TH. MORTENSEN

ON THE SALENIDÆ OF THE UPPER CRETACEOUS DEPOSITS OF SCANIA, SOUTHERN SWEDEN

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By

TH. MORTENSEN.

(M. S. received $^{22}/_{9}$ 1932.)

On working out the chapter dealing with the family Salenidæ for the second part of my Monograph of the Echinoidea, now under preparation, I was surprised in finding in the collections of the Mineralogical Museum of Copenhagen some — undetermined — specimens of a *Salenia*, from the locality of Ifö in Scania, Southern Sweden, considerably larger than any Salenid hitherto on record, up to a size of no less than 40 mm in horizontal diameter. Examining these specimens, none of which had the oral side free of the matrix, I saw an indication of the pore zones of the ambulacra widening towards the peristome. This roused my interest, nearly all Salenids hitherto known having the pore zones quite simple unto the peristomial edge. My friend, Docent J. P. J. RAVN, then kindly left me his whole material for study. Fortunately, the matrix proved to be not too hard, so that it was possible to clean the whole of the oral side; I found then the pore zones to widen very considerably towards the peristome, and it was clear that this was a new genus of Salenids, both larger and more specialised than any Salenid hitherto known. Having made this interesting discovery, I made up my mind to undertake a more detailed study of the Salenids of the Cretaceous deposits of Ifö and other localities in the vicinity, the more so since there was some doubt as to the correctness of the description and figures given by COTTEAU of the *Salenia Loveni*, established by him for some specimens from these same deposits.

First of all I wanted to see the locality of Ifö and get a personal impression of the conditions under which the deposits there have been formed. Prof. K. A. GRÖNWALL of the University of Lund very kindly undertook arranging a trip to the locality and to accompany me on that excursion; also Dr. RAVN and Mr. EIGIL NIELSEN offered to go with me, and so, in the end of May this year, we went there together for some days, and, due particularly to Prof. GRÖNWALL's local knowledge and

his excellent arrangement of the excursion, I had the best possible opportunity of seeing both Ifö and the other localities in the neighbourhood where Echinoids have been found, the Barnakälla and the Balsberg grottos, as also Bromölla, likewise given as locality for Echinoids, which is, however, no geological locality, but a factory. The Echinoids recorded in literature as coming from Bromölla in reality must have come from Ifö, material from that locality being used in the Bromölla factory.

Besides the material collected on this excursion, together with that of the Mineralogical Museum of Copenhagen, I naturally wished to study also the material found in various Swedish collections. Prof. GRÖNWALL sent me the material in the palæontological collection of the University of Lund, containing also the type specimen of *Salenia Lundgreni* Cotteau. Prof. SIXTEN BOCK sent me the Salenids of the department of Evertebrates of the Naturhistoriska Riksmuseum, Stockholm, in which the type and cotypes of *Salenia Loveni* Cotteau and two specimens marked (but not described) by LOVÉN as new species. A considerable material was sent me by Prof. WIMAN from the palæontological collections of the University of Upsala, including the type specimens of *Salenia areolata* of WAHLENBERG, and Dr. A. H. WESTERGÅRD sent me the material of the Sveriges Geologiska Undersökning. But by far the largest material I got from the department of palæontology of the Naturhistoriska Riksmuseum, Stockholm, the director, Prof. E. STENSIÖ, kindly placing the whole of his rich collection at my disposal; in this collection I found a new generic type of Salenids, *Polysalenia* n. g., the largest and highest specialised of all Salenids.

I beg to tender my cordial thanks to all these gentlemen, through whose kindness I have thus had a perfectly unique material at my disposal.

First a few words may be said about the deposits in which these Salenids have been found.

The Cretaceous deposits of Ifö and neighbouring localities in N. E. Scania (the Kristianstad basin) belong to the Upper Senon, the *Belemnitella mucronata* and the *Actinocamax mamillatus* zones. They are very clearly littoral formations, formed along the shores of a sea, which »with deep inlets indented the land of the Cretaceous period«. The present outlines of these Cretaceous formations even generally directly represent the shores of the Cretaceous sea, as evident from the occurrence of conglomerates all over in these deposits. (Cf. J. C. MOBERG. Cephalopoderna i Sveriges Kritsystem, I. Sveriges Kritsystem systematisk framställd. Sveriges Geologiska Undersökning, Ser. C. No. 63. 1884,

p. 7; E. VOIGT: Die Lithogenese der Flach- u. Tiefwassersedimente d. jüngeren Oberkreidemeeres. (Dissertation). 1929. p. 67). Particularly in the Ifö deposits the presence of numerous large rock-boulders, partly covered with rock-oysters and other littoral organisms, shows beyond any doubt that this is a strictly littoral deposit. (Fig. 1) Also numerous fragments of broken shells bear witness of the surf that has been prevailing here. Consequently the Echinoids which are found in these deposits must have been littoral forms, partly, at least, specially

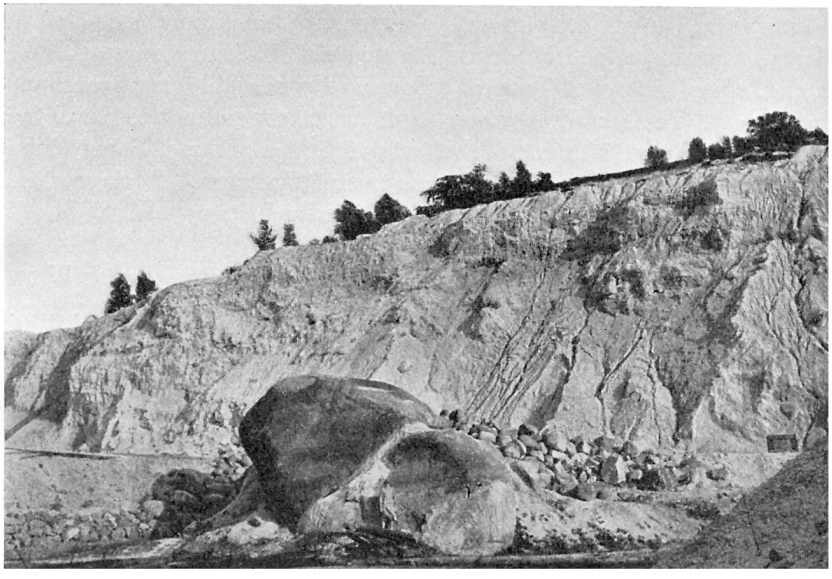


Fig. 1. From the deposit of Ifö. The large boulder in the foreground lies in its original place in the deposit. After a photo by A. ROSENKRANTZ (11/VIII. 1928).

adapted to life on a rocky shore, and, as a matter of fact, the Echinoids particularly characteristic of this locality (*Trisalenia Loveni* and *Polysalenia notabilis*) show structural features characteristic of such Echinoids as in recent seas are found living on rocky shores.

Also the deposits of the two other localities where Salenids have been found, the Barnakälla and Balsberg grottos, are clearly littoral deposits; but the somewhat finer character of the material, and the smaller size of the boulders contained, tend to show that these deposits were formed not directly on the shore, but in somewhat deeper, more calm places (cf. G. DE GEER. Om Barnakällagrottan, en ny Kritlokal i Skåne. Sveriges Geologiska Undersökning. Ser. C. No. 90. 1887; B. LUNDGREN. Jämnförelse mellan Molluskfaunan i mamillatus

och mucronata Zonerna i Nordöstra Skåne (Kristianstadområdet). K. Svenska Vetensk. Akad. Handl. 26. 6. 1894).

It is a natural consequence of the character of the Ifö deposit that no specimens of the sea-urchins have been found with spines preserved attached to the test. In the Balsberg deposit a single specimen of *Salenia areolata* has been found with some of the primary spines attached, in accordance with the somewhat more calm condition under which this deposit has been formed.

The specimens from Ifö are as a rule only half imbedded in the matrix, and in by far the majority of the specimens it is the aboral side that is free, the oral side being imbedded in the matrix. The large, very smooth, shining, apical system of *Trisalenia Loveni* may probably partly account for this fact. The matrix is rather hard, but in general not too hard for allowing a complete cleaning of the tests of the sea-urchins. Some of the specimens are impregnated with a green substance, of glauconitic character, as Professor O. B. Böggild kindly informs me.

The first to record a Salenid from the Cretaceous of Sweden is Wahlenberg, who in his »Petrificata telluris Suecanæ« (Acta Soc. Reg. Scient., Upsal. VIII. 1818, p. 46, Tab. III. 4—5) describes and figures »*Echinites areolatus*«, now *Salenia areolata* (Wahlenberg), from Balsberg. For a very long time this was the only Salenid known from any of the Swedish Cretaceous deposits. Hennig in his paper »Faunan i Skånes yngre Krita. I. Echiniderna« (Bih. K. Sv. Vet. Ak. Handl. 24, 1898) does not mention a single Salenid, not even *Salenia areolata*. De Geer in his paper »Om Barnakällagrottan, en ny Kritlokal i Skåne« (Sveriges Geol. Undersökning, Ser. C. No. 90, 1887) records (p. 16) *Salenia areolata* and *Salenia* n. sp. (identified by Lundgren, but not described or figured). But it was Cotteau, who in 1888 in his »Échinides nouveaux ou peu connus« II. 7. (Mém. Soc. Zool. France, 1888) gave the first real addition to the knowledge of the Salenids of the Swedish Cretaceous formations, describing two new species, *Salenia Loveni* and *Salenia Lundgreni*, from Balsberg and Mörby, based on material sent him by Lovén. As for the *Salenia* n. sp. recorded by De Geer, it appears to be the same as *Salenia Loveni*, since in 1894 Lundgren in his paper quoted above on the Mollusc-fauna of the mammillatus and mucronata zones (p. 18) records the two species *areolata* and *Loveni*, and these two species being the only ones actually known to occur in the Barnakälla deposit. Finally, in 1916, C. Wiman in his paper »Über das Kreidegebiet bei Båstad« (Bull. Geol. Inst. Upsala. XV. p. 79) mentions a *Salenia* sp. from Malen at Båstad.

In the material of fossil Salenids sent me by Prof. Bock from the

Department of Evertebrates of the Naturhistoriska Riksmuseum, Stockholm, there were two more species of *Salenia* from these same deposits, designated by LOVÉN as *Salenia Cottaldi* n. and *S. bellula* n., evidently regarded by him as new species, but he never published any description of them, and, according to the kind information of Prof. BOCK, no manuscript notes or figures of them were left by LOVÉN. Thus no less than 5 species have been recorded, or distinguished, from the Cretaceous deposits in the Kristianstad basin, namely

Salenia areolata (WAHLENBERG)
» *Loveni* COTTEAU
» *Lundgreni* COTTEAU
» *Cottaldi* LOVÉN (in litteris)
» *bellula* LOVÉN (in litteris)

Of these, however, *S. bellula* cannot be acknowledged as a distinct species, at most as a variety of *S. areolata*. But then, on the other hand, I find in the material placed at my disposal by Prof. STENSIÖ a very distinct new form, which I shall describe here under the name of *Polysalenia notabilis* n. g., n. sp.

The *Salenia* from the Båstad deposit, which Prof. WIMAN has very kindly sent me for examination, is decidedly not identical with any of the above species. Unfortunately, it is only a fragment of a very small specimen, though with part of the apical system preserved. Probably it is a new species, but I do not think it possible to arrive at a definite conclusion on the base of this fragmentary specimen, so I deem it better not to describe it.

We thus know no less than 4 distinct species of Salenids from the localities Ifö, Balsberg, and Barnakälla, besides one more, *Salenia Lundgreni*, from Mörby and the species from Båstad, a surprisingly rich fauna for such a small area — the more surprising as two of these species represent the most specialised and by far the largest forms of the whole family, and also the more surprising since not a single Salenid has been recorded from the other group of Cretaceous deposits of Southern Sweden, in the S. Western region of Scania, the Malmö basin.

The fact that none of these species are known to occur in any locality outside Sweden most probably is due, not to these species having really been confined to this area of the Cretaceous Sea, but to the very peculiar, strictly littoral character of these deposits. So far as I am aware, no other deposits of quite the same character are known, and at least the two forms specially adapted to a littoral life could hardly be expected to be found in deposits formed in greater depths, as are most of the Cretaceous deposits.

Description of the Species.

Salenia areolata (WAHLENBERG).

Pl. 5. Figs. 6—12.

Echinites areolatus. G. WAHLENBERG. 1818. Petrificata telluris Suecanæ. Acta Soc. Reg. Sci. Upsal. VIII. p. 46. Tab. III. 4—5.

Echinus areolatus. KOENIG. 1820. Icones sextiles. p. 4. Pl. VIII. 100.[1]

» » W. HISINGER. 1837. Lethæa suecica, seu Petrificata Sueciæ. p. 92. Tab. XXVI. 1. a—b.[1]

Salenia areolata. AGASSIZ & DESOR. 1847. Catalogue raisonné des Échinides. p. 37.

» » G. COTTEAU. 1888. Échinides nouveaux ou peu connus. II. 7. (Mém. Soc. géol. France) p. 105. Pl. XIII. 1—4.

» » LAMBERT & THIÉRY. 1910. Essai de nomenclature raisonnée des Échinides, p. 211.

Non:

Salenia » QUENSTEDT. 1852. Handbuch d. Petrefactenkunde. p. 576. Pl. XLIX. 1.

» » QUENSTEDT. 1875. Petrefactenkunde Deutschlands. p. 244. Tab. 69. 81—92. (*Salenia Quenstedti* Schlüter).

The very rich material of this species in hand, partly from the collections of Lund, Stockholm, and Uppsala, partly collected by myself during my visit to the above mentioned localities, allow me to give a more complete description of it than that given by COTTEAU, and also to correct some errors in COTTEAU's description and figures.

The test is of rather small size, as a rule not exceeding ca. 20 mm in horizontal diameter; the largest ones are 22—22.5 mm in diameter; specimens of ca. 12—15 mm diameter are the most common. The smallest specimens seen are 5 mm in diameter. As a rule the test is rather low, the height some 50—60 % of the horizontal diameter; in the largest specimens the height is 62—64 % of the diameter. Generally the shape of the test is low hemispherical, the apical system usually rising more or less in the middle. The oral side of the test is simply flattened, not sunken at the peristomial edge.

Ambulacra straight; only in the larger specimens there is an incipient sinuation at the upper end. The primary ambulacral tuberc-

[1] The work of KOENIG I have not seen (quoted from COTTEAU); HISINGER only reproduces WAHLENBERG's figures, gives no new information of the species.

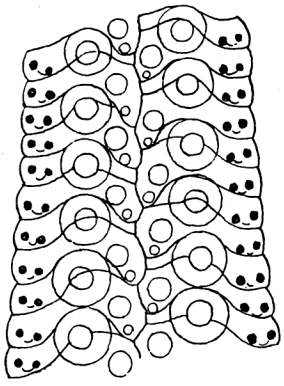


Fig. 2. Part of ambulacrum of *Salenia areolata*, at the ambitus. × 10.

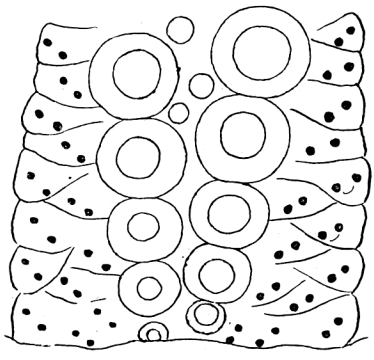


Fig. 3. Part of ambulacrum of *Salenia areolata*, smaller specimen, adoral part. × 15.

Fig. 4. Copy of COTTEAU's figure (Ech. nouv. ou peu connus, I, Pl. XIII, 4), representing the ambulacral structure of *Salenia areolata*.

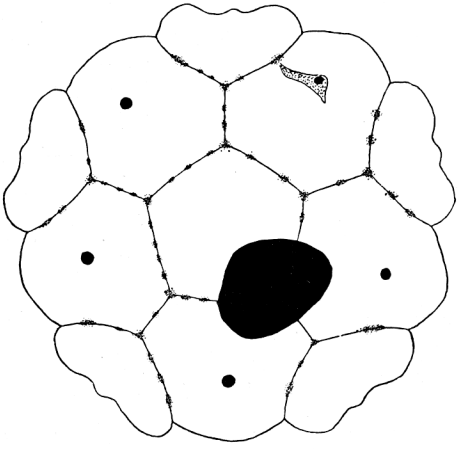


Fig. 5. Apical system of *Salenia areolata*. × 6.

les form two very regular series, fairly conspicuous in spite of their small size on account of the interporiferous zone being somewhat raised. At the transition to the oral side the tubercles increase a little in size, then becoming again smaller towards the peristome. The primary series are rather far apart so that there is room for a distinct double series of secondary tubercles between them, and at the ambitus even some smaller tubercles along the midline. There is no crenulation on the ambulacral tubercles (Figs. 2—3). The pores are, as usual in Salenids, arranged in a single, regular line, there being very regularly two pore-pairs to each tubercle. The figure of the ambulacral structure of *S. areolata* given by COTTEAU (Pl. XIII. 4, reproduced here in fig. 4),

showing three pore-pairs to each primary tubercle, the pores even partly arranged in rather distinct arcs of three, is quite erroneous (as already pointed out by SCHLÜTER, Op. cit.[1] p. 174, Note 3). On the oral side the pore-zone widens a little, the pores forming here a double series, and at the peristomial edge there are even three pore-pairs (Fig. 3), recalling thus to some degree *Trisalenia*.

Interambulacra. Primary tubercles not very large, equally developed; they are distinctly crenulate. At the peristomial edge the two primary series join, so that we have here the indication of an arch, recalling — but only to a slight degree — the very characteristic arrangement found in *Trisalenia Loveni*. The areoles are confluent, the scrobicular tubercles on the adradial side reduced to 2, or at most 3, situated in the corner between each two adjoining areoles. The median area is rather broad, covered with more or less numerous secondary tubercles, not regularly arranged.

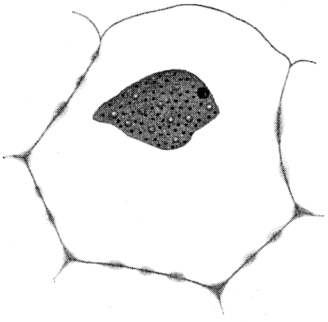


Fig. 6. Madreporite of *Salenia areolata*, showing the genital pore and a number of tubercles in the madreporic pit. × 8.

The apical system (Fig. 5) is as a rule ca. 50—60 % of the diameter of the test, rarely somewhat larger (up to 69 % — 11 mm — in a specimen of 16 mm diameter), except in the younger specimens. It is always smooth, but not shining as in *Trisalenia Loveni*. Only in the pit in which the madreporic pores are situated there may be some small tubercles (Fig. 6). The genital pores are situated rather distant from the margin, though not in the centre of the plates, that of the madreporite is situated in the madreporic pit. The ocular pore is situated below the edge of the ocular plate.

As the main difference between the species *areolata* and *Lundgreni* COTTEAU emphasizes the existence of small, but distinct pits in the sutures between the plates of the apical system in *Lundgreni* and the total absence of such pits in *areolata*. This supposed difference does, however, not at all hold good. Every gradation is found between the total absence of pits and the existence of very conspicuous pits, like those of the type of *S. Lundgreni* (Fig. 5); as a matter of fact, on a closer inspection traces of pits are found in nearly all specimens, such as are entirely devoid of pits being comparatively rare. The specimens with distinct pits are otherwise exactly like those with the pits less developed or totally lacking, the test low as in typical *areolata*, not high as in

[1] Quoted on p. 480.

Lundgreni. It is quite impossible to distinguish two forms, one with, the other without pits. This variation in the development of pits in the apical system is in good accordance with what obtains also in other species of *Salenia*.

The peristome is somewhat smaller than the apical system, ca. 50—57 % of the horizontal diameter of the test; the gill-slits are distinct, but not very deep. In some specimens I have been able to clean away the matrix so as to lay the perignathic girdle free. The auricles are slightly widening at the upper end, converging, but not joining. There is a distinct raised wall along the interambulacral edge, the apophysis (Fig. 7).

By the character of the deposits it was not to be expected that any specimen would be found with the spines preserved. The more agree-

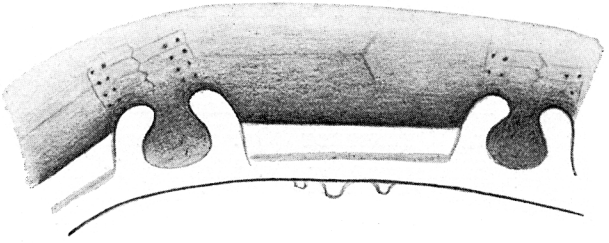


Fig. 7. Part of perignathic girdle of *Salenia arealota*, showing two pairs of auricles and the intervening raised wall, the apophysis. × 9.

ably surprised I was to find in the collection of the Lund Museum a specimen, from Balsberg, with some of the primary spines still in situ (Pl. 5 Fig. 6). Similar isolated spines are also found in good numbers in the deposit of Barnakälla, together with Cidarid spines, and it would have been possible to conclude with great probability that they must belong to *S. areolata;* but it is, of course, much more satisfactory to have found them actually in connection with the test. The length of these spines cannot be ascertained, all of them being broken. Fine longitudinal lines are to be observed on some of those attached to the specimen. — Secondary spines are not preserved on the said specimen, and it is quite impossible to see which of the various small spines found loose in the deposit may have belonged to *S. areolata*.

The widening of the ambulacra at the peristome would seem to indicate an incipient adaptation to littoral life-conditions; also the comparatively thick spines may represent such adaptation. Its occurrence principally in the Barnakälla deposit, which — as set forth above — must have been deposited not directly at the coast, but in somewhat deeper

water, under more calm conditions, is in accordance with this beginning adaptation. — Perhaps a more close study of other species of Salenids will show a similar beginning widening of the pore zones at the peristome. Thus I find indications thereof in a beautiful specimen of *Salenia scutigera* Goldfuss, in the collection of the Stockholm Museum. SCHLÜTER likewise states this to be the case in the species *S. Gehrdenensis* Schlüter and *S. Quenstedti* Schlüter.

This species occurs numerously in the deposit of the Barnakälla grot; it also occurs at Balsberg and Ifö, though in much smaller numbers. There are also a few specimens from Ignaberga in the collections of Uppsala and Lund. The specimens are, on the whole, well preserved, several of them are broken, which is apparently due to the water which has been percolating the Barnakälla deposit (cf. DE GEER Op. cit.), as a rule not to their having been broken before being buried in the deposit. Many of the specimens which I collected myself were complete when found, but so brittle that they fell to pieces. Some of the specimens have been rather much rolled before being buried, the tubercles being quite worn off. The species is not known to occur in any other localities. It is true, QUENSTEDT (Op. cit.) has recorded *S. areolata* from Rügen and Salzbergen (by Quedlinburg) in Germany, but, as already COTTEAU suggested, this identification is erroneous, and SCHLÜTER (Die Regulären Echiniden d. Norddeutschen Kreide. Abh. Kgl. Preuss. Geol. Landesanstalt. N. F. 5. 1892, p. 176) described this form as a separate species, *Salenia Quenstedti* Schlüter.

In the material sent from the Uppsala Museum there are some specimens labelled *Echinites areolatus*, the label being very old; there can hardly be any doubt that these are the originals of WAHLENBERG's species — and they give some quite important information. One of them, 19.5 mm in diameter, 12 mm in height, fits very well with the figure 4 of WAHLENBERG, representing the species in natural size, and thus must be regarded as the holotype. Another specimen, 23 mm in diameter, 11 mm in height, is not the same species, but *Salenia Loveni* Cotteau; it thus seems that WAHLENBERG in reality confounded these two species in his »*Echinites areolatus*«; there can, however, not be the slightest doubt that it is the species now understood as *Salenia areolata* which has the right to keep the name. Thus, when SCHLÜTER (Op. cit. p. 174—175) says: »man dürfte demnach, wenn zwei Arten (viz. *S. areolata* and *Loveni*) aufrecht zu erhalten sind, für die niedrigen Gehäuse die Bezeichnung *Salenia areolata* erhalten« — which would mean that *S. Loveni* were the real *areolata* — this is by no means acceptable. Even if there could be any doubt of which of the two species had the better claim to the name *areolata*, the fact of COTTEAU's designating the

low form as *S. Loveni*, the other as *S. areolata*, has settled the matter definitely.

A very interesting anomaly is found in some specimens, the suranal (central) plate being double (fig. 8). In another specimen, not figured, also Ocular V is divided in two; in a third specimen the suranal plate is divided longitudinally, there being no changes in regard to the other apical plates in this specimen. These three cases are the only ones found among several hundreds of specimens that I have examined. A similar case is found in *Trisalenia Loveni* (see below, p. 489); also SCHLÜTER (Op. cit. Tab. 19. 9) figures the same anomaly in a specimen of *Salenia petalifera* Ag.

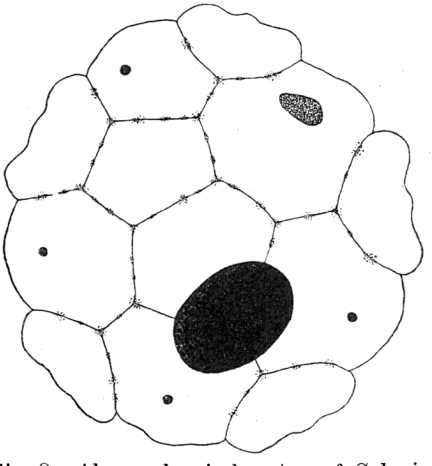


Fig. 8. Abnormal apical system of *Salenia areolata*, showing double suranal plate. × 6.

Another interesting anomaly is found in a specimen in the collection of Sveriges Geologiska Undersökning, labelled Karlshamn, Schmalensee, 1879, the left anterior interambulacrum being swollen and perforated in various places (Pl. 5, Fig. 12). There can be no doubt that this must be due to some parasite, probably a parasitic Gastropod.

A small specimen from Ifö (Sveriges Geologiska Undersökning) is remarkable in having the pits in the corners of the sutures in the apical system unusually large, recalling *Trisalenia Loveni*. As also the test is lower than usual, the suggestion lies at hand that this specimen might be a hybrid between *S. areolata* and *Trisalenia Loveni*. Unfortunately it is rather poorly preserved (much crystallized) — still it is very unlikely that the large size of the pits could in any way be due to this fact.

Among the specimens sent me by Prof. BOCK there is a very small one labelled in LOVÉN's hand »*Salenia bellula* n.«, thus evidently meant to be described as a new species. The specimen is in rather poor condition, so that one could only to some degree see its characteristic features. Fortunately, I find in the rich material now at my disposal a few specimens which are quite evidently identical with LOVÉN's specimen. All of them are quite small, c. 5—8 mm in diameter. They are in general very much like small *S. areolata*, only the apical system differs in being not flat as typical in *areolata*, but more »sculptured« so to say, the su-

tures being on the whole rather deep and wide, not simple, sharp lines as usual in *areolata;* particularly the corners of the ocular plates are somewhat elevated, and the pits in the sutures between the oculars and the genital plates are rather large (Fig. 9). Genital pores are just beginning to appear in these young specimens.

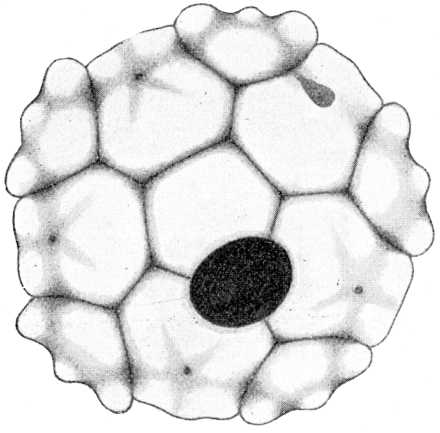


Fig. 9. Apical system of young *Salenia areolata*, the »*bellula*« type. × 9.

This difference between a typical »*bellula*« and the typical *areolata* is very conspicuous. But all gradations between the two are found, so that it is impossible to draw a definite line of distinction between them — and there are no other differences to be observed in the test. It is mainly among the small specimens that the »*bellula*« type is found, so it is evidently a juvenile character that the apical system is thus »sculptured« — but there are also young specimens of *areolata* with the apical system flat as in the adult.

To regard this form as a separate species I think out of question; besides, the name *bellula* has already been used for an American species of *Salenia* by W. B. CLARK.[1]

Salenia Lundgreni COTTEAU.

Pl. 5. Figs. 3—5.

Salenia Lundgreni. COTTEAU. 1888. Échinides nouveaux ou peu connus; II. 7. (Mém. Soc. Géol. France), p. 109. Pl. XIII. 10—13.

» » LAMBERT & THIÉRY. 1910. Essai de nomenclature raisonnée des Échinides, p. 211.

No new material of this species has come to hand. The type-specimen having been lent me by Prof. GRÖNWALL I take the opportunity of giving photographic figures of it. Otherwise there is nothing essential to be added to or corrected in the description given by COTTEAU; even the detailed figure of the ambulacral structure (Pl. XIII. 13) gives cor-

[1] W. B. CLARK & M. W. TWITCHELL. The Mesozoic and Cenozoic Echinodermata of the United States. Monogr. U. S. Geol. Survey. Vol. LIV. 1915, p. 51.

rectly 2 pore-pairs as corresponding to each primary ambulacral tubercle.

COTTEAU was prepared that this *Salenia Lundgreni*[1] might ultimately prove to be identical with *S. areolata*. »Si plus tard on découvrait des variétés intermédiaires, il faudrait réunir les deux espèces, et la *Salenia Lundgreni* ne serait plus qu'une variété de très grande taille de la *Salenia areolata*«. It was mainly the existence of distinct pits in the apical system in *S. Lundgreni* and their complete absence in *S. areolata* that made him regard them as two distinct species. As it has now been shown that this difference is not real, *S. areolata* having often as distinct pits as *Lundgreni*, this reason for regarding them as separate species disappears. As a matter of fact, there is not a single character in the test, beyond its shape, by which to distinguish them.

However, I do not think it correct simply to declare *S. Lundgreni* identical with *S. areolata*. The general shape of their tests is so different that it is hard to see how *S. areolata* could ever assume the same shape as *Lundgreni*, even if it grew to the same size in horizontal diameter. *S. Lundgreni* is 26.5 mm in horizontal diameter, the largest *S. areolata* seen (out of several hundreds) is 22.5 mm; in this latter specimen the height, 14 mm, is 62 % of the horizontal diameter, otherwise the height of *S. areolata* is only ca. 50—60 % of the diameter. But in *S. Lundgreni* the height is 72 % of the horizontal diameter (19—26.5 mm). Further, the dimensions of apical system and peristome are quite different from what they are in *areolata*, the apical system (12.5 mm) being only 47 % of the diameter, against ca. 50—60 % in *areolata*, and the peristome of the same size as the apical system in *S. Lundgreni*, distinctly smaller than the apical system (ca. 50—57 % of h. d.) in *areolata;* also, Ocular I is insert in *S. Lundgreni*, which it never is in *S. areolata*. It is highly probable that if we had complete specimens of both, with spines and pedicellariæ, we would also find other differences — of this, however, we shall most probably remain ignorant. But, anyhow, the differences in the dimensions of the test seem to me to forbid regarding the two forms as identical, the more so as *S. Lundgreni* comes from another locality, Mörby, from which *areolata* is not known. According to MOBERG (Op. cit. p. 45) the Mörby deposit also belongs to another horizon, the *Belemnitella mucronata* zone, than the deposits where *S. areolata* occurs, these latter belonging to the *Actinocamax mammillatus* zone, which is older than the former.

[1] SCHLÜTER. Die Regulären Echiniden d. Norddeutschen Kreide. II. Cidaridæ. Salenidæ (Abh. Kgl. Preuss. Geol. Landesanstalt, N. F. 5. 1892, p. 188) by a mistake names it *Salenia Lindströmi* Cotteau.

Thus, I think *S. Lundgreni* should be upheld, at least for the present, as a separate species, until typical *areolata* be found together with it, or specimens of *areolata* more intermediate in shape.

Trisalenia Lambert.

Ambulacra with the pore zones considerably widening towards the peristome, the pores here arranged in two—four series. The ambital ambulacral plates partly triple-compound. Periproct pushed out towards the right as in typical Salenias. Large form.

Upper Cretaceous, Ifö, Sweden.

Genotype *Salenia Loveni* Cotteau.

The genus *Trisalenia* was established for the species *Salenia Loveni* by Lambert, 1895, in his »Essai d'une monographie du genre Micraster et notes sur quelques Echinides«, contained in Grossouvre's »Stratigraphie de la Craie Supérieure« (p. 262), the genus being founded only on the regular trigeminate character of its ambulacra as shown in Pl. XIII, fig. 9 of Cotteau's »Échinides nouveaux ou peu connus«, II, though not mentioned in Cotteau's description of the species. In Lambert & Thiéry's »Essai de nomenclature raisonnée des Échinides«, 1910, p. 210, *Trisalenia* is, however, abandoned, being now regarded as a synonym only of *Salenia*, the study of a cast of the type of *Salenia Loveni* having convinced Lambert of the said figure of Cotteau's being erroneous.

Having had the original specimens of *Salenia Loveni* for examination, I can only join Lambert in maintaining the said figure of Cotteau's to be quite erroneous — as on the whole the figures of this species given by Cotteau are rather inaccurate, even in regard to the large interambulacral tubercles. However, even though the character on which the genus *Trisalenia* was founded was a mistake, due to an erroneous figure, there can be no doubt of *Salenia Loveni* representing a distinct generic type, and I think it then perfectly correct to revive the name *Trisalenia*, the more so as it is a quite appropriate name, together with the name *Polysalenia* indicating the steps in the specialisation of the Salenid type.[1]

[1] This is a parallel to the case of the names *Eriechinus-Lovenechinus*. The genus *Eriechinus* was established by Pomel founding on the description of de Koninck of *Palæechinus sphæricus*, indicating a peculiar structure of its apical system. A reexamination of de Koninck's specimen showed his statement to be erroneous, as well as the identification as *Palæechinus sphæricus* to be wrong. As the specimen, however, really represented a separate generic type — for reason of other characters than those used by Pomel — it would have been the correct thing to use the name *Eriechinus* for this genus, only with an amendment of the diagnosis; Jackson, however, rejected the name *Eriechinus* and created the new name *Lovenechinus* for the genus. I don't think that was correct; another thing is that, since the name *Lovenechinus* now has been introduced and used in the main work on Palæozoic Echinoids, it ought to be preserved. (Cf. A Vote on some Echinoid Names, Ann. Magaz. Nat. Hist., Ser. 10. X, 1932, p. 365.)

Trisalenia Loveni (COTTEAU).

Pl. 4. Figs. 4—10. Pl. 5, Figs. 13—24.

Salenia Loveni. COTTEAU. 1888. Échinides nouveaux ou peu connus, II. 7. Mém. Soc. Zool. France. 1888. p. 107, Pl. XIII. 5—9.

» » LAMBERT & THIÉRY, 1910. Essai de nomenclature raisonnée des Échinides, p. 211.

The largest specimen is 45 mm in horizontal diameter, but this is an exceptional size, the larger specimens otherwise measuring only ca. 40 mm in horizontal diameter. All sizes, however, are represented, down to 5.5 mm h. d. The height of the test is usually about half the horizontal diameter; both the oral and aboral side generally conspicuously flattened, more rarely the apical system is slightly elevated, the aboral side of the test being then low hemispherical. The sides of the test are subvertical, the circumference circular.

Ambulacra slightly sinuate at the upper end, narrow, but rather suddenly widening where passing on to the oral side. The pores form a regular, single line in the upper part, but on the oral side the pore zone widens very conspicuously towards the peristome, the pores being here arranged in 2—4 series (figs. 10—11). The interporiferous zone is very conspicuously raised, forming thus five prominent ribs on the test. The tubercles are rather large, distinctly mamelonate, not quite contiguous (as erroneously represented in COTTEAU's figure). At the transition to the oral side the ambulacral tubercles increase rather considerably in size so as to be about as large as the primary interambulacral tubercles of the oral side. It is, however, only one or two tubercles of each series that are so large; then they decrease again in size so as to be very small, or even absent, nearest the peristomial edge. There is no trace of crenulation on any of the ambulacral tubercles. On the oral side there are no smaller tubercles along the midline of the interporiferous zone, but from just above where the enlargement begins there is a median series of smaller tubercles, alternating with the primary ones.

As stated above, the figure given by COTTEAU showing the ambulacral plates to be regularly trigeminate (fig. 12) is erroneous. Fig. 13 shows the real condition of the ambulacra in the specimen from which COTTEAU's figure has been drawn. The specimen is very much worn, the mamelon of the tubercles quite indistinct; it has been introduced on free hand in the figure, as there is no doubt that it was there originally — this is a matter of little importance, as is also the fact that the tubercles are rather distinctly oblong here; as a rule they are simply round. But the figure 13 shows beyond any doubt — although the limits of the primary plates are indistinguishable — that there are in this specimen only two

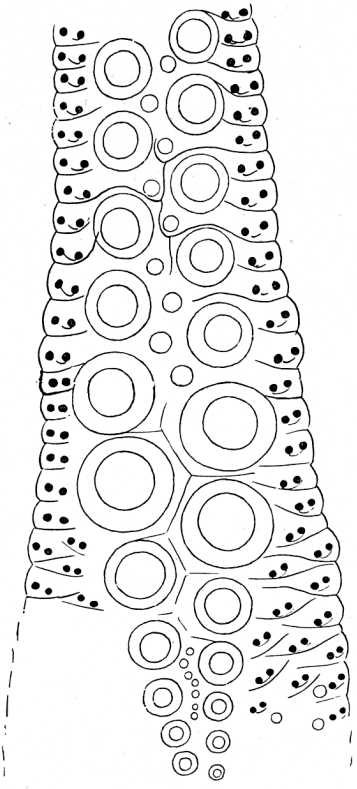


Fig. 10. Ambulacrum of *Trisalenia Loveni*. Pores not to be made out in the adoral part. × 6.

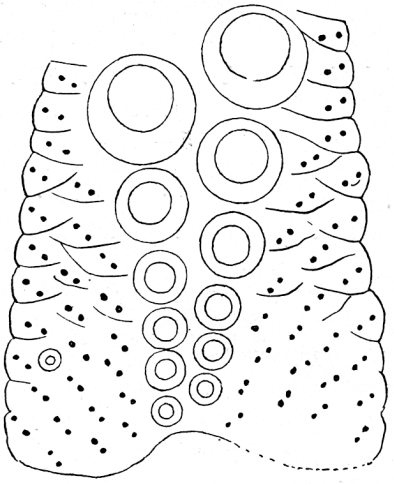


Fig. 11. Adoral part of ambulacrum of *Trisalenia Loveni*, showing the widened pore-zones with up to 4 series of pores. × 6.5.

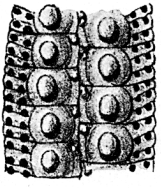


Fig. 12. Copy of COTTEAU's figure (Éch. nouv. ou peu connus, II, Pl. XIII, 9), illustrating the ambulacral structure of »*Salenia*« *Loveni*.

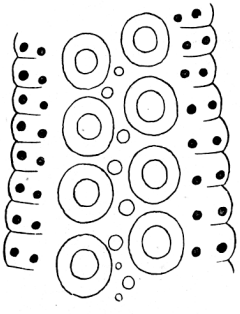


Fig. 13. Ambulacral structure, drawn from the same specimen, same ambulacrum after which COTTEAU's figure must have been drawn. × 6.

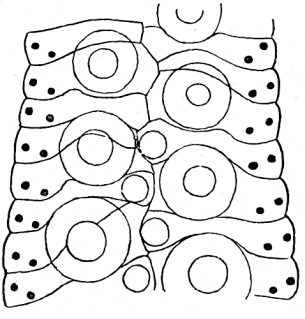


Fig. 14. Part of ambulacrum of *Trisalenia Loveni*, showing the ambulacral structure distinctly. × 8.

pore-pairs corresponding to each primary tubercle, not three as in the figure of COTTEAU. Likewise in the other specimens studied by COTTEAU, as far as anything of the pore-arrangement can be made out. But it is equally certain that in this species more generally the two primary plates covered by the tubercle alternate with one primary plate, not covered by the tubercle, such ambulacral plates being in reality trigeminate (Fig. 10). As a rule the limits of the primary plates cannot be made out, but in some rare cases they are seen quite distinctly (Fig. 14). In the widened oral part of the ambulacra I have been able to trace these limits only to some extent (figs. 10—11).

Interambulacra. There are 6—7 plates in each column. The two upper primary tubercles in each series are very large and conspicuous, distinctly crenulate. At the transition to the oral side the primary tubercles decrease somewhat in size, though still rather prominent, but non-crenulate; they assume here an exceedingly characteristic arrangement, forming together a very conspicuous arch, or semicircle, across the interambulacrum (Pl. 4. Figs. 8, 10). Adorally to this arch there are only some few much smaller tubercles. The areoles of the large upper tubercles are rather large, though not very deep, somewhat confluent; the scrobicular tubercles, which are rather large, distinctly mamelonate, thus do not form a complete circle round the areoles, being interrupted both in the midline between the two adjoining areoles and particularly at the adradial side, where they are reduced to only two tubercles placed in the corner between the two areoles. At the ambitus there is a rather broad median area covered with a number of irregularly arranged tubercles somewhat smaller than the scrobicular tubercles. The lowermost of these are somewhat larger and generally form an arch parallel with the arch formed by the primary tubercles. Between the two uppermost large areoles there is no room for small tubercles in the midline, the scrobicular circles occupying the whole median space. The uppermost plate in one of the series in each interambulacrum has no primary tubercle, but is wholly covered with smaller, secondary tubercles.

One specimen shows a curious anomaly, in the uppermost large tubercle in one place lacking and the somewhat sunken space belonging to it being wholly covered with small, secondary tubercles (Pl. 4. Fig. 6).

The apical system is very large, varying from ca. 61—67 % of the horizontal diameter of the test. In the young specimens it is still larger, up to ca. 80 % of the diameter. It is always perfectly smooth and shining, generally very flat, only with the outer edge slightly rising, so that it is very distinctly set off from the test. The genital pore is situated in the middle of the genital plates, in the madreporite it is

situated in the deep pit in which the madreporic pores are found — the usual arrangement of the madreporic pores in Salenids. There may be distinct tubercles in the madreporic pit. The genital pores are of about the same size in all the specimens, so that one cannot distinguish male and female specimens. In the youngest specimens, 5—10 mm in diameter, the genital pores have not yet appeared. They begin to appear at a size of ca. 10—12 mm in diameter. The ocular pore is situated below the edge of the ocular plates. The periproct, which may be somewhat irregular in outline — rather often rounded triangular, with the apex towards the central plate — is pushed out towards the right, but the Ocular I always remains distinctly exsert. There are distinct pits along the sutures between the apical plates, one in each corner and generally one in the middle of each line, but there may sometimes be 2—3 pits in the lines between the central plate and the genital plates.

The peristome is distinctly smaller than the apical system, ca. 44—50 % of the horizontal diameter. The gill slits are rather deep and very distinct, with somewhat raised borders (Pl. 4 Figs. 8, 10). The interambulacral edge between the gill slits forms a rather distinct, somewhat raised lip, distinctly narrower than the peristomisal border of the ambulacra. The auricles are narrow columns, directed somewhat obliquely inwards; they do not join in the midline.

From the nature of the deposits at Ifö it could not be expected that any specimen could have its spines preserved in connection with the test. Nevertheless we can with great probability point out some of the spines which occur in good numbers in these deposits as belonging to *Trisalenia Loveni*. The large size of the primary tubercles makes it certain that the primary spines must have been rather stout. Among such larger spines found in the deposits some of them, which are distinctly longitudinally striated, are clearly Cidarid spines and apparently belong to a species closely related to *Cidaris Bolli* Lambert[1], which is found in fair numbers, always as isolated interambulacra; but others are of a different type, with no trace of longitudinal striation, except at the point, but with distinct traces of quite irregularly disposed low tubercles on the shaft. They are fusiform, thickest in the middle, some 30—50 mm. long (Pl. 5 Figs. 18—24). Some of them show an indication of flattening. As only the said *Cidaris* and *Trisalenia* are at all common in these deposits, I think that there can be no doubt that these spines really do belong to *Trisalenia Loveni*. The only other Echinoid that might come into consideration here is *Polysalenia notabilis*. But as this is a rare form, only 7 specimens known against more than a hundred specimens of

[1] According to a kind information from LAMBERT, to whom I sent a specimen of this Cidarid, it may rather be a new species.

Trisalenia, the probability of these spines belonging to *Polysalenia* is quite negligible.

It may be emphasized that even the youngest specimens in hand (Pl. 5, Figs. 13—17) are perfectly recognizable as belonging to this species, the character of the apical system, the arrangement of the primary interambulacral tubercles and the widening of the pore-zones at the peristome being already quite distinct.

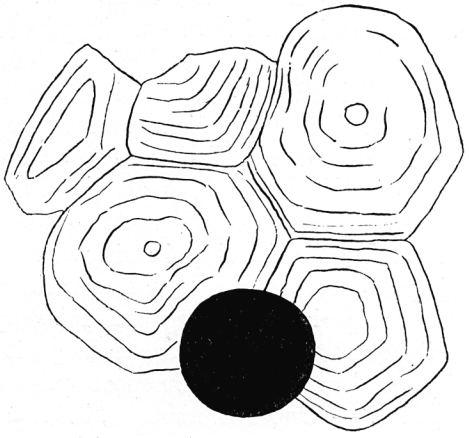


Fig. 15. Part of apical system of weathered specimen of *Trisalenia Loveni*, showing growth-lines. × 5. The figure shows the periproct the suranal plate, two genital plates, one ocular plate, and one upper interambulacral plate.

One specimen has been weathered in such an extraordinary way that a number of growth-lines have become very distinct, particularly on the plates of the apical system (Pl. 4 Fig. 5, textfig. 15). These lines show clearly 5 growth-zones. If each period of growth means a year — as is highly probable — the specimen is 5 years old. As it has a horizontal diameter of 28 mm only, this would mean that the large specimens of 40—45 mm diameter must be some 8—10 years old.

An anomaly of quite unusual interest is found in the apical systems of two specimens, in that the suranal plate is represented by three separate plates (Fig. 16; Pl. 5, Fig. 2). This very strikingly recalls the condition in *Acrosalenia*. As the specimens are otherwise typical *Trisalenia Loveni*, we must evidently recognize this anomaly as an atavism, since there can hardly be any doubt that the Salenids are the direct descendants of the Acrosalenids.

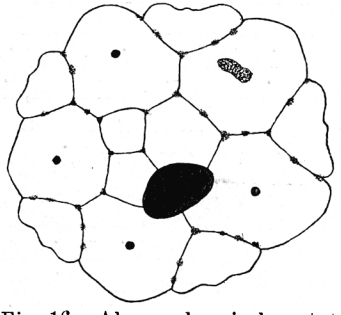


Fig. 16. Abnormal apical system of *Trisalenia Loveni*, showing the suranal plate divided into three plates. × 2.

The numerous specimens of this species, more than a hundred, which I have had for examination, nearly all of them have been found in the deposit of Ifö (Blaksudden, the mamillatus-zone). There is, however, one small specimen

from Barnakälla in the collection of the Stockholm Museum, and in the collection from Lund there are 7 specimens from the latter locality, all of them small, ranging from ca. 25—10 mm diameter. Also LUNDGREN (Op. cit. 1894, p. 18) has *Salenia Loveni* in his list of the fossils from the Barnakälla grot. (Very probably this is the *Salenia* n. sp. mentioned in DE GEER's paper on the Barnakälla, cf. p. 474). The type specimens of *Salenia Loveni* are stated to be from Balsberg; otherwise I have seen no specimens from Balsberg. Evidently then the occurrence of *Trisalenia Loveni* at the localities Barnakälla and Balsberg is more casual. Its true home was on the rocky coast of Ifö.

Polysalenia n. g.

Ambulacra suddenly widening at the ambitus, the ambulacral plates being here polyporous, with large primary tubercles. Pore zones widened at the peristome. Large tubercles (spines) on apical system. Madreporic pores spread over the madreporite, not in a sunk space as otherwise usual in Salenids. Periproct pushed out to the right, as in typical Salenias. — Upper Cretaceous, Ifö, Sweden.

Genotype: *Polysalenia notabilis* n. sp.

This genus differs markedly from all other Salenids in being polyporous, and accordingly the highest specialised of all Salenids. At the same time one of the two species is the largest of all Salenids, reaching the very respectable size of 55 mm in horizontal diameter, the Salenids being otherwise of small or even very small size; a size of some 25 mm horizontal diameter is otherwise regarded as very large for a Salenid — the *Salenia maxima* of ARNAUD reaches a diameter of only 25—30 mm. The only Salenid approaching *Polysalenia notabilis* in size is *Trisalenia Loveni* (Cotteau) from the same formation and locality, which reaches a size of 45 mm.

The fact that the ambulacra are much widened at the peristomial edge in *Polysalenia notabilis* proves that this Salenid, like *Trisalenia Loveni*, was a littoral form, living on rocky coasts. All recent Echinoids with such widening of the ambulacra at the peristome are littoral forms, living on rocky coasts, the numerous tubefeet of the oral side serving to attach them to the rocks, so that they are not washed away by the surf. There can be no doubt that such was also the case with *Polysalenia notabilis* (and *Trisalenia Loveni*), and the character of the locality perfectly bears out this conclusion. The other species, *Polysalenia Cottaldi*, shows the adaptation to a littoral life much less pronounced.

The fact that we thus have a polyporous form also in the family of the Salenidæ is of very considerable interest and of great classificatory

importance, supporting the view held by the present author that the oligoporous or polyporous condition of the ambulacra cannot form the foundation of main divisions within the Regular Echinoids, as maintained by H. L. CLARK (cf. e. g. his Catalogue of the Recent Sea-Urchins in the British Museum. 1925, p. 103). The question: to which main type of compound ambulacral plates those of *Polysalenia* belong, the Diadematoid or the Echinoid type, is not easily answered — it rather seems to have both types represented, as set forth below (cf. figs. 19—21). This fact shows that the type of the compound ambulacral plates is not to be relied on too rigorously as indicating genetic affinities.

Polysalenia notabilis n. sp.

Pl. 4. Figs. 1—3.

The type specimen has a horizontal diameter of 51 mm, a height of 29 mm. Apical system 18 mm, peristome 25 mm in diameter. Another, larger, specimen has a horizontal diameter of 55 mm and is the largest specimen known of any Salenid. The smallest of the specimens in hand is 45 mm in horizontal diameter.

The test is very regularly hemispherical; the oral side is flattened, slightly incurved at the peristomial edge.

Ambulacra on the aboral side distinctly sinuate, narrow, then at the ambitus suddenly widening to twice the width. The tubercles, which are in the upper part rather small and of uniform size, suddenly become large primaries, remaining so on two plates in each series and then gradually, or rather abruptly, again diminishing in size towards the peristome. These large primary ambulacral tubercles may show distinct traces of crenulation (Fig. 21). Secondary tubercles are found at the ambitus, generally only one to each of the larger tubercles, alternating with these latter (cf. fig. 17). Quite exceptionally a small tubercle may be found in the pore zone at the ambitus.

The pores are arranged in a single line above the ambitus; below the ambitus the pore zone widens, and the pores become crowded, so as to assume an arrangement, first in two, then in three, and finally, at the peristomial edge, in four series, some of the primary plates being completely excluded from the abradial edge of the pore zones (fig. 18). In the aboral part each tubercle covers two primary plates, a single plate with no tubercle alternating with the compound plates (fig. 19; from a specimen in rather crystallised condition, which shows these details fairly distinctly). These plates may with equal right be regarded as triple-compound plates, the middle plate being the largest, thus belonging to the Diadematoid type of compound ambulacra. The plates at the ambitus with the large primary tubercles are very distinctly poly-

porous, composed of 5—6 primary plates, the lowermost of which is generally the largest (figs. 20—21), thus rather belonging to the Echinoid type of compound ambulacra. In a single case one of the primary

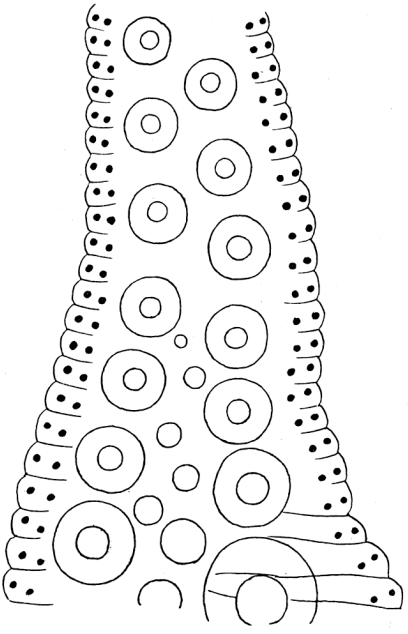


Fig. 17. Part of ambulacrum of *Polysalenia notabilis*, from ambitus upwards. × 4.5.

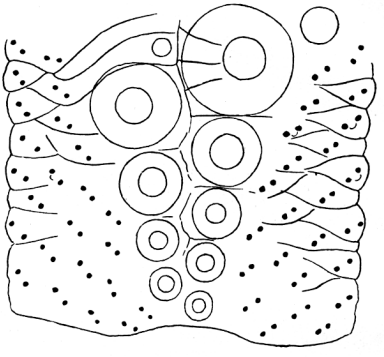


Fig. 18. Adoral part of ambulacrum of *Polysalenia notabilis*, showing widened pore-zones, with up to 4—5 pore series. × 4.5. At the mark * is seen a primary ambulacral plate divided into two parts, a smaller outer poriferous, and a larger inner non-poriferous plate.

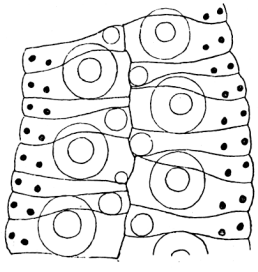


Fig. 19. Part of ambulacrum of *Polysalenia notabilis*, above the ambitus, showing the structure of the compound plates. × 4.5.

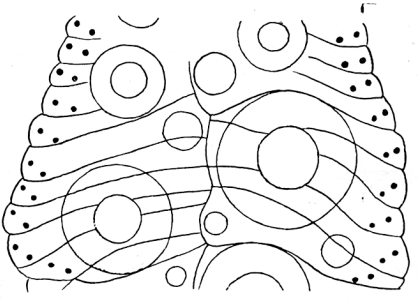


Fig. 20. Part of ambulacrum of *Polysalenia notabilis*, from the ambitus, showing polyporous compound plates. × 4.5.

plates has been divided in an inner and outer part (Fig. 18, at the asterisk). In the aboral part of the ambulacra the limits between the single primary ambulacral plates can only partly be made out (Fig. 18).

Interambulacra with 7—8 plates in each series, each with a large primary tubercle, excepting the uppermost one or two plates in each series, which are covered with small secondary tubercles only. The aboral surface of the test thus looks rather bare. The large tubercles are distinctly crenulate. The areoles of the large ambital primary tubercles are comparatively small, shallow; the rather large scrobicular tubercles make a complete circle round the two uppermost areoles, whereas below these the areoles are confluent, the secondary tubercles forming only a longitudinal series to each side of the areoles, particularly distinct along the adradial side. The median space of the interambulacra at the ambitus wholly covered by secondary tubercles, there being no naked or sunken median line.

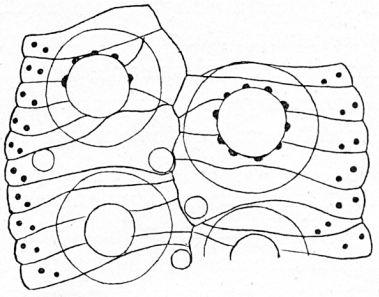


Fig. 21. Part of ambulacrum, at ambitus, of another specimen of *Polysalenia notabilis*, showing polyporous compound plates, and partly crenulate primary tubercles. × 4.5.

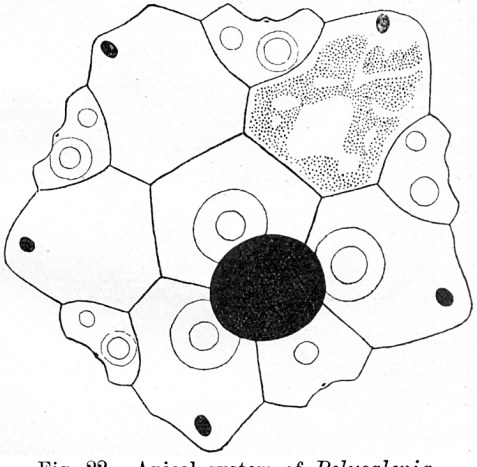


Fig. 22. Apical system of *Polysalenia notabilis*. × 3.

In one specimen, which has the mamelon of the large tubercles better preserved than usual, partly retaining their original smooth, shining surface intact, some of the largest interambulacral ones are distinctly perforate, whereas others are as clearly imperforate. The perforation looks so normal and distinct that it is hard to believe it could be due to some sort of damage after the death of the animal. I do not see how it could be explained otherwise than as a case of atavism. That *Polysalenia* could have anything to do with the Acrosalenids (which have perforate tubercles) is out of question; also, it must be emphasized that it is only this single specimen which shows this perforation in some of its tubercles.

The apical system (Fig. 22) is remarkably small, only 35 % of the horizontal diameter in the type specimen, varying in the other

specimens from 31 to 37.5 %. The periproct is pushed out to the right, Ocular I being widely insert. The madreporite is unusual in the pores occupying nearly the whole of the plate, not collected in a small sunken space, as is otherwise the rule in Salenids. Some small parts of the plate devoid of pores are slightly elevated, like small islets. The apical plates otherwise smooth, excepting a few large tubercles, generally one on the central plate and one on each of the genitals 1 and 5, these three tubercles encircling the periproct. More exceptionally there may be another such tubercle at the anterior edge of the central plate and also one on the genital 3 or 4. The ocular plates as a rule have one or two smaller tubercles. These large, evidently spine-bearing, tubercles of the apical system again represent a feature unique in the Salenids.

The genital pores are of about equal size in all the (7) specimens at hand; thus no distinction of males and females is possible.

The peristome is much larger than the apical system, about 50 % of the horizontal diameter. The gill-slits are rather deep. The auricles are simple, rather high, parallel columns, at their upper ends not widening or coalescing.

The spines are unknown, and no reasonable conjecture can be made of any of the loose spines found in the same deposits belonging to this species.

7 specimens, all from Ifö (Blacksudden), collected by S. HOLM and R. HÄGG. They are all in a more or less weathered condition, the mamelon of the tubercles being only as an exception well preserved.

Polysalenia Cottaldi (LOVÉN, in litteris); n. sp.

Pl. 4. Figs. 11—13.

The only specimen at hand is 14 mm in horizontal diameter, 7.5 mm high. The test is low hemispherical, flattened on the underside. The ambulacra (Fig. 23) are distinctly sinuate, narrow on the aboral side, then at the ambitus rather suddenly widening to twice the width of the upper part, and remaining of this width unto the peristome. In the upper part there is an almost regular alternation of plates with a primary tubercle and such without a tubercle; sometimes two consecutive plates carry a tubercle. All the plates above the ambitus are simple; then at the ambitus the plates become bigeminate and trigeminate, one of the plates in each ambulacrum even 4-geminate, thus polyporous. Below the ambitus the plates are trigeminate. The pores are arranged in a single series until below the ambitus, where they become more crowded so as to form 2—3 series. The primary tubercles in the upper part are so close together as to join in the midline, leaving no

room for secondary tubercles, only at the ambitus some few secondary tubercles are found along the midline. The transition from the small primary tubercles of the upper side to the large ones at the ambitus is very abrupt; from the ambitus toward the peristome the size of the tubercles decreases very gradually. No trace of crenulation is found on the ambulacral tubercles.

Interambulacra with 5 (4) primary tubercles in each series, only on the uppermost, small plate of one column in each interambulacrum the primary tubercle is more or less rudimentary. The areoles are relatively large, confluent, the scrobicular tubercles being confined to the admedian and adradial edges. The median space of the interambulacra is very narrow, leaving no room for secondary tubercles, the scrobicular tubercles filling the whole space. There are distinct traces of crenulation on the large interambulacral tubercles.

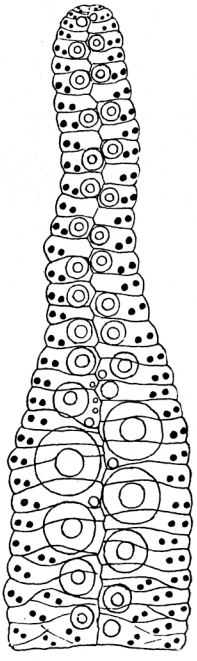


Fig. 23. Ambulacrum of *Polysalenia Cottaldi*. × 8.

The apical system (Fig. 24) is rather small, only 6 mm in diameter, thus scarcely 43 % of the diameter of the test. It is highly characteristic in having a deeply sunken edge around the periproct and a sunken space where the sutures meet, viz. at the corners of the suranal plate and at the inner corner of the ocular plates. In all these sunken spaces distinct tubercles are found; there has, accordingly, been a circle of spines round the periproct, and one or two spines in the sunken spaces — true spines, not non-articulated, spine-like prominences such as are found in various Salenids. Also the outer corners of the ocular plates and a narrow outer part of the genital plates are sunken, the genital pore lying in this sunken part. The ocular pore lies below the edge. The madreporite has the pores confined to the distal half, arranged in irregular groups. The proximal half of the madreporite is thick, raised, as are the other genital plates. The periproct is pushed out towards the right, Ocular I being broadly insert.

The peristome is conspicuously larger than the apical system, 8 mm in diameter, thus 57 % of the diameter of the test. The gill-slits appear to have been rather shallow.

The specimen is labelled: Bromölla. A. F. Carlsson. This evident-

ly means that it comes from the Ifö deposit, Bromölla being, as stated above, a factory, not a geological locality.

That this species is quite distinct from *P. notabilis*, and by no means to be regarded only as a young specimen of the latter, is quite evident. The characters of the apical system and the ambulacra leave no doubt that it must be congeneric with *Polysalenia notabilis*, but representing a much less progressed stage in regard to the ambulacral structure, the polyporous condition having just been reached. Also, the pore zones are much less widened at the peristome than in *P. notabilis*, the adaptation to life on a rocky shore being much less pronounced than in the latter.

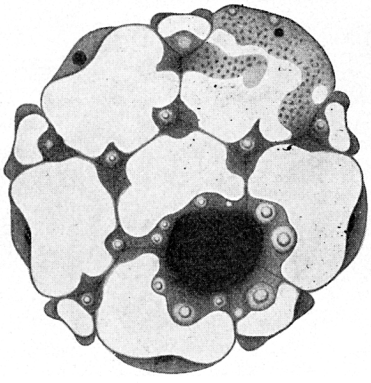
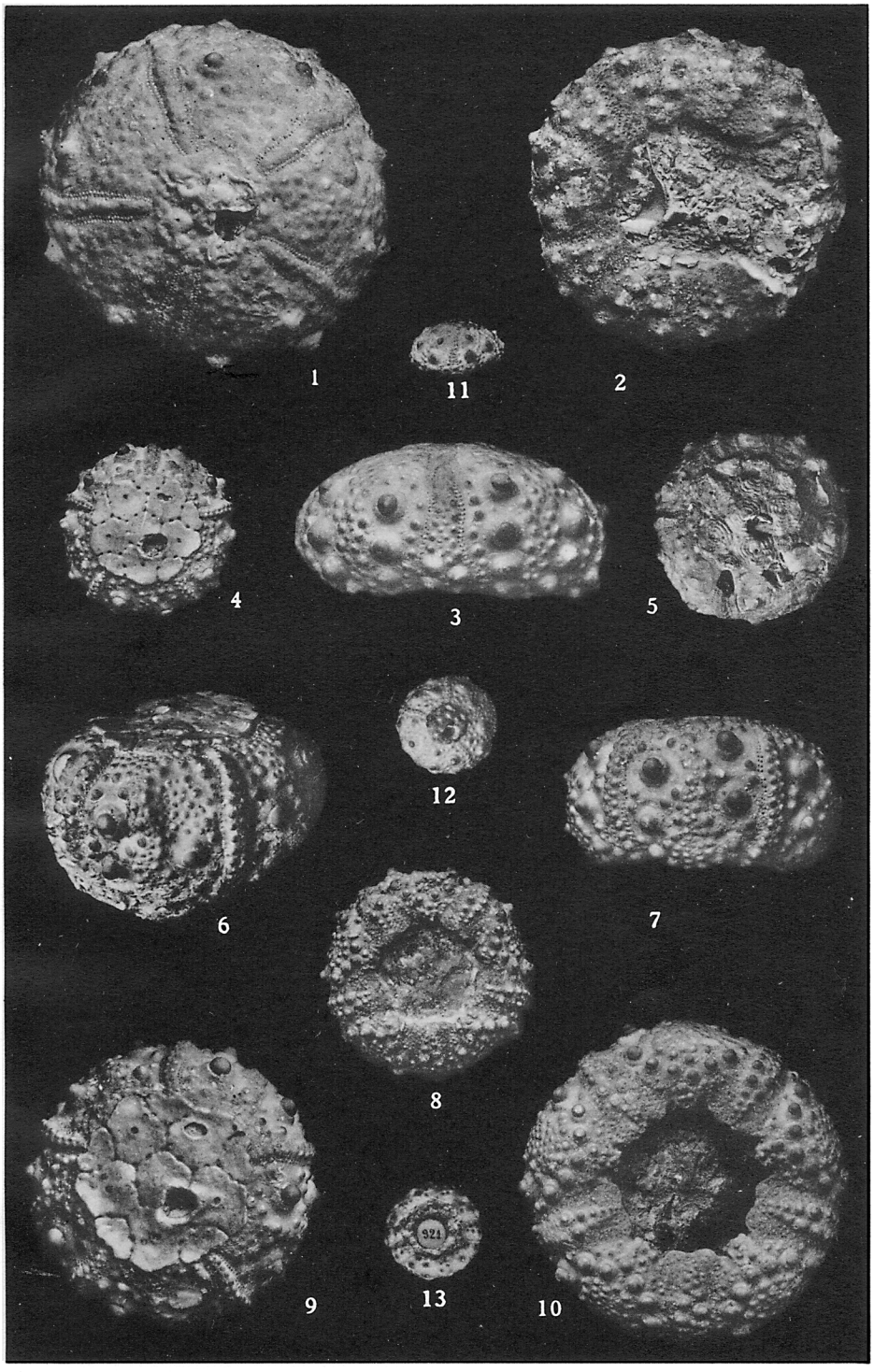


Fig. 24. Apical system of *Polysalenia Cottaldi*. × 8.

The specimen is fortunately in very good condition, only the tubercles being somewhat worn, so that the exact size of the mamelon in the ambulacral tubercles can only be ascertained here and there. In spite of its small size the specimen appears to be adult.

The specimen was labelled in Lovén's hand »*H. Cottaldi* n«. Perhaps this means that Lovén regarded it as belonging to the genus *Hyposalelenia*. This is, however, out of question. But I have thought it fair to designate the species with the name *Cottaldi* given to it by Lovén in honour of the great French palæontologist, to whom echinological science must foreover owe the deepest admiration for his glorious work on fossil Echinoids.



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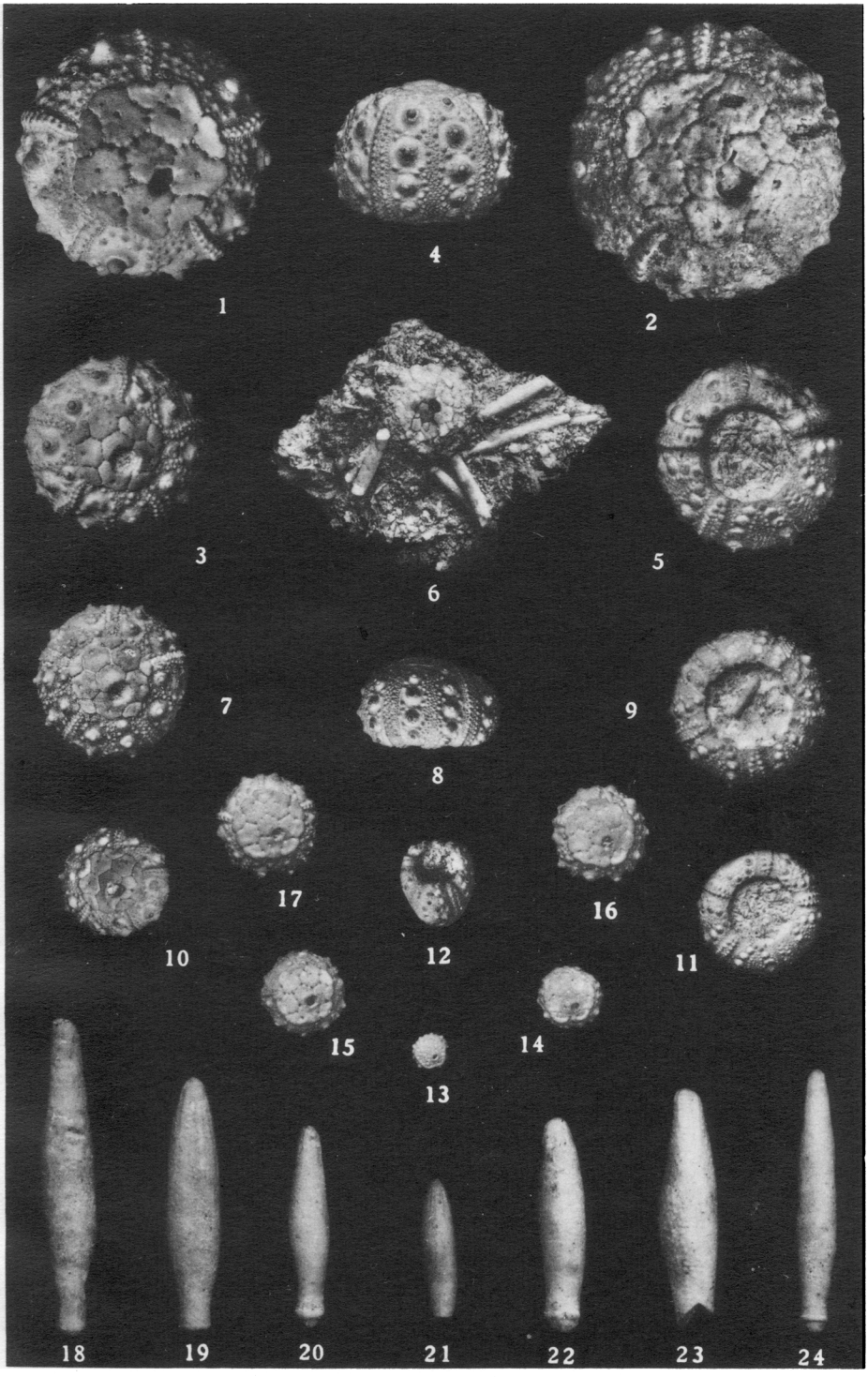

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A. BÖRTZELLS TRYCKERI A. B. STHLM.

EXPLANATION OF THE PLATES.

Plate 4.

Figs. 1—3. *Polysalenia notabilis* MRTSN. Aboral (1), oral (2), and lateral view (3). Fig. 1 represents the Holotype.

Figs. 4—10. *Trisalenia Loveni* (COTTEAU). 4. A young specimen from above; 5. weathered specimen, showing growth rings; 6. a large specimen in side view, showing the anomaly of the primary tubercle lacking on one of the upper interambulacral plates, being replaced by a number of secondary tubercles; 7. large specimen in side view; 8. a younger specimen from the oral side; 9. a large specimen from above; 10. a large specimen from the oral side.

Figs. 11—13. *Polysalenia Cottaldi* (LOVÉN). Type specimen, in side view (11), aboral side (12), and oral side (13).

All figures natural size.

Plate 5.

Figs. 1—2. *Trisalenia Loveni* (COTTEAU). 1. Large specimen, aboral side; 2. abnormal specimen, with three suranal plates.

Figs. 3—5. *Salenia Lundgreni* COTTEAU. Type-specimen, from above (3), in side view (4), and from below (5).

Figs. 6—12. *Salenia areolata* (WAHLENBERG). 6. Specimen with some of the primary spines preserved; 7. large specimen, from above; 8. large specimen in side view; 9. large specimen, from the oral side; 10. smaller specimen, from above; 11. medium sized specimen, from the oral side; 12. small, abnormal specimen, showing distinct pores in one, swollen interambulacrum, probably due to a parasite.

Figs. 13—17. *Trisalenia Loveni* (COTTEAU); series of young specimens, all from above.

Figs. 18—24. Primary spines of *Trisalenia Loveni* (COTTEAU).

All figures natural size.