locality and Horizon: Järve, Kukruse, kuckersite quarries; Estonia. Kuckers stage (C_2). M.-Ordovic. In kuckersite and marly-limestone.

Measurements:	f. 2 on Pl. V.	f. 3 on Pl. V.
Length	11,5 mm.	14 mm.
Heigth	6,5 „	9 „
Width (middle valve)	13 „	15,5 „
„ at hinge line	11 „	13,5 „

Description: Valves concavo-convex. Outlines of the convex *ventral* valve rounded quadrangular. Widest (Pl. III, f. 4) and highest in middle of the length. Area narrow, nearly straight. Laterally the valve is slightly auriculate. The delthyrium is triangular, very broad. The surface of valves is finely ribbed. Between 2 stronger are usually 1—3 finer. All these ribs are crossed by close transverse striae. Strong irregular concentric growth lines are seen in the anterior portion of the valve. Profile of valve shows that the highest portion of valve is nearly in the middle of its length (Pl. V, f. 3a). Hinge teeth are developed.

Interior: From the apical cavity a septum-like process proceeds to the end of the outer muscular area. It is enclosed in its upper portion by two incurved marks, which enclose the elliptical area of adductor scars. The septum in the middle of this area shows often a small tubercle (Pl. V, f. 2, 3, Pl. III, f. 2, 3). The area of the two diductor scars is broad, flabellate (Pl. V, f. 2) marked often by strong radiating ribs (Pl. III, f. 2, 3).

On the interior of the concave *dorsal* valve (Pl. III, f. 1) are the elevated laminae (2 pairs) for attachment of the adductors, characteristic of the globose *Rafinesquinae.*

Rafinesquina dorsata, sp. n. (Pl. III, f. 9—13, Pl. V, f. 4—8).

Diagnosis: Valves concavo-convex. The outlines of margins rounded-trapezoidal. The convex ventral valve is highest nearly above the hinge line. From the little incurved beak the valve reaches its greatest height nearly in a straight line, slightly curved in upper part, then it slopes, more or less gently to the rounded anterior margin. The cardinal area is nearly straight. Delthyrium comparatively broad, triangular. It is closed by a deltidium, in shells with both valves. Widest near the anterior margin. Surface of the type of *R. imbrex.* Concentric growth lines very strong.

Material: Geol. Mus. Univ. Tartu: 2 ventr. (inter.); 1 dors. v. (inter.); 2 with both valves. 1 paratype in Imperial College of Science and Technology, London.

Locality and Horizon: Kukruse, Järve, in kuckersite quarries, Estonia. Kuckers stage (C_2). M.-Ordovic. In marly-limestone and kuckersite.

Measurements:	specim. Pl. V, f. 4, 5.	specim. Pl. V, f. 6.
Length	10,5 mm.	11 mm.
Height	8 „	9 „
Width on area	10 „	11 „
Greatest width	13 „	14 „

Description: *Ventral valve* (Pl. III, f. 11, 13): The septum as in preceding species, bears just below the beak in the apical cavity an ovoid callosity (Pl. V, f. 6). Just below it is the elliptical area of adductor scars much smaller than that of *Pl. imbrex.* The broad flabellate diductor scars are less clearly lined than in *Pl. imbrex.* This region is broader than in the preceeding species.

The relation of the dorsal valve to the ventral is shown on the profile (Pl. V, f. 8).

Both valves are usually found together or only the ventral valves. Single dorsal valves are very rare in the kuckersite and marly limestone. By heating one specimen I was able to remove the ventral valve and got the well preserved details of the dorsal valve (Pl. III. f. 9, Pl. V, f. 6a-b).

On pl. III, f. 10 is a well preserved dorsal valve found in marly-limestone from Järve quarry.

The *dorsal* valve is most concave (in relation to ventral valve) $^1/_5$ of length from anterior end of valve. It has a cardinal process which above the hinge line is bilobed, from it proceeds towards the anterior end an elevated septum-like process, sharpened anteriorly (Pl. III, f. 9), possibly for attachment of diductor scars. On the better preserved specimen the septal process is shorter and incurved anteriorly. (Pl. III, f. 10). On the broad, nearly flat area between the central elevation and the sloping borders are two pairs of strong ridge-like elevations or plates for attachment of strong adductor scars.

Rafinesquina jaervensis, sp. n. (Pl. I, f. 23, Pl. III, f. 5—8).

Diagnosis: Valves concavo-convex, dorso-ventrally. Widest on hinge line. Valves as wide as long.

Material: Holotype: Geol. Mus. Univ. Tartu. Authors collection. 9 specimens (2 dors. v. inter., 5 ventr. v. inter., 2 with both valves).

Locality and Horizon: Vanamõisa, Järve, Kukruse; kuckersite quarries; Estonia. Kuckers stage (C_2). M.-Ordovic. In the kuckersite.

Measurements:	Dors. v. (Pl. III, f. 6)	Ventr. v. (Pl. III, f. 5)	smaller specim.
Width at hinge:	9 mm.	9 „	8 „
„ in middle of valve .	8 „	8,5 „	7 „
Length :	8 „	9 „	8 „
Height of the curve . . .	2,5 „	5,5 „	2,5 „
Distance of curve from area	6,5 „	6 „	4 „

Description: *Ventral* valve (Pl. III, f. 5, 7, 8) is highest $1/3$ of its length from anterior end. The posterior slope is very gentle and almost flat (Pl. III, f. 8); the anterior slope is slightly convex and more abrupt. The interior is like the interior of *R. imbrex* (Pl. III, f. 5). The surface is ribbed; between stronger ribs are usually 3—4 finer. All ribs are crossed by fine concentric lines.

The *dorsal* valve (found separately in kuckersite, as an extreme rarity) is very well preserved. (Pl. III, f. 6). The cardinal process is bilobed. (Pl. I, f. 23). The lobes broad, quadrangular. The elevation for diductor scars (medial septum-like process) is separated into two parts. The lamellae for attachment of strong adductor scars are in 2 pairs at the sides of the median elevation. The larger lamella has posteriorly a gentle slope, anteriorly the slope is more abrupt and the lamella bends with a curve outwards to the lateral borders of the valve. This abrupt curvature of the anterior adductor lamallae marks the dorsal valve of this species from the very similar dorsal valve of *R. dorsata*, where the curvature is very gentle.

Gen. *Strophomena* Blainville.

Strophomena cf. *corrugatella* Davidson.

Strophomena corrugatella Davidson, 1866—71, Brit. Sil. Brachiop. p. VII, p. 301, pl. 41, f. 8—14.
„ „ „ 1882—84, Brit. Foss. Brachiop. Sil. Supplem vol. V, p. 192, pl. 15, f. 23—26.
Rafinesquina cf. *corrugatella* Dav., 1916, O. Holtedahl „The Strophom. of the Kristiana Region", p. 29, pl. 9, f. 7.

Material: Geol. Mus. University Tartu.

Locality and Horizon: Järve, kuckersite quarry. Estonia. Kuckers stage (C_2). M.-Ordovic. In oil shale.

Measurements:

Width . . .	26 mm.	27 mm.	24 mm.
Length . . .	15 „	15,5 „	11 „

Description: The estonian specimens have 10—12 stronger ribs, with 10—20 intercalated finer striae. The stronger ribs stand usually 2—3 mm. from each other. After Davidson (see Davidson, Brit. Sil. Br., part. VII, p. 302) „to the more closely striated and corrugated varieties (f. 8) Portlock give the name of *corrugata;* and M'Coy that of *undulata* to those specimens in which the ribs are fewer in number and the interspaces consequently wider (f. 14). These extremes are, however, intimately connected by examples possessing every intermediate characters".

The *ventral* valves of the estonian specimens from Kuckers stage are slightly concave; the greatest width of valves is at the straight hinge line. The lower end is slightly sharper pointed than in the British specimens; in the cardinal edges are strongly marked wrinkles as in the British specimens (Davidson, Suppl. Brit. Foss. Brachiop., vol. V, p. 192, pl. XV, f. 25). The cardinal edges are sharper than in the British specimens.

The British specimens are from: Woodland point, M. Llandovery at Drummock, in the upper Caradoc etc.

Occurrence in Kristiania Region: 5 a, Stavnaestangen, Ringerike, 5 a Herø, Skien — Langesund Distr.

Strophomena asmussi Vern.

Strophomena asmussi Vern. 1916, O. Holtedahl, The Strophom. of the Kristiania Region, p. 51, pl. VIII, 1—3.

Occurence in Kristiania Region: 4 b (transition 4 b α—4 b β) Bratterud, Ringerike.

Material: 2 ventral valves (interior), in authors collection, Geol. Mus. Univ. Tartu.

Locality and Horizon in Estonia: Järve, kuckersite quarry. Estonia. Kuckers stage (C_2). M.-Ordovic. In marly-limestone.

Measurements:

	Kristiania specimens				*Estonia specimens*	
Width	27 mm.	31 mm.	39 mm.	43 mm.	31 mm.	29 mm.
Length	18 „	21 „	23 „	25 „	20.5 „	20.5 „

Undetermined Brachiopod of the ***Strophomenacea.***
(Pl. I, f. 13, 14. Pl. IV, f. 13).

Material: 1 fragmentary ventral valve (interior), 1 nearly complete ventr. valve (exterior), 1 dorsal valve (exterior).

Locality and Horizon: Järve, kuckersite quarry. Estonia. In kuckersite. Kuckers stage (C_2). M.-Ordovic.

Measurements:

	Ventr. v.	Dorsal v.
Width . . .	24.5 mm.	20 mm.
Length . . .	21 „	16 „
Height . . .	5.5 „	

Description: Valves, respectively dorsal and ventral, concavo-convex. Cardinal area straight, well developed. Muscular area of the uniformly convex *ventral* valve comparatively small, below the umbonal region. The teeth are supported by dental lamellae which encircle the muscular area and proceed with a curvature anteriorly (Pl. IV, f. 13); in anterior portion of muscular area between these lamellae is a short prominent septum, which divides and encircles two large pallial fields; in these pallial regions are ridge-like shell callosities, often more or less sub-parallel.

The *dorsal* valve is concave. Its interior not exposed.

The surface (ventr. v., pl. I, f. 14) of valves striated by double ribs, 1—1,5 mm. apart, with 4—8 finer striae between; the spaces between finer striae bear shallow pits. On worn portions of surface are shallow pits disposed in longitudinal rows. The shell structure is fibrous.

Remarkable for this specimen are the pallial fields with shell callosities of ventral valve, encircled by the laminae. By these peculiarities this species resembles *Davidsonia* (Hall and Clarke, op. 4, p. 301, pl. XV^{A}, f. 33). The described species is not attached, as *Davidsonia*, not plano-convex, the dental lamellae are not obscure, the callosities are not grooved by spiral furrows as in *Davidsonia*.

Gen. *Porambonites Pander.*

Porambonites kuckersensis sp. n.
(Pl. I, f. 21, 22; Pl. IV, f. 7; Pl. V, f. 21).

Diagnosis: The convex dorsal and ventral valves respectively with a fold and a sinus. Outline of the flattened (as found usually in kuckersite beds) valves more or less circular. Delthyrium elongated triangular, narrow, crenulated. The surface is striated and bears shallow pits.

Material: Authors collection in Geol. Mus. Univ. Tartu.

Locality and Horizon: Järve, kuckersite quarry, Estonia. Kuckers stage (C_2). M.-Ordovic. In kuckersite and marly-limestone.

Measurements:	Flattened specimens On pl. III, f. 4	Flattened specimens On pl. III, f. 5.	Dorsal valve in marly-limest.
Width . .	57 m.	42 m.	42 m.
Length. .	50 „	38.5 „	42 „

Description: *Dorsal valve*: (Pl. IV, f. 7). The fold is anteriorly very wide. The lip of the fold does not hang over the ventral valve as seen often in other sp. of Porambonites. Outlines of valve posteriorly rounded triangular. The transversly striated area is a little higher and less wide than that of ventral valve. The surface is striated. In 1 mm. are 2—3 striae. In the furrows between the striae, especially in the anterior portion of valve, are oblique shallow pits, which in the anterior region gives a zig-zag line appearance to the striae.

Ventral valve: Outlines of flattened valves more or less circular. The area of the same valve (Pl. I, f. 22) is 2 mm. high, 6 mm. long. It begins not from top of the delthyrium, but a little lower. The interior of the ventral valve (Pl. I, f. 21) has two dental lamellae, which support 2 not very strong hinge teeth. From these lamellae proceed two submedian septa, which anteriorly are only slightly elevated; their length is 23 mm. At a distance of about 17 mm. they curve towards each other only 1 mm. apart, when they bend abruptly and continue in a sub-parallel course as faintly marked lines to a distance $^3/_4$ the length of the valve towards the anterior border.

Between the dental lamellae or spondylia are strongly and well marked scars of two adductors — posteriorly, and 2 diductors — anteriorly.

Related undoubtedly to the described species is *Porambonites schmidti* Noetling, Pl. IV, f. 3, 4 (see op. 5). But the differences are marked enough for the described species as the long crenulated area, the width of the fold, surface striated and with only shallow pits, not the characteristic deep pits or punctures of *P. aequirostris*, *P. schmidti*, the remarkable bending of the median septa in the ventral valve of the described species. *Porambonites schmidti* occurs in the *Jewe* stage (D_1) and gives rise in the Lyckholm stage (F_1) to the large *Porambonites gigas* Schmidt.

Noetling says (*op. cit.* 5, p. 380):

„Die andere breite Reihe beginnt etwas später mit einer noch unbekannten Art des Echinosphaeritenkalkes (C_1), setzt sich im höheren Niveau fort, wo sie durch meist noch unbekannte Arten vertreten ist, und erreicht in F_1, in dem riesigen *P. gigas* das Maximum ihrer Grösse; damit erlischt auch diese Reihe etc.“

It seems obvious that *P. kuckersensis* is one of the large unknown species from C_2.

Porambonites laticaudata sp. n.

(Pl. I, f. 18, 19, 20. Pl. IV, f. 1, 2. Pl. V, f. 22, 23).

Diagnosis: Valves broader than long. Hinge line slightly curved. Delthyrium arched above, broadly triangular. Area elongated triangular to the sides of Delthyrium. The area is laterally slightly sinuated. The surface is marked on the borders (especially distinctly) by fine striae which are anteriorly intercalated. Near the apex and on the flat surface there are oblique elongated pits between the striae.

Material: Holotype in authors collection, Geol. Mus. Univ. Tartu. Fragmentary valves and 1 complete specimen.

Locality and Horizon: Järve, kuckersite quarry. Estonia. Kuckers stage (C_2). M.-Ordovic. In kuckersite and marly-limestone.

Measurements:	Complete specimen	Fragmentary valves
Width	42.5 mm.	40 mm.
Length	38.5 „	
Thickness . . .	29 „	

Description: *Dorsal valve*: This valve is thicker than the opposite valve. Hinge line slightly incurved. The beak is obtusely rounded. The area narrower than that of the opposite valve, it is crenulated. The fold is broader than that of *P. schmidti* from Jewe limestone, but narrower than the fold of *P. kuckersensis* from the same stage. The valve is broadest in middle of its length (Pl. IV, f. 2).

Ventral valve: Sinus of ventral valve correspondingly of the same width as the fold (anteriorly 18 mm.). The beak is slightly sharper than the beak of dorsal valve. As seen on fragmentary valves the delthyrium is arched triangular, the area higher than that of the dorsal valve, crenulated; hinge teeth comparatively strong (Pl. V, f. 22, 23).

Surface of valves striated. In 1 mm. 4—5 striae. The striae are strongest on the fold and in the sinus, anteriorly of valves. The furrows between the striae bear shallow pits. Intercalation of striae is characteristic, especially on lateral borders.

Relations: Nearly related with the described species is *Porambonites bröggeri* Lamanski (see: op. 6). The Kuckers species differs by its more acute apical region, the median septa of the ventral valve are longer.

Porambonites baueri Noetling (Pl. IV. f. 5, 6).

Porambonites baueri Noetling, 1883, Zeitschr. d. deutsch. geol. Gesellsch. vol. XXXV, p. 362, pl. XVI, f. 9—12.

Material: 1 ventral valve in authors collection, Geol. Mus. Univ. of Tartu.

Locality and Horizon: Järve, kuckersite quarry. Estonia; in marly-limestone, containing kuckersite. Kuckers stage (C_2). M.-Ordovic.

Measurements:

	Specimen from Järve, Kuckers stage (C_2)	Near Kukruse I (Jeve stage (D_1))	Aluvere II (Jeve stage (D_1))	near Rakvere III (Jeve stage (D_1))
Length . . .	29.5 mm.	29 mm.	28.5 mm.	26 mm.
Width . . .	23 „	23 „	21.5 „	20.5 „

Description: The typical narrow form, *Porambonites baueri*, which Noetling describes from the Jewe limestone, seems to be represented also in the higher beds of the Kuckers stage. A ventral valve from the marly-limestone, containing kuckersite, corresponds exactly, as show the measurements, with a specimen from Jewe limestone to south of Kukruse. The Kuckers specimen shows, on ventral valve, the characteristic surface structure of *P. baueri* Noetling, as: well developed growth lines, circular pits in longitudinal rows. The kuckers specimen is slightly smaller, than that from the Jewe limestone near Rakvere, figured on pl. IV, f. 5, 6.

Gen. *Lycophoria* Lahusen.

Lycophoria sp. (Pl. I, f. 9, 10, 11).

Material: 1 specim. in authors collection, Geol. Mus. Univ. Tartu.

Locality and Horizon: Järve, kuckersite quarry, Estonia. In the kuckersite bed *k*, Kuckers stage. M.-Ordovic.

Measurements:

Length	12,25 mm.
Width	12,75 „
Thickness (both valves) . . .	10.5 „

Description: Outlines of the biconvex valves nearly rounded-quadrangular. The greatest width of the valves is near the anterior end. (Pl. I, f. 9.)

Surface of the valves is worn; of the shell structure there is little left. On the lateral borders of the valves are fine plications, stronger in the anterior portion, growing fainter posteriorly. On each side can be seen 5 plications. As seen on the worn surface of the ventral valve, the plications have left very faint marks; after these we can suspect that the plications have reached nearly the apical portion of the valve. (Pl. I, f. 11).

Anteriorly the ventral valve is inconspicuously sinuated towards the dorsal valve.

Posteriorly may be noticed the rounded pedicle opening of the ventral valve; the beaks of both valves are very obtuse, but that of the ventral valve is slightly sharper. (Pl. I, f. 10).

Mollusca.

Pelecypoda.

General remark: The lamellibranchs in my collection are all casts of both valves. In the specimens found up to the present nothing is to be seen of the hinge teeth. It is therefore difficult to find the precise relations and all described species are to be regarded as more or less provisional.

Gen. *Aristerella* Ulrich.

Aristerella Ulrich, 1892–96, Pal. of Minnesota, v. III, pt. II, p. 524.

Aristerella nitiduloides, sp. n. (Pl. V, f. 14—17).

Diagnosis: Shells (cast of shells) inequivalve. Beaks obtuse, pointed, straight or very inconsiderably incurved, they project above the hinge line. Ventral and dorsal border almost straight. The posterior end more or less compressed, rounded. Anterior scar distinct, ovoid shaped.

Material: Geol. Mus. Univers. Tartu, authors collection.

Locality and Horizon: Kukruse, kuckersite quarry, Estonia. Kuckers stage (C_2). M.-Ordovic. In marly-limest. and kuckersite.

Measurements:

	Specim. Pl. V, f. 14.	Specim. Pl. V, f. 16.
Length	22 mm.	21 mm.
Length from anterior to lower end	24 „	
Height	26.5 „	
Thickness	13 „	10.5 „
		thickness: right v.
Distance between pointed beaks .	3 „	6.5 „
		„ left v. 3.5 „
Distance of beak from anterior end (left v.).	7 „	5 „
Distance of beak from anterior end (right v.)	— „	5 „

Description: On surface of the casts are traces of concentric growth lines. Anterior muscular scar mark is prominent, ovoid shaped. We conclude naturally that the shells had deeply impressed scars. The cast of right valve is larger, more convex. The beaks stand opposite or that of the right valve stands a little nearer to the anterior end (Pl. V, f. 17). The casts show on the surface from beaks towards the ventral end a slightly prominent ridge, possibly traces from corresponding excavations in shells. The posterior muscular impressions are not visible. The pallial line is faintly marked.

Cardinal area is very slightly incurved, almost straight. On left valve between beak and posterior end is an elongated ridge, possibly as result of a lateral tooth groove in the shell.

The specimen (Pl. V, f. 17) is more distinctly inequivalve. The right valve is nearly twice as thick as the left. Posterior end compressed, nearly alate in this specimen. Anterior end a little more rounded than in specimen f. 14. The beaks are disymmetrical. It is possible this specimen represents a distinct species.

Comparison with *Aristerella nitidula* Ulrich (see: op. 7): The described specimens are by the inequivalvity related to *A. nitidula*. They differ in size. *A. nitidula* are known as small specimens. The beaks in *A. nitidula* are closer to anterior end, not disymmetrical. My specimens have a more pointed lower end.

Gen. ***Cyrtodonta*** Billings.

Cyrtodonta Billings 1858, The Canadian Naturalist and Geologist, vol. III, N. 6, p. 431.

Cyrtodonta (?) rotundata, sp. n. (Pl. V, f. 18, 19, 20).

Diagnosis: Equivalve, nearly circular in outlines. Beaks very obtuse but slightly prominent above the incurved hinge line. Anterior end more compressed than posterior. The anterior scars strongly developed, they are close to ventral margin. The lower end of valves rounded. The valves are thickest $^1/_3$ of length from beaks. Prominent rounded ridge from beaks to ventral end.

Material: My collection, Tartu, Estonia.

Locality and Horizon: Kukruse, kuckersite quarry, Estonia. Kuckers stage (C_2). M.-Ordovic.

Measurements:	Length . . .	21.5 mm.
	Height . . .	21 „
	Thickness . .	13 „

Gen. ***Clionychia,*** Ulrich.

Ambonychia (part.) Hall, 1847, Pal. New-York, vol. I, p. 163.
Clionychia, Ulrich, 1892, American Geologist, vol. X, p. 97.
„ „ 1897, Geol. of Minnes., Paleontol. Vol. III, pt. II, p. 493.

Clionychia cf. lamellosa Hall. (Pl. IX, f. 5.)

Clionychia lamellosa Hall, 1897, Geol. of Minnes., Pal., v. III, pt. II, p. 494, pl. 35, f. 10—14.

Formation and locality in America: Lower Blue and Upper Buff limestones, Beloit, Mineral Point and Janesvill, Wisconsin;

Dixon, Illinois and the upper part of the Trenton limestone at Minneapolis and St. Paul, Minnesota.

Material: 1 specim. in the authors collection, Geol. Mus. Univers. Tartu.

Locality and Horizon: Järve, kuckersite quarry, Estonia. In the „Building limestone". M.-Ordovician.

Gen. *Modiolopsis* Hall.

Modiolopsis aff. *concentrica* Hall and Whitfield.

Modiolopsis concentrica Hall. and Whitfield, 1875, Pal. Ohio, vol. II, p. 86.
„ „ „ 1897, Ulrich, Pal. Minnes., vol. III, pt. II, p. 510. Pl. XXXVII, p. 15—16.

Formation and Locality in America: „A common species in the upper beds of the Cincinnati group at numerous localities in Ohio, Indiana, Kentucky. Probably also in the Hudson River shales near spring Valley, Minnesota".

Material: 1 spec. in my collection, Estonia, Tartu.

Locality and Horizon: Kukruse, kuckersite quarry, Estonia. Kuckers stage (C_2). M.-Ordovic. In marly-limest.

Gen. *Ctenodonta* Salter.

Ctenodonta logani Salter.

Ctenodonta logani Salter, 1859, Canadian Organic Remains, Dec. I, p. 36.
„ „ „ 1897, Ulrich, The Geol. and Nat. Hist. Surv. of Minnes., Paleont. Vol. III, pt. II, p. 591, pl. 42, f. 26—28.

Formation and locality of American species: Upper Buff. limest. of the Trenton formation Beloit. Wisconsin. In Canada the species occurs in the Black River limestone at Pauquettes Rapids, near Ottawa.

Material: My collection (1 specimen).

Locality and Horizon: Kukruse, kuckersite quarry, Estonia. Kuckers stage (C_2). M-Ordovic.

My specimen from Kuckers stage in Estonia has the incurved beaks a little nearer to the anterior end of shell. The shape of the shell-cast is very similar to the figure of Ulrich.

Gastropoda.

Haplospira variabilis Koken.

Haplospira variabilis K. 1897, Koken, Bull. de l'Acad. Etc. Vs., vol. VIII, p. 195, f. 36.

Occurence after Koken: Gräsgårad, Oeland, Eriksöre. In the boulders near Berlin (Chasmops limestone, the same as the limestone in Graesgårad).

Material: Geol. Mus. Univ. Tartu. Authors collection. 1 specimen.

Locality and Horizon: Kukruse, kuckersite quarry. Estonia. Kuckers stage. M.-Ordovic. In marly-limestone.

Cephalopoda.

Orthoceras regulare Schlotheim.

Orthoceras regulare Schl. Foord, 1888, Catal. of Foss. Cephalop. pt. I, p. 5.

Material: 1 fragmentary specimen; authors collection, Geol. Mus. Univ. Tartu.

Locality and Horizon: Järve, kuckersite quarry. Estonia. Kuckers stage (C_2); in bituminous marly-limestone. M.-Ordovic.

Measurements:

Diameter (maxim. of fragm.)	21.5 mm.
Distance between septa in widest portion	12.5 „
Diameter of central siphuncle	3 „

Orthoceras sp. (Pl. V, f. 24, 25).

Material: 1 fragm. specim. in authors collection; Geol. Mus. Univ. Tartu.

Locality and Horizon: Järve, kuckersite quarry, Estonia. Kuckers stage (C_2); in kuckersite. M.-Ordovic.

Measurements:

	Compressed specim. (fragm.)
Diameter (long)	29 mm.
„ (short)	15.5 „
Distance between septa $^1/_7$ of long diameter.	
Diameter of siphuncle (long)	5.5 mm.
„ „ „ (short)	3.5 „

Description: The specimen contained in kuckersite is slightly compressed so that the section (Pl. V, f. 24) is elliptical. The siphuncle is eccentric, but in this specimen it seems to be out of its right position.

Endoceras wahlenbergi Foord.

Endoceras wahlenbergi Foord, 1888, Catal. of Foss. Cephal. pt. I, p. 136, f. 14.

Material: Authors collection: 1 fragm. specimen and 1 siphuncle (identified in the Imper. College of Sc. and Technol., Paleontol. Dept.).

Locality and Horizon: Järve, kuckersite quarry. Estonia. In marly-limestone and kuckersite. Kuckers stage (C_2). M.-Ordovic.

Trilobita Walch.

Gen. ***Asaphus*** Brogniart.

Asaphus ornatus Pomp. (Pl. XI, f. 1).

Asaphus ornatus Pomp., 1901, F. Schmidt, „Rev. d. ostbalt. sil. Trilob." Abt. V., II. Pl. VI. f. 6—13, Pl. XII, f. 25, 26.

F. Schmidt has given a very complete description of the species. According to Schmidt it occurs in the upper portion of the Echinosphaerite limestone (C_{1b}) near Reval, Baltishport, Rogo Odensholm.

Material: Geol. Mus. Univ. Tartu.

Locality and Horizon: Järve, kuckersite quarry, Estonia. Kuckers stage (C_2). M.-Ordovic.

Measurements:

Total length		91	mm.
Length of cephalothorax		21	„
Width „ „		53	„
Length of thorax		39	„
Width „ „		53	„
Length of pygidium		31	„
Width „ „		49	„
Width of rachis of the thorax	near cephaloth.	18.5	„
„ „ „ „ „ „	in the middle	22	„
„ „ „ „ „ „	near pygidium	17.5	„

Asaphus platyurus Ang. (Pl. XI, f. 2).

Asaphus platyurus Ang. 1901, F. Schmidt, Rev. d. ostbalt. sil. Trilob. Abt. V, Lief. II, Pl. III, f. 1—7, pl. XII, f. 19.

According to Schmidt the species occurs (especially the larger form var. *laticauda*) in the upper part of Orthoceratite limestone. (B_3) near Reval, Palms, Malla etc. and lower portions of the Echinospaerite limestone (C_{1a}).

Material: My collection (1 specimen).

Locality and Horizon: Kukruse, kuckersite quarry, Estonia. Kuckers stage (C_2). M.-Ordovic. In marly-limestone.

By comparisons of measurements given by Schmidt for the var. *laticauda*, it seems my specimen belongs to this var.

Measurements:

Total length	14	mm.
Length of cephalothorax	4	„
Width „ „	10	„
Length of thorax	6	„
Width „ „	8	„
Length of pygidium	4	„
Width „ „	7	„
Length of spines	2	„

Asaphus kovalevskii, Lawrow (Pl. XI, f. 3).

Asaphus kovalevskii, Lawrow, 1901—02, F. Schmidt, Rev. d. ostb. silur. Trilob. Ser. 8. 12 p. 52, pl. II, f. 11—17, pl. XII, f. 16—18.

F. Schmidt figures larger specimens and accordingly the eye stalks are comparatively larger and stronger. It occurs according to Schmidt in the lower Echinosphaerite limestone (C_1a).

Material: Geol. Mus. Univ. Tartu. Fragm. of cephalothorax.

Locality and Horizon: Järve, kuckersite quarry, Estonia. Kuckers stage (C_2). In the kuckersite and marly-limestone (bed *n*) rare.

Gen. ***Ampyx*** Dalm.

Ampyx rostratus, Sars. (Pl. XI, f. 14, 15, 16).

Ampyx rostratus Sars, 1894 F. Schmidt „Rev. d. ostb. sil. Trilob.“ ser. VII, t. XLII, N. 5.

Material: Geol. Mus. Univ. Tartu.

Locality and Horizon: Järve, kuckersite quarry, Estonia. Kuckers stage (C_2). M.-Ordovic.

According to Schmidt the species occurs in C_1 and C_2. The figure of a specimen (Pl. X, f. 16) is almost identical with *A. drummuckensis* Reed from Girvan District (See: op. 8).

Gen. *Lichas* Dalman.

Lichas kuckersiana Schmidt (Pl. XI, f. 10).

Lichas kuckersiana F. Schmidt, 1885, Rev. d. ostbalt. sil. Trilob. Abt. II, pl. III, f. 1—5.

Material: Authors collection. G. M. U. Tartu.

Locality and Horizon: Kukruse, kuckersite quarry. Estonia. Kuckers stage (C_2). M.-Ordovic.

The pygidium which I found (Pl. XI, f. 10) differs from a pygidium of same size and from same locality and horizon by width of the rachis on lower end. On F. Schmidts figure the rachis measures towards end of pygidium 7 mm., while on my specimen the width of rachis on corresponding place is 10 mm.

Gen. *Cybele* Lovén.

Cybele kutorgae F. Schmidt (Pl. XI, f. 11).

Cybele kutorgae F. Schmidt, 1882, „Rev. d. ostb. sil. Trilob." VII, ser. t. XXX, p. 217, pl. XV, f. 11.

According to F. Schmidt the species occurs in Jewe stage (D_1) at Perifer, Estonia.

Material: Authors coll., Geol. Mus. Univ. Tartu.

Locality and Horizon: Järve; kuckersite quarry. Estonia. Kuckers stage (C_2). M.-Ordovic. In kuckersite.

Gen. *Cheirurus* Beyr.

Cheirurus macrophtalmus, Kutor. (Pl. XI, f. 12, 13).

Cheirurus macrophtalmus, Kut., 1881. „Rev. d. ostb. sil. Trilob." ser. VII, t. XXX, N. 1, p. 143, pl. VII, f. 1—5, pl. XVI, f. 9.

According to F. Schmidt the species occurs in Echinosphaerite limestone (C_1) in Russia: Wolchow (Duboviki), Gostiliz, Pawlowsk.

Nearly related specimens occur in Estonia at the same horizon in Malla, near Jaggowal.

Material: Geol. Mus. Univ. Tartu.

Locality and Horizon: Järve, kuckersite quarry, Estonia. Kuckers stage (C_2). M.-Ordovic. In kuckersite.

Gen. *Chasmops* M'Coy.

Chasmops praecurrens, F. Schmidt (Pl. XI, f. 4—7).

Chasmops (Phacops) praecurrens, F. Schmidt, 1881, Rev. d. ostb. sil. Trilob. I, p. 98, Pl. II, f. 14, 15, 17.

According to Schmidt the species occurs in Echinosphaerite limestone (C_1).

Material: My collection (1 specimen).

Locality and Horizon: Kukruse, kuckersite quarry, Estonia, Kuckers stage (C_2). M.-Ordovic. In marly-limestone.

Measurements of my specimen:

Total length	12 mm.
Length of cephalothorax	3.5 „
Width „ „	9 „
„ „ thorax (in middle)	7 „
length „ „	7 „
Width of glabella in middle of its length	5 „

F. Schmidt hat not the opportunity to describe the eyes of *Ph. praecurrens*. On the Pl. XI we see the facetted eye and portion of the eye magnified 22 diam. (f. 6). There we see sixangular facetts. There are 21 vertical rows of facetts. The facetts are in this order in the vertical rows:

3 5 5 6 6 7 7 8 8 8 8 8 8 8 7 7 6 6 5 5 3

The total number of facetts is 127.

The facetts of nearly related *Ch. odini* as figured by Schmidt (Rev. etc. I., t. II, f. 9) are circular.

The surface of body of *Ch. praecurrens* is finely granulated.

Gen. *Pterygometopus* Schmidt.

Pterygometopus panderi Schmidt (Pl. XI, f. 8).

Phacops panderi F. Schmidt, 1881, Rev. d. ostb. sil. Trilob. VII. ser., t. XXX. N. 1, p. 84, pl. I, f. 15—17, pl. XII, f. 10—12.

According to Fr. Schmidt the species occurs in Echinosphaerite limestone (C_1) in differ. local. in Russia, govern. Petersburg, in Estonia, near Reval. Osmusaar (Odensholm).

There is nothing to add to F. Schmidt's excellent description. The figure of Kuckers specimen may be compared with Schmidt's figure 15 a. pl. I. („Rev. d. ostb. etc.").

Material: Geol. Mus. Univ. Tartu.

Locality and Horizon: Järve, kuckersite quarry, Estonia. Kuckers stage (C_2). M.-Ordovic. In the kuckersite.

Pterygometopus sclerops ? Dalm. (Pl. XI, f. 9).

Phacops sclerops Dalm., 1881, F. Schmidt, Rev. d. ostb. sil. Trilob., ser. VII, t. XXX, N. 1, p. 77, Pl. I, f. 3—8. Pl. XII, f. 1—4.

According to F. Schmidt the species occurs in Orthoceratite limestone (B_3).

Material: Geol. Mus. Univ. Tartu.

Locality and Horizon: Järve, kuckersite quarry, Estonia. Kuckers stage (C_2), M.-Ordovic. In kuckersite.

Undetermined (Pl. XI, f. 17, 18).

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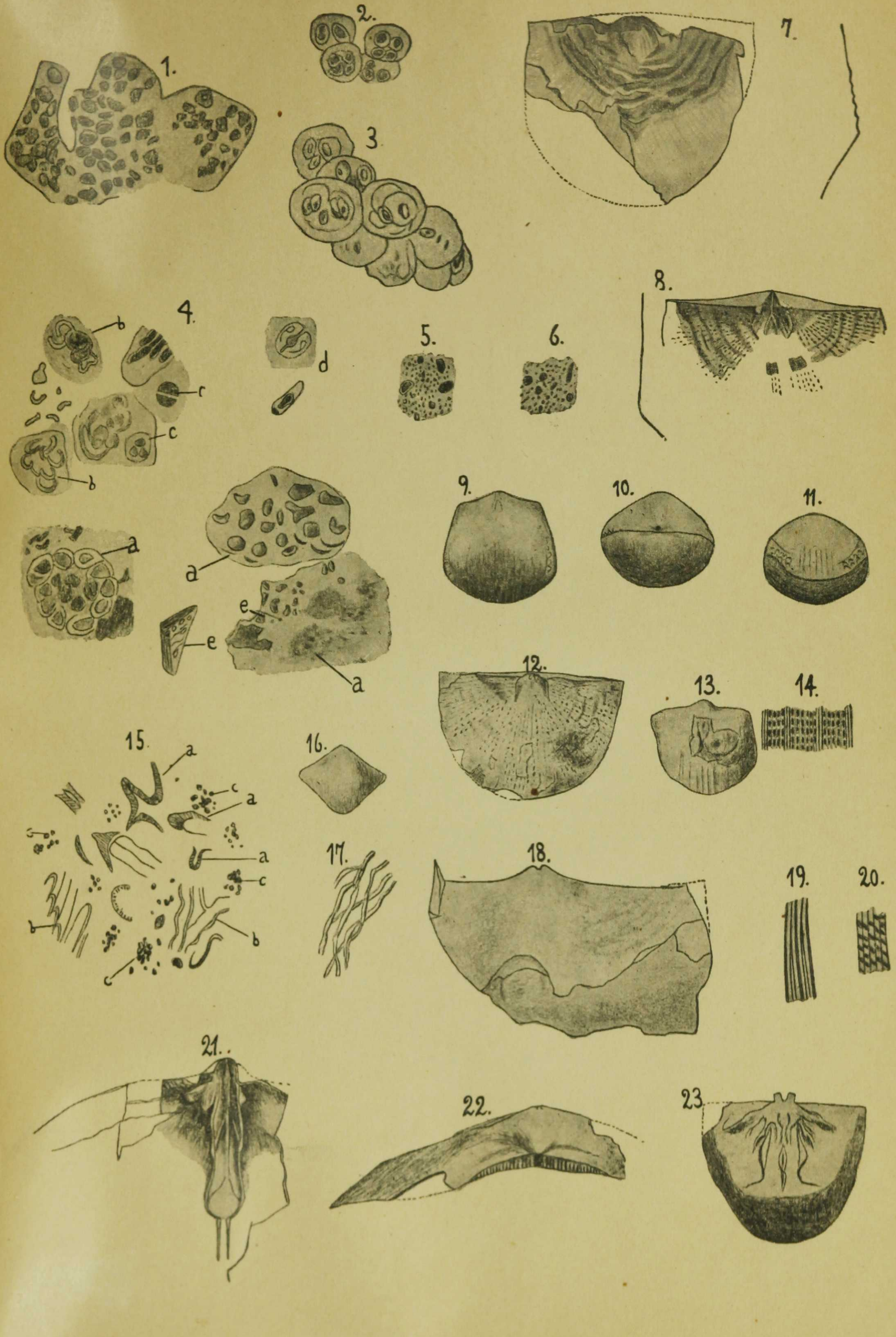
Plates

All drawings on the plates are by the author
The figures on pl. III, IV and XII are photographed by H. Riedel, Tartu

Pl. I.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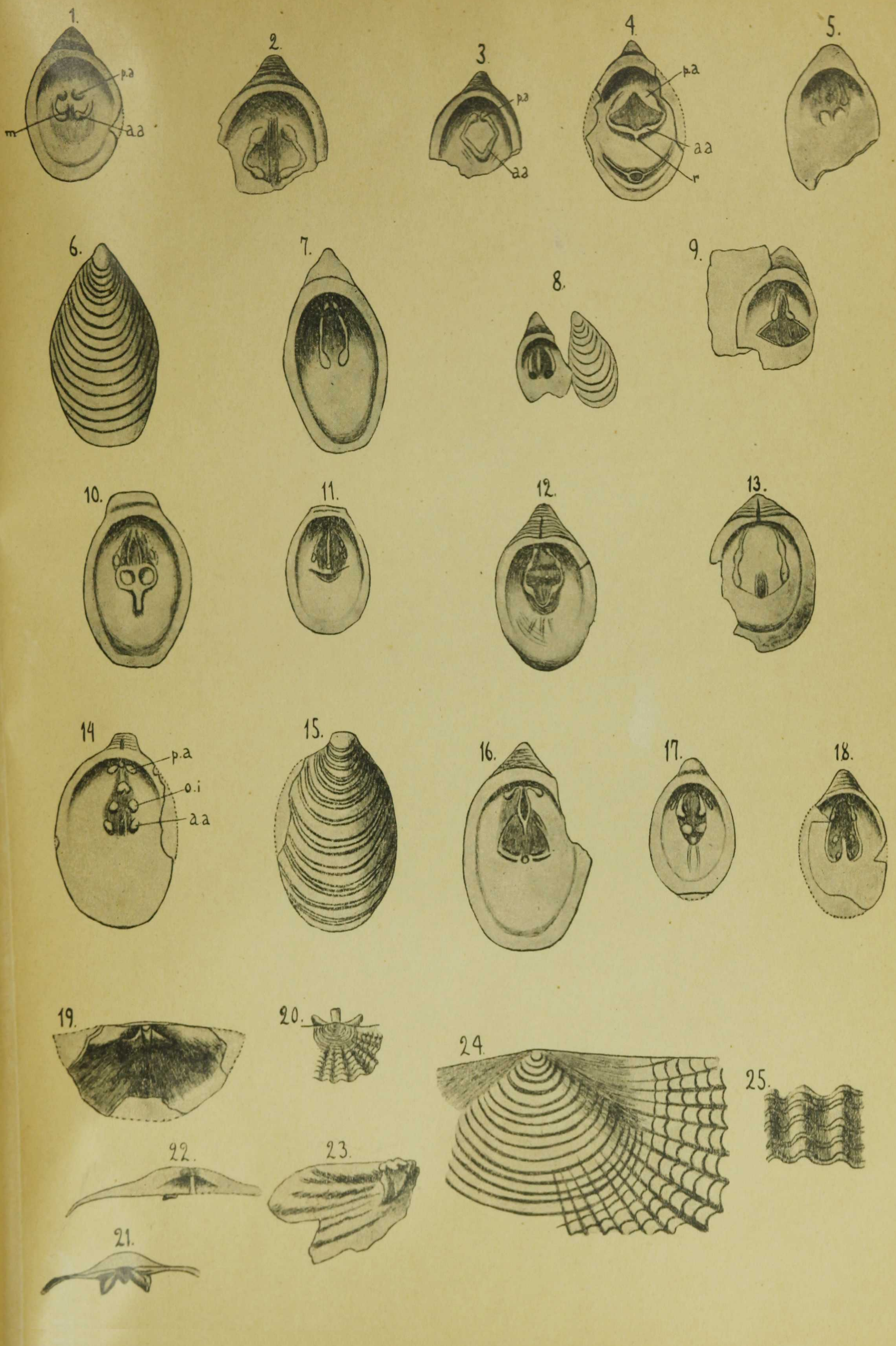
Pl. II.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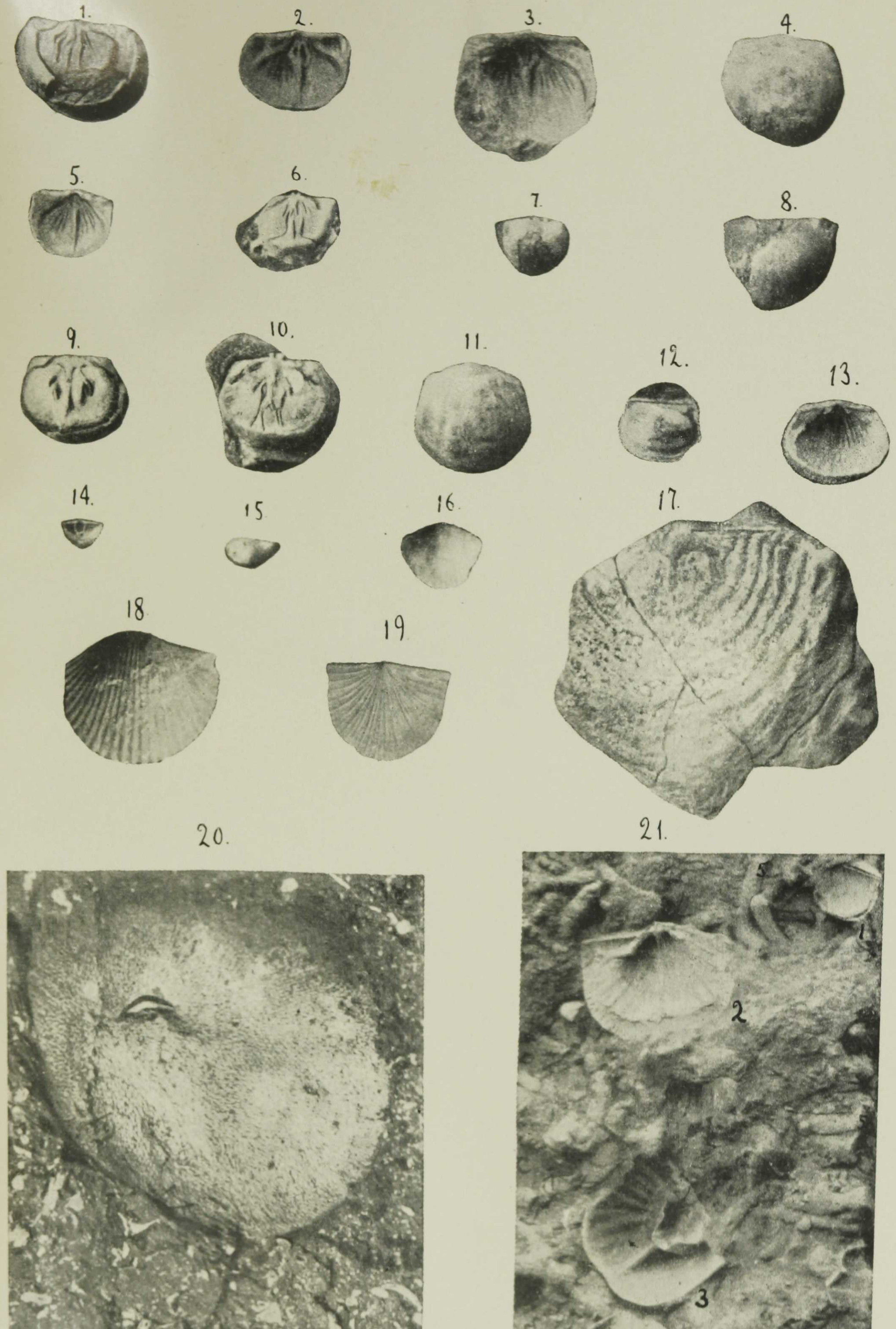
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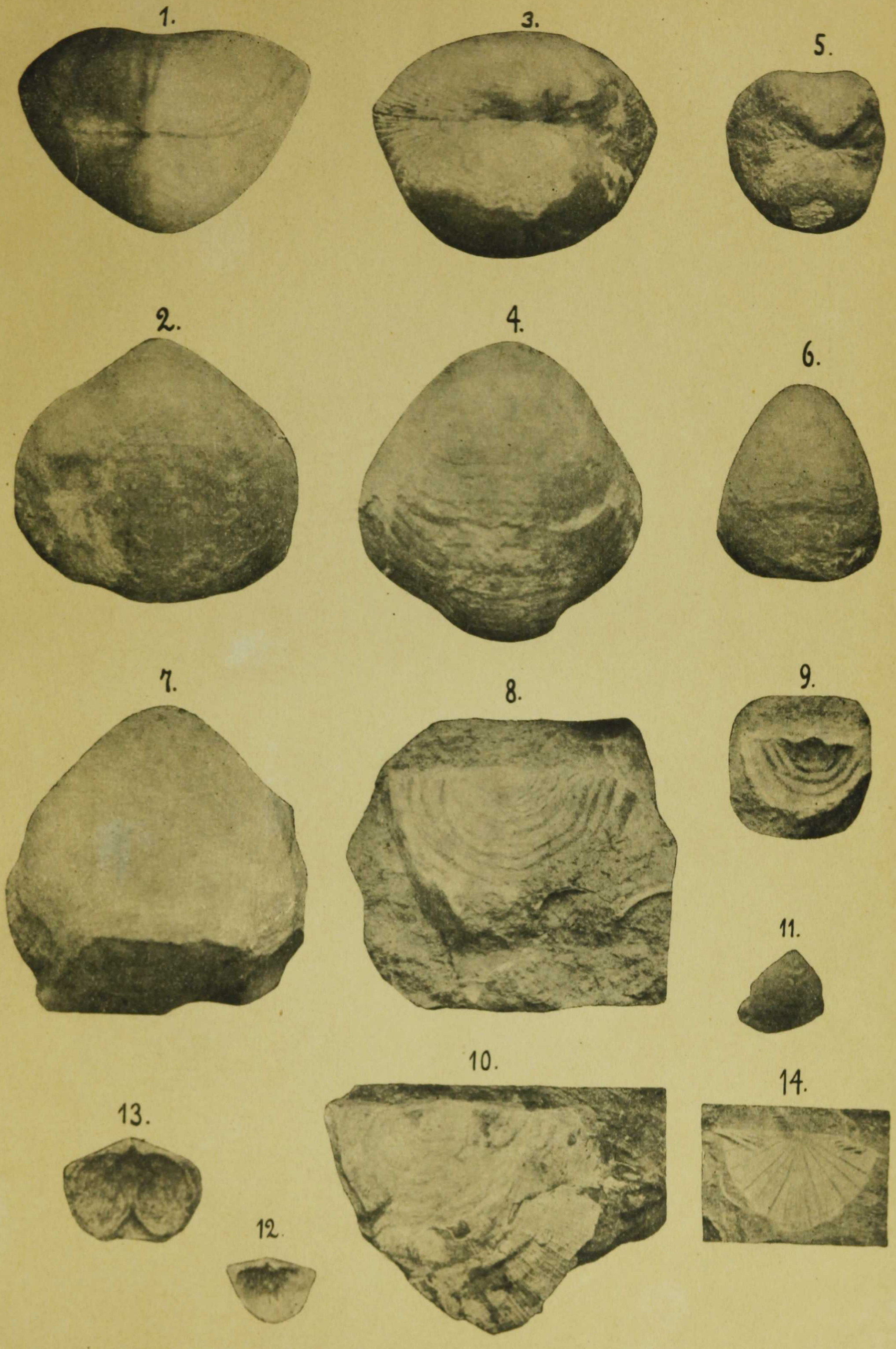
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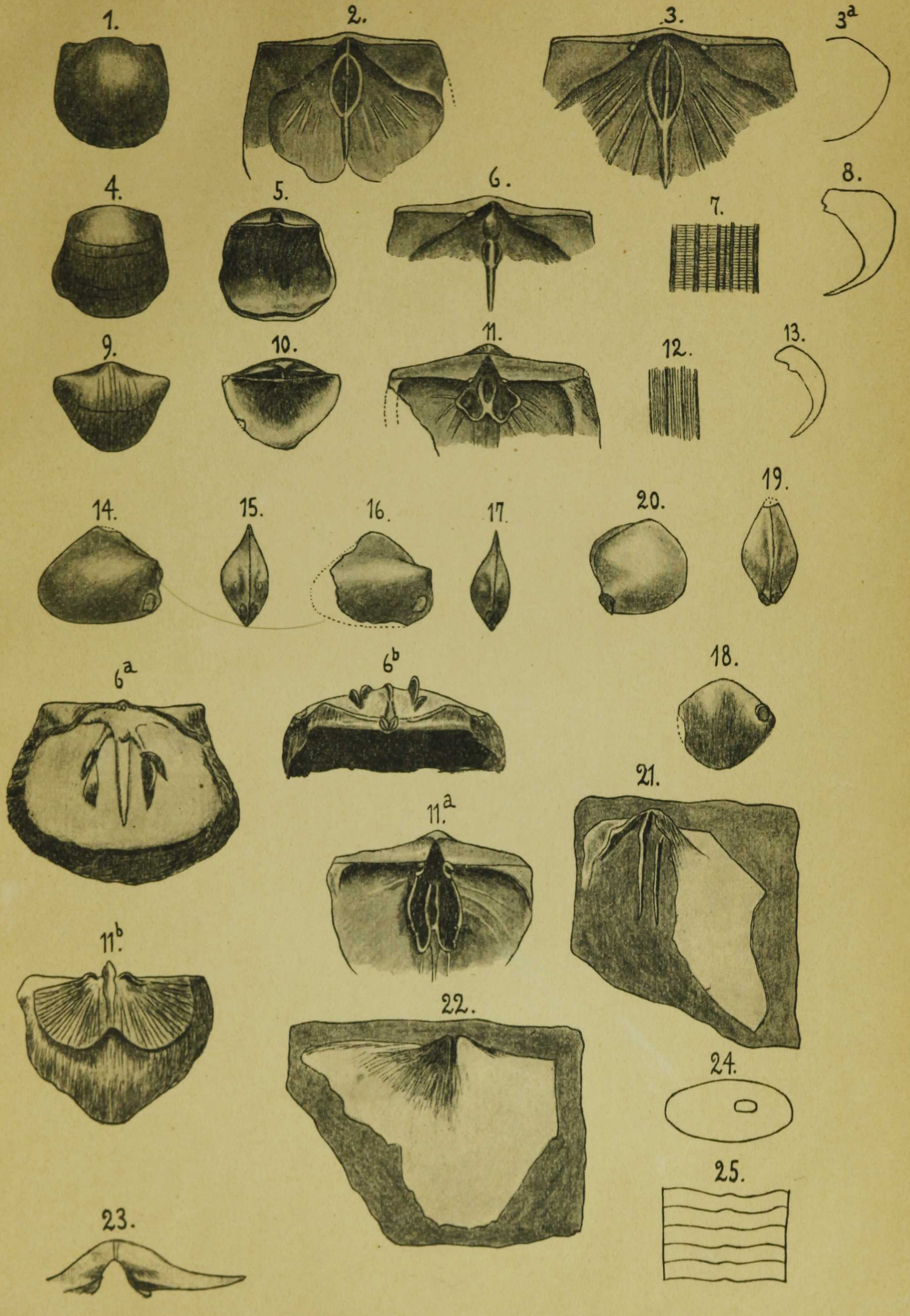
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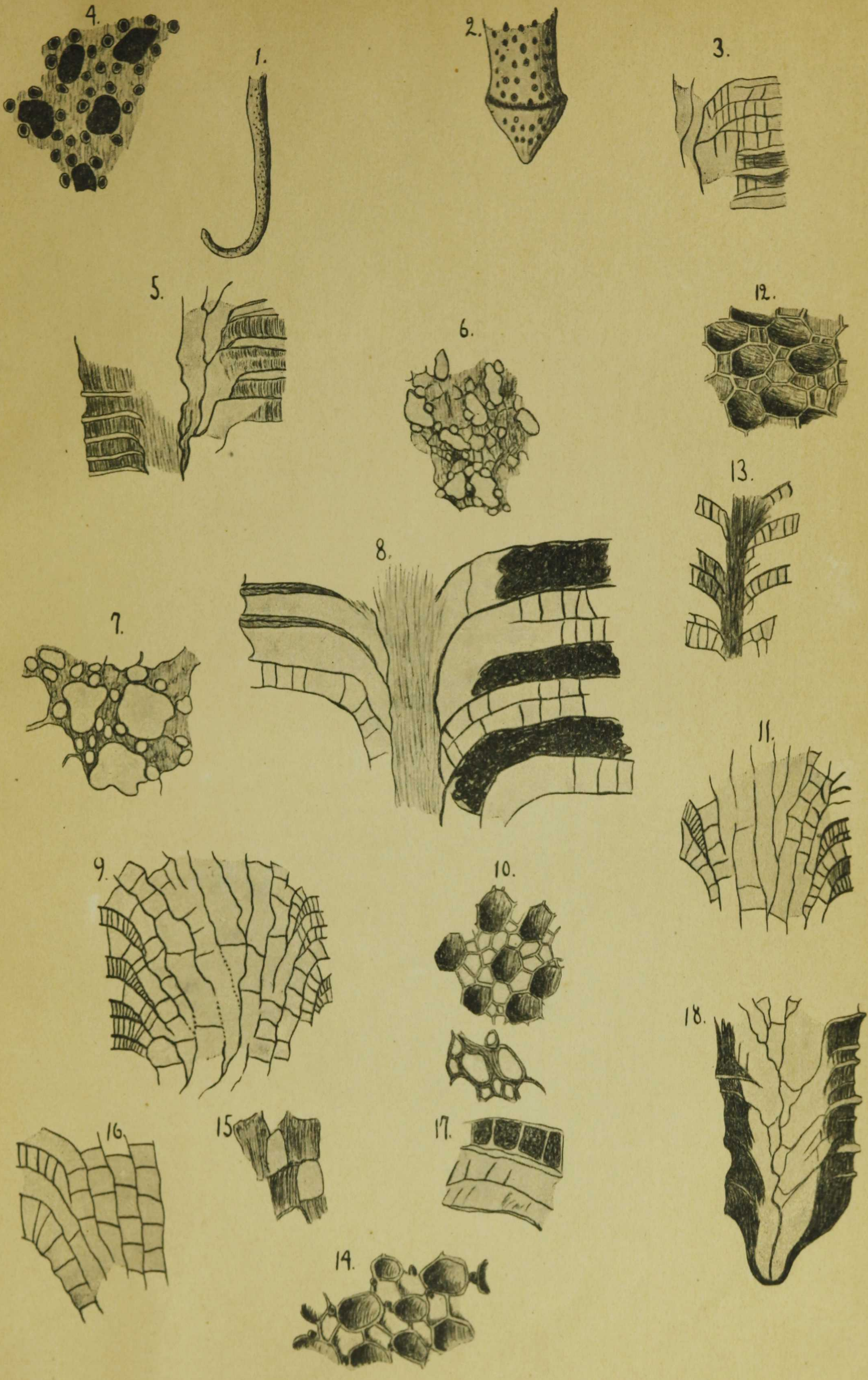
Pl. VI.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„ 36.	„ „ „ surface of zoar. near basal portion, × 3	„
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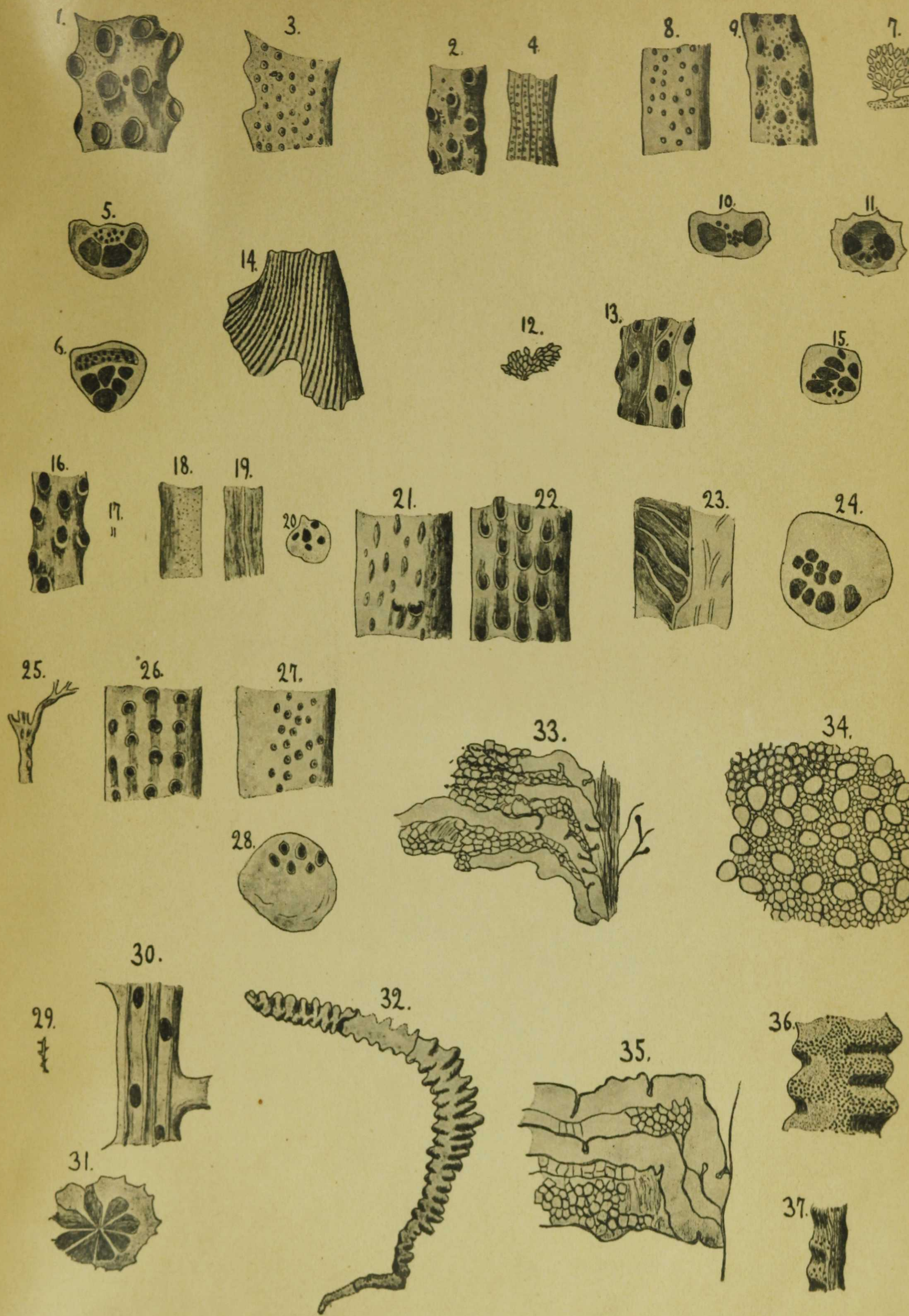
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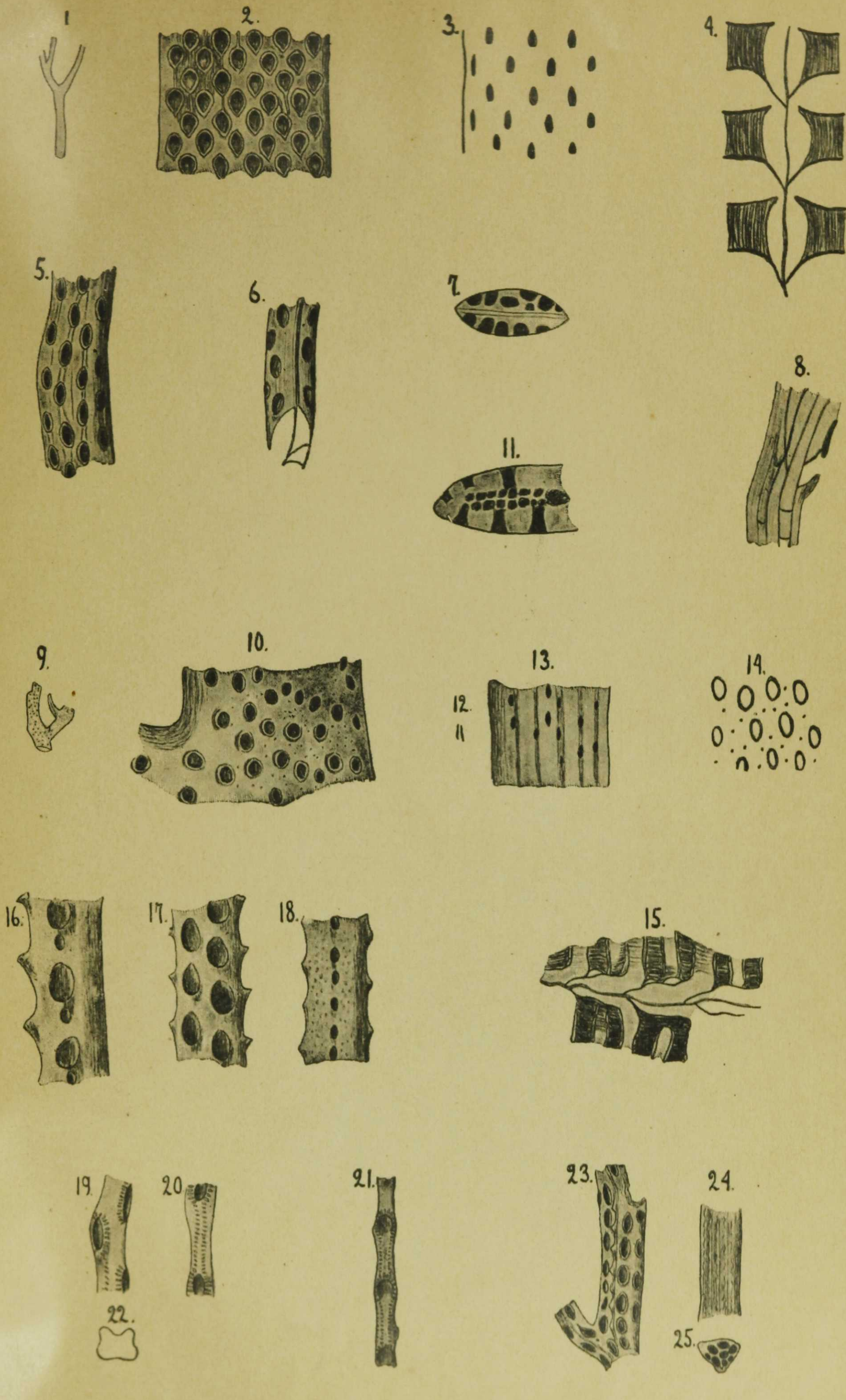
Pl. VIII.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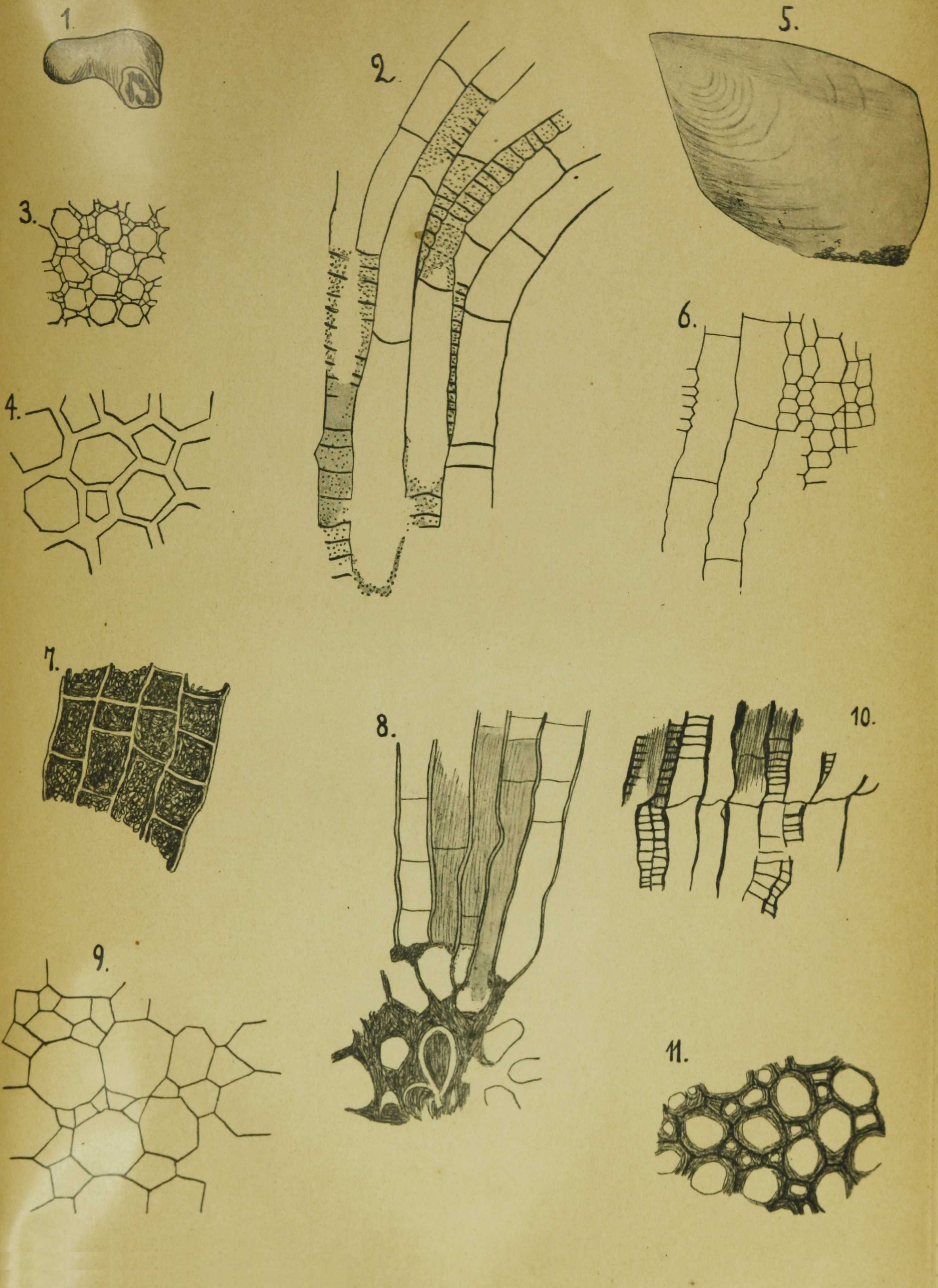
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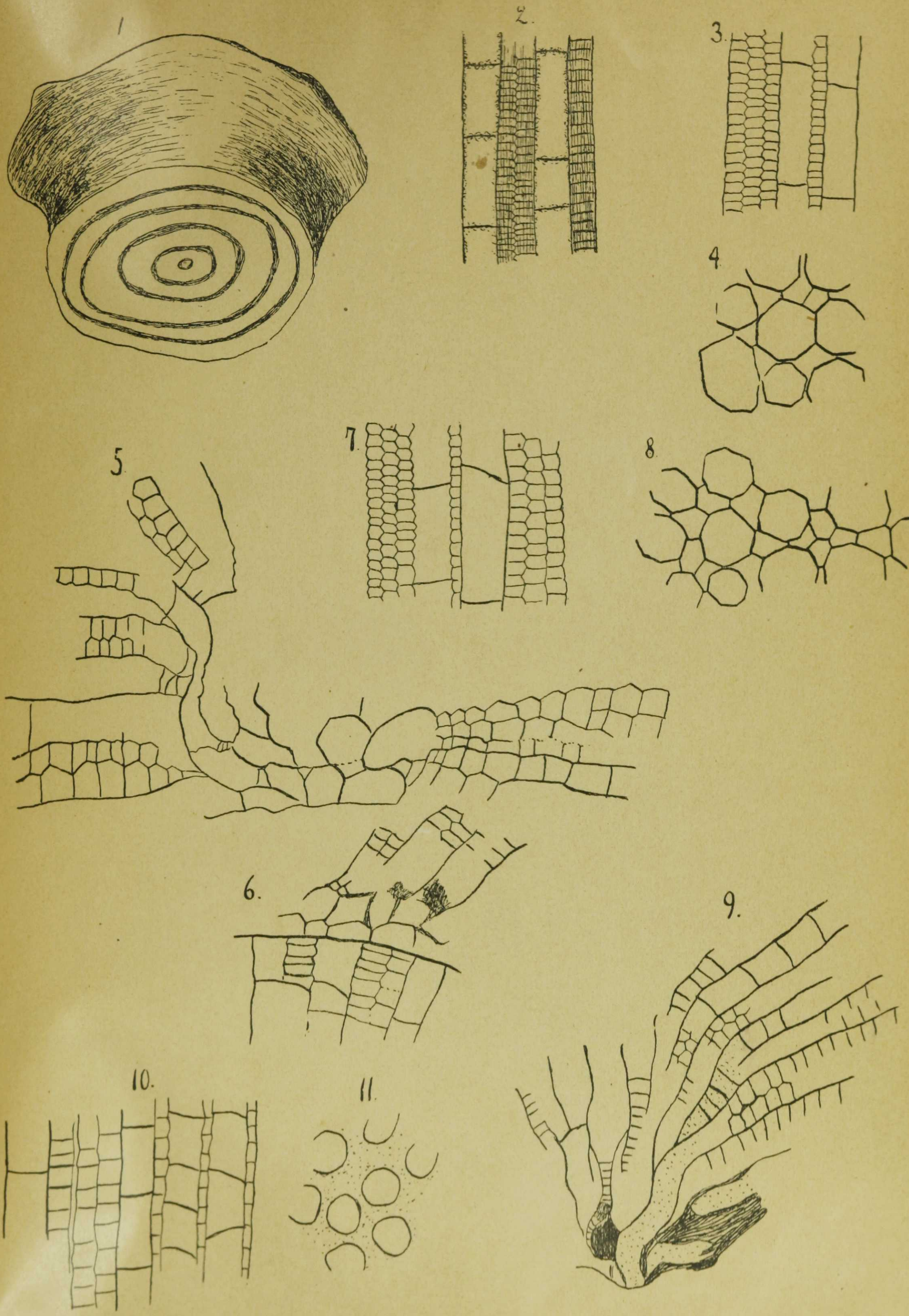
„ 9.	„ „ „	vert. thin section, with initial budding stages, $\times$ 20	„
„ 10.	„ „ „	vertic. thin section, $\times$ 10 . .	„
„ 11.	„ „ „	tang. thin section, $\times$ 10 . . .	„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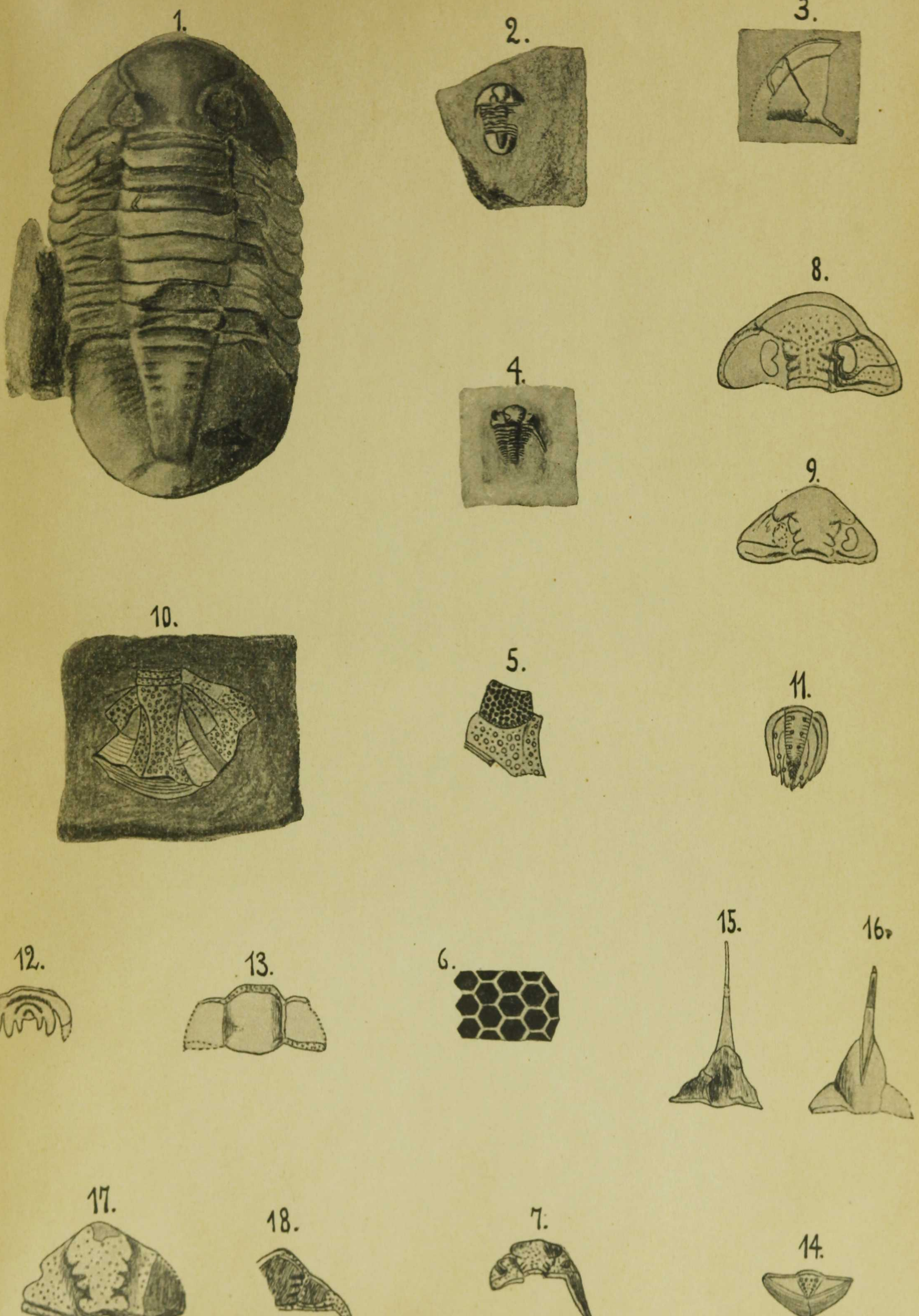
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Pl. XII.

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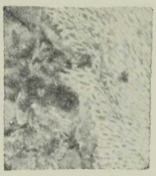

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