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ON LIASSIC AMMONITES FROM SKÅNE, SOUTHERN SWEDEN

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6. On Liassic ammonites from Skåne, southern Sweden

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CONTENTS

Abstract. Ammonites of Sinemurian to Toarcian age from southern Sweden are described and figured. The material comes from the northwestern and southeastern Lias occurrences of the area. One new species, *Euagassiceras lundgreni* sp. nov., is described.

ACKNOWLEDGEMENTS

The author wishes to acknowledge his indebtedness to Professor G. REGNÈLL of Lund for making the greater part of the collection studied available. Dr. D. DONOVAN, Bristol, kindly gave much helpful advice on Jurassic ammonite taxonomy both in correspondence and during his visit in Stockholm in April, 1958; the author also wishes to thank Dr. DONOVAN for reading and criticizing the manuscript. Professor H. HÖLDER answered many questions during the author's visit to Tübingen in June, 1958 and guided him through the QUENSTEDT collection. In this connexion thanks are due to Professor O. SCHINDEWOLF, Tübingen, for making available

the facilities of his institute and to Mr. J. WIEDMANN for assistance in various ways. Dr. K. HOFFMANN, Hannover, was of great help in supplying information on the occurrence of certain of the species treated in the lower Lias in northern Germany and also in permitting the writer access to unpublished work of his. Dr. E. BÖLAU, Hälsingborg, kindly initiated the author into certain aspects of his work on the tectonics of northwestern Skåne and Dr. H. GRY, Copenhagen, made him acquainted with the results of his investigations into the Lias of Bornholm, during a visit there in August in 1958. Dr. E. MOHRÉN, Stockholm, also supplied information. Special thanks are due to Professor I. HESSLAND, Stockholm, for first interesting the writer in the Lias ammonites of southern Sweden.

Most of the photographs were taken by Mr. L. KUTNAR and the maps were redrawn by Miss M. ASKLIN, both of the Geological Institute; technical assistance was rendered by Mr. B. STEEN. Part of the cost of the investigation and publication was defrayed by grants from The Swedish Natural Science Research Council. Financial assistance towards the cost of the field work was received from "THOMAS NORDSTRÖM's testamentsfond" and the Department of Geology, University of Stockholm.

REPOSITORIES

The repositories of the specimens treated are Paleontologiska institutet, University of Lund (L.), Geologiska institutet, University of Stockholm (G. I.), Sveriges Geologiska Undersökning (S. G. U.) and Paläontologisches Institut und Museum, Tübingen. The letters in brackets denote the abbreviations used in the text.

INTRODUCTORY REMARKS

Lias ammonites were first described from Sweden by LUNDGREN (1881). In this paper a large number of pelecypods were figured but only a few ammonites, the determinations of the latter being based on a small number of specimens. MOBERG (1888) in describing pelecypods from the Lias deposits of southeastern Skåne, exposed in the Fyle valley, also treated an ammonite species. The comprehensive account of the Jurassic stratigraphy of Skåne published by TROEDSSON (1951) also included reference to a few ammonites, of which one fragment was figured. The last author to be concerned with Swedish Jurassic ammonites was NILSSON (1953) who figured the largest Jurassic ammonite yet found in Sweden in a popular account of the paleontology of the Höganäs area.

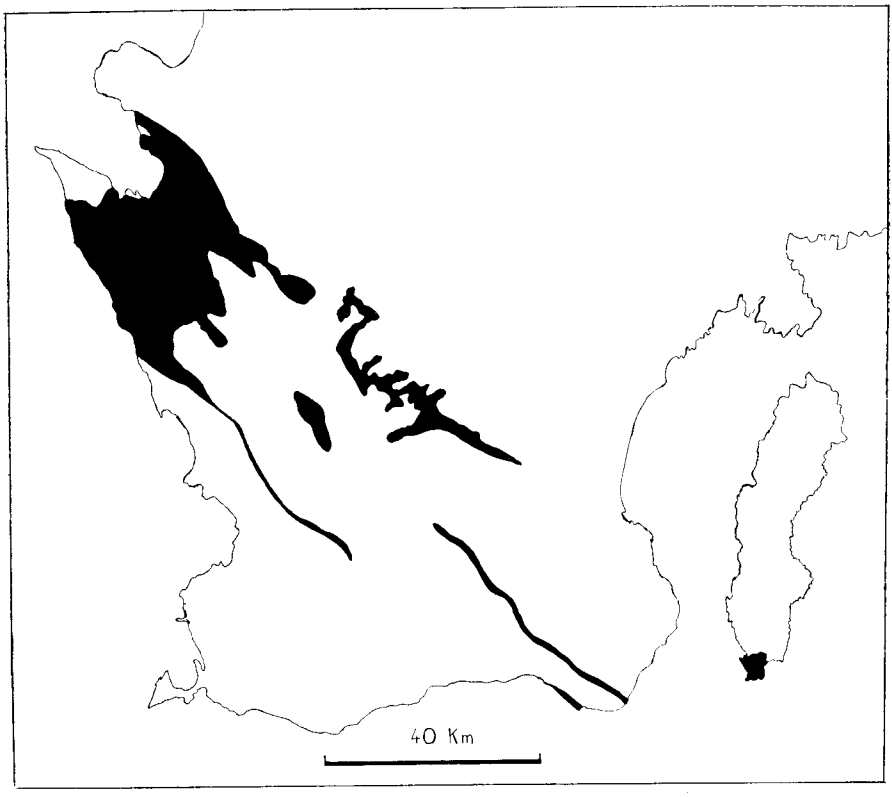
In the period of time since LUNDGREN recorded some 8 specimens a fairly large amount of material has been brought together, most of it in Lund, but also a few specimens in Stockholm. Considering the im-

portance of ammonites in Mesozoic stratigraphy and the now outmoded determinations of LUNDGREN, in which all species were referred to the "genus *Ammonites*", it was decided that an evaluation of the material already at hand was called for. Ammonites are far from rare in certain sequences of the area under consideration, as proved by cored boreholes, but owing to the intensive cultivation and the scarcity of natural exposures, the field collector is seldom rewarded. Up to about 70 years ago it was the custom to obtain fertilizer by digging so-called "marl pits" *(märgelgravar)* in clays with generally some calcareous content. More than half of the specimens treated in the present paper were collected by H. SJÖGREN, a student of LUNDGREN's, from such excavations. This method is no longer employed as better fertilizer is more conveniently obtainable from other sources. Although no definite chronologic information is available it would seem that the bulk of the material brought to Lund by SJÖGREN was collected after the preparation of LUNDGREN's monograph, as no mention is made therein of further material of the species treated and the SJÖGREN collection embraces many more forms, in better preservation, than those figured by LUNDGREN.

The present author had three opportunities of becoming acquainted with the area, first a few days in August, 1956, on a geological excursion under the leadership of Professor I. HESSLAND, and later in the summers of 1957 and 1958. The valuable borehole material from Nya Vilhelmsfält and Oregården, already commented on by TROEDSSON (1938, 1951), was studied by the writer at Lund in 1957 and more intensely in 1958, thanks to the courtesy of Professor G. REGNÈLL. Particularly Oregården proved to be richly ammonitiferous but also the Vilhelmsfält cores yielded ammonites of very great interest.

The present study makes no claims whatsoever to being a comprehensive monograph of the Lias ammonites of Sweden. It does cover the collections such as they are to date (apart from some of the Vilhelmsfält species being treated by Dr. K. HOFFMANN in a forthcoming separate account), but every new borehole will without doubt bring up hitherto unrecorded forms. As will become apparent from the following pages, ammonites occur in sufficient numbers throughout the Swedish Lias to permit accurate correlation with the standard zonal sequence and fortunately, therefore, the pessimistic picture once painted by TROEDSSON (1955, p. 605) is exaggerated.

The present research has resulted in several essential deviations from the stratigraphic framework envisaged by the late Professor TROEDSSON (1951, 1954); for example, the Kattslösa formation is proved to belong to the Lias β and not Lias γ and uppermost Lias (Lias ε) is demonstrated to occur, whereas TROEDSSON believed the youngest possible division to be Lias δ (TROEDSSON, 1955, p. 606). It should nevertheless be borne in mind that TROEDSSON's pioneer work on the Swedish Jurassic laid the grounds to all future work on the subject.



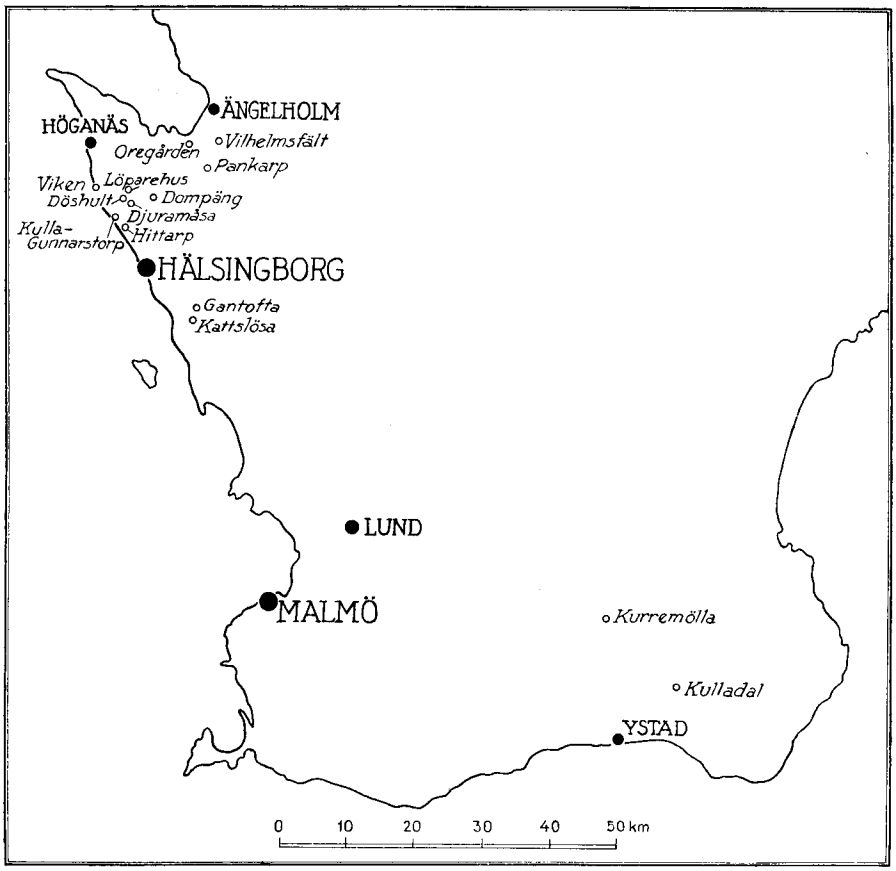
Sketch map showing roughly the distribution of Jurassic and Rhaetic (marked in black) in the province of Skåne, southern Sweden (after EKLUND (1937; Sveriges Geologiska Undersökning, geological map of Skåne), MOHRÉN (1948), and TROEDSSON, 1951). The inset map displays the position of the county of Skåne relative to the rest of Sweden.

PROVENANCE OF THE MATERIAL

As already observed, the rarity of ammonites in surface exposures is no indication of their actual abundance and every borehole through marine strata is likely to yield large numbers of specimens. Over the last 70 years, however, a moderately large collection has accumulated from outcropping beds and most of the material forming the basis of the present paper is derived from the Döshult area. The lists of species from the various localities are given below; the locations of the boreholes, outcrops and wells are given in the accompanying sketch map.

Northwestern Skåne

1. *The Döshult area.* — This area includes the classical localities from which LUNDGREN's material was obtained. The marl pits in the Dompäng, Djuramåsa, Viken, and Döshult vicinities are no longer accessible (cf.



Sketch map showing the location of localities and boreholes in northwestern and southeastern Skåne, mentioned in the text.

TROEDSSON, 1951, p. 41). During a visit in 1957 the writer was able to collect a few fragmentary specimens from a temporary excavation at Dompäng. The following species have been found:

Paracoroniceras charlesi DONOVAN
Paracoroniceras crossi (WRIGHT)
Megarietites meridionalis (REYNÈS)
Agassiceras scipionianum (D'ORBIGNY)
Agassiceras nodulatum (BUCKMAN)
Euagassiceras lundgreni sp. nov.
Euagassiceras resupinatum (SIMPSON)
Cymbites striaries (QUENSTEDT)
Euagassiceras spinaries (QUENSTEDT)
Arnioceras falcaries (QUENSTEDT)?
Coroniceras (Primarietites) reynesi (SPATH)

2. *Hittarp.* — In a coarse, ferruginous grit, very rich in plant material, and which may be a lateral continuation of TROEDSSON's Döshult formation a single ammonite was found by the writer in 1957. This specimen could only be determined as to the genus as *Arnioceras* sp. indet.

3. *Nya Vilhelmsfält borehole.* — This cored hole was drilled in 1917 to a depth of 426.24 m (cf. TROEDSSON, 1938, pp. 516, 517; 1951, p. 30). TROEDSSON mentioned the presence of ammonites at depths of around 180 and 240 m and announced his intention of working through the core. This was never completed owing to TROEDSSON's demise. In 1954 E. BÖLAU of the Höganäs—Billesholm Co. made a preliminary investigation of the remains of the core and took out all the ammonites at the two levels mentioned by TROEDSSON. The fossils were later sent to K. HOFFMANN, Hannover, and it is to these two workers credit is due for first recognizing the presence of Upper Lias in northwestern Skåne. This was also confirmed by ammonites recovered from the cored hole drilled by the Höganäs—Billesholm Co. at Pankarp nearby. In 1958 the present writer spent two days in going through what was left of the material from Nya Vilhelmsfält, preserved in the borehole archive at the University of Lund. At 170 m several well preserved fragments of *Dactylioceras* cf. *tenuicostatum* (Y. & B.) were found. The ammonites from Pankarp, Nya Vilhelmsfält 240, 180 m, and a borehole at Kattslösa are preserved in the collection of the Amt für Bodenforschung, Hannover.

4. *Oregården borehole.* — At depths of 53 and 63 m ammonites were encountered. The following species occur:

Euagassiceras resupinatum (SIMPSON)
Agassiceras spp.
Cymbites striaries (QUENSTEDT)
Arnioceras sp.

5. *The sequence at Kattslösa.* — This sequence between Kattslösa and Gantofta has yielded ammonite fragments of the genera *Eparietites* and *Promicroceras* in its lower parts, which indicate the presence of middle Upper Sinemurian. Unfortunately, the fragment referred by TROEDSSON to *Uptonia* could not be located so conclusive evidence for Pliensbachian is lacking, although it is quite possible that the upper part of the sequence in question may belong to that stage.

Southeastern Skåne

Ammonites are less frequently found in this area than in the aforementioned. The following forms have been found in the Fyle Valley, particularly at Kurremölla:

Uptonia jamesoni (SOWERBY)
Uptonia angusta (QUENSTEDT)
Uptonia sp. juv.
Polymorphites sp. indet.

At Kulladal numerous badly preserved fragments of *Oxynoticeras*? sp. indet. have been collected, thus indicating the possible presence of Upper Sinemurian. No Lower Sinemurian has yet been recorded from south-eastern Skåne.

DESCRIPTIVE SECTION

Preliminary observations

The material occurs in two preservations; all specimens from surface exposures are ferruginized, often with calcitic cameral fillings, but generally consisting of ironstone. Specimens from borehole cores are unaltered, so that the original aragonitic shell material is preserved. Core specimens are seldom mature and mostly crushed; it is of interest to record that all ammonites obtained from the cores at Oregården and Nya Vilhelmsfält were found in shale, often rich in plant debris; the ammonites derived ftom surface exposures come either from ironstone or clay. Considering rhe fact that much of the material is well preserved it is strange that sutures are uncommonly found.

The systematic subdivisions employed in the following are those proposed by ARKELL (1957).

FAMILY ARIETITIDAE HYATT, 1874

SUBFAMILY ARIETITINAE, HYATT, 1874

Genus *Coroniceras* HYATT, 1867

Subgenus *Primarietites* BUCKMAN, 1926

TYPE SPECIES. — *Primarietites reynesi* (SPATH).

Coroniceras (Primarietites) reynesi (SPATH)
Plate I, fig. 1

1879 *Ammonites multicostatus* SOWERBY, REYNÈS, pl. 24, figs. 18, 19.
1879 *Ammonites multicostatus* SOWERBY, var. *spinaries* QUENSTEDT, pl. 24, figs. 25—28.
1923 *Agassiceras reynesi* SPATH, p. 73.
1926 *Primarietites primitivus* BUCKMAN, pl. 678.
1952 *Coroniceras (Primarietites) reynesi* (SPATH), DONOVAN, p. 737, pl. 29, fig. 1; text-fig. 14.
1955 *Coroniceras (Primarietites) reynesi* SPATH, DONOVAN, pp. 29, 30.
1957 *Primarietites primitivus* (= *Agassiceras reynesi* SPATH, 1923), ARKELL, p. L 239, fig. 262, 2.

REPOSITORY. — Lund, LO 3904.

PROVENANCE. — "Ammonitbanken", Döshult, N. W. Skåne.

COLLECTOR. — H. SJÖGREN.

AGE. — Lower Sinemurian; according to DONOVAN (1955, p. 29) *C. reynesi* has its typical development in the *gmuendense* subzone of the *semicostatum* zone.

DESCRIPTION. — A single large specimen is referred here. The body chamber occupies at least two-thirds of the last whorl. The ribs are simple; they are slightly bowed to straight on the flanks. At the ventrolateral shoulder they flare somewhat to form an elongated subtubercle; on the venter they swing sharply forwards and vanish rapidly short of the keel. The ribs begin slightly above the umbilicolateral margin and the last preserved rib is twice as strong as the preceding rib. There are no side furrows to the strong keel and the venter is arched. The last half whorl possesses 12 ribs and the second last whorl has 24 ribs. The presence of much altered shell on the inner whorls obscures the sutures.

DIMENSIONS. —

diameter	= 211 mm	(= 1.00)	(of the partially preserved outer whorl)
thickness	= 38 »	(= 0.18)	
umbilicus	= 115 »	(= 0.55)	
height of last whorl	= 51 »	(= 0.24)	

REMARKS. — The Swedish specimen agrees well with the figures given by BUCKMAN (1926, pl. 678); both have about the same number of ribs on the last half whorl. On first sight the agreement is less satisfactory with REYNÈS figures (1879, pl. 24, figs. 18, 19, 25—28) as these are more densely costate and the ventrolateral tubercles are more distinct. The inner whorls of our specimen indicate, however, that the ribbing gradually becomes more spaced with growth; at a diameter of 60 mm there are approximately 36 ribs, which agrees well with the 32—36 ribs of REYNÈS specimens. The English and Swedish specimens would seem to be of approximately the same size and much larger than the others.

DONOVAN (1952, p. 738) observed that BUCKMAN's specimen from Radstock is atypical of the species in the rather low rib-frequency, but indicated that this feature is not outside the range of variation observed by him in the assemblage from Bristol. The Swedish specimen would seem to lie near BUCKMAN's.

Genus *Megarietites* SPATH, 1922

TYPE SPECIES. — *Ammonites meridionalis* REYNÈS.

REMARKS. — This genus was regarded by DONOVAN (1955, p. 15) and ARKELL (1957, p. 238) as synonymous with *Pararnioceras*, the latter being regarded as invalid. In a personal communication Dr. DONOVAN pointed out to the writer that the name *Pararnioceras* was published in January, 1922, as against April, 1922, for *Megarietites*. If the two forms then are synonymous, *Pararnioceras* must have priority. The author desists at this

stage from expressing an opinion on the question as he feels access to the type material to be essential before a decision may be made.

Megarietites meridionalis (REYNÈS)

Pl. II, figs. 1, a—b; pl. III, figs. 1, a—b; fig. 1

1879 *Ammonites meridionalis* REYNÈS, pl. 22, figs. 1, 2, 3.

1924 *Megarietites meridionale* REYNÈS sp., BUCKMAN, pl. dxviii.

1927 *Megarietites meridionalis* REYNÈS sp., BUCKMAN, pls. dxviii A, B.

1952 *Megarietites meridionalis* (REYNÈS), DONOVAN, p. 741.

1955 *Pararnioceras meridionale* (REYNÈS), DONOVAN, p. 14.

1957 *Megarietites meridionalis* (REYNÈS), ARKELL, p. L238, fig. 263, 1, a—d.

MATERIAL. — 7 fragments.

REPOSITORY. — Lund, LO 3905—LO 3909 B.

PROVENANCE. — Döshult.

COLLECTOR. — Unknown.

AGE. — Lower Sinemurian; according to DONOVAN (1955, p. 14) *M. meridionalis* has its typical development in the *gmuendense* subzone of the *semicostatum* zone; it is also known in the upper *bucklandi* zone (ARKELL, 1956, p. 67).

DESCRIPTION. — The collection contains only large fragments of the species. Specimen LO 3906 (pl. III, figs. 1, a—b) is strongly tricarinate on the inner preserved whorl but on the last preserved portion the side keels are very weak; the three keels are equally strong on the inner whorls. The ribs are slightly bent and culminate on the last part in feeble tubercles. The strength of the median keel varies considerably on adult whorls and in specimens LO 3905 and LO 3908 it is relatively high and sharp; on LO 3907, however, it is feeble. Specimen LO 3905 (pl. II, figs. 1, a—b; fig. 1) has straighter ribs than the other specimens that are straight and sharp on the inner preserved whorl.

The whorl section of the Swedish specimens is subquadrate with a tendency for the flanks to slope towards the venter.

The furrows beside the median keel may virtually disappear (LO 3907). One specimen (LO 3908) is relatively strongly ornamented with a sharp, parallel-sided keel and moderately strong tubercles.

REMARKS. — The specimens agree well with REYNÈS' (1879, pl. 22, figs. 1, 2) original drawings, although the slope of the ventrolateral shoulders of his fig. 1 seems to be more angular and steeper; specimen LO 3907 is, however, closely comparable in this respect. DONOVAN (1952, p. 741) noted that the degree of slope of the ventrolateral shoulders of the type specimen as figured is exaggerated. A crushed fragment (LO 3909) seems

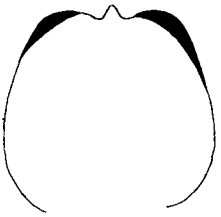


Fig. 1. *Megarietites meridionalis* (REYNÈS). Whorl section of specimen LO 3905. (× 0.5).

to display the type of ornament on the ribs and intercostal areas mentioned by BUCKMAN (1927, pl. dxviii A). Specimen LO 3907 A in ventral aspect is very close to BUCKMAN's figure (1927, pl. dxviii B) as regards the remnants of the side keels uniting the ventral terminations of the ribs.

The Swedish specimens differ from the two representatives figured by BUCKMAN (1924, 1927) in having generally weaker side keels on mature whorls.

Genus *Paracoroniceras* SPATH, 1922

TYPE SPECIES. — *Ammonites gmündensis* OPPEL (= *Paracoroniceras charlesi* DONOVAN).

Paracoroniceras charlesi DONOVAN

Pl. I, figs. 2, a—b; fig. 2

1879 *Ammonites Gmundensis* OPPEL, REYNÈS, pl. 16, figs. 1, 2.

1881 *Ammonites bisulcatus* BRUG., LUNDGREN, p. 51.

1951 *Coroniceras bisulcatum* BRUG., TROEDSSON, p. 240.

1955 *Coroniceras (Paracoroniceras) charlesi* DONOVAN, p. 12.

MATERIAL. — A single fragmentary specimen.

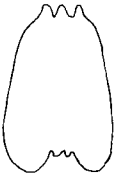
REPOSITORY. — Lund, LO 3910 (original to LUNDGREN, 1881, p. 51).

PROVENANCE. — Djuramåsa.

COLLECTOR. — H. SJÖGREN.

AGE. — Lower Sinemurian; *P. charlesi* is an early form in the *semicostatum* zone and occurs in the *gmuendense* subzone thereof.

DESCRIPTION. — The specimen is a fragment about 50 mm in length. The maximum whorl height is 22 mm and there are 9 ribs present. The maximum whorl width, measured over the intercostal area, is 14 mm and this occurs at the umbilical margin. The venter is bisulcate and strongly tricarinate. The ribs are relatively high and sharp and curve slightly with



Fig, 2. *Paracoroniceras charlesi* DONOVAN. Whorl section of specimen LO 3910. (× 0.5).

the convexity facing inwards; they thicken a little towards the venter and some terminate in subtubercles just below the outer keels. There is a tendency for the ribs to bend forwards just short of the ventrolateral shoulder. A few ribs reach the outer keels, but most weaken and disappear a short distance away from these. All three keels are equally thick and strong.

REMARKS. — The specimen was referred to "*Ammonites bisulcatus*" by LUNDGREN (1881). It has, however, a higher whorl section and stronger keels that are more deeply bisulcated. The agreement with REYNÈS' figures is good (REYNÈS, 1879, pl. 16, figs. 1, 2), although his drawings do not show a tendency towards thickening of the ventral terminations of the ribs.

Unfortunately the exact provenance of the specimen is unknown, as it was picked up loose in crushed rock *(krosstenslera)*. The original label bears a note by LUNDGREN saying that the specimen in all probability came from the "ammonitbank", although it was found in loose material in the fields around property 12 at Djuramåsa, northwestern Skåne.

Paracoroniceras crossi (WRIGHT)

Pl. IV, fig. 1; figs. 3, a—b

1879 *Arietites crossi* WRIGHT, p. 283, pl. 10, figs. 1, 2.

1953 "*Arietites*", NILSSON, p. 161, fig. 34.

1954 *Coroniceras (Paracoroniceras) crossi* (WRIGHT), DONOVAN, p. 27.

MATERIAL. — A single large, well-preserved specimen.

REPOSITORY. — Lund, LO 3911.

PROVENANCE. — Dompäng in the Döshult district.

COLLECTOR. — Unknown.

AGE. — Lower Sinemurian; according to DONOVAN (1954, p. 27) the holotype comes from the *gmuendense* subzone of the *semicostatum* zone.

DESCRIPTION. — The specimen consists of at least nine whorls of which the final quarter whorl is body chamber. The last whorl is, however, incomplete and it seems probable that the body chamber was much

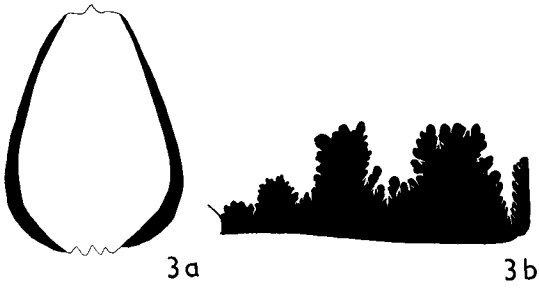


Fig. 3, a—b. *Paracoroniceras crossi* (WRIGHT); a, whorl section (× 0.3); b, suture line (weathered) (× 0.5). Specimen LO 3911.

longer, possibly at least an entire whorl. The whorl section is high (B/H = 76 %) and the coiling very evolute. Owing to damage to the umbilicolateral part of the last part of the last preserved whorl (see pl. IV, fig. 1) the coiling appears more evolute than is actually the case. As far as can be ascertained the ribbing is simple throughout. The ribs are weakly concave-forwards and widen and vanish at the side keels. At the beginning of the last whorl the side keels are moderately strong and the side furrows broad and rather deep. On the last half of the whorl the furrows become broader and shallower and the side keels round off until barely perceptible. The umbilicus occupies about 56 % of the total diameter. At a diameter of 385 mm there are 29 ribs; at a diameter of 330 mm there are 30 ribs.

Owing to the weathered nature of the surface of the specimen no well-preserved sutures occur; the suture line figured in fig. 3 b is therefore only approximate.

DIMENSIONS. —

diameter	= 385	mm	(= 1.00)	
thickness	= 63	»	(= 0.16)	(measured intercostally)
	71	»	(= 0.18)	(over the ribs)
umbilicus	= 215	»	(= 0.56)	
height of last whorl	= 93	»	(= 0.24)	

REMARKS. — The present specimen agrees most closely with *Paracoroniceras crossi* (WRIGHT) and is referred to that species, although certain differences do occur. At a diameter of about 360 mm the figure of the holotype has about 26 ribs and is thus slightly less densely ribbed than the Swedish form. The B/H ratio is approximately 83 % (ascertained from the figure), while that of the Swedish specimen is 75 % and the umbilicus of the holotype takes up about 51 % of the total diameter and that of our specimen 56 %. The ribs of the holotype as figured seem to be slightly more bent and a little stronger near the umbilical margin. The ventral terminations of the ribs of our specimen are somewhat stronger at the beginning of the last whorl but with a definite tendency towards weakening there. Unfortunately, *P. crossi* is a rare and poorly known species.

The specimens attributed by SCHMIDT (1914, pl. 3, figs. 1, 2) to *P. crossi* are similar, as far as can be judged from the figures, but the ribbing is denser.

The present specimen was mentioned and figured by NILSSON (1953, p. 161, fig. 34) but it does not seem to have been known to LUNDGREN; it would therefore seem likely that it was collected after the appearance of his monograph.

Paracoroniceras charlesi DONOVAN (1955) is somewhat similar but it is more densely ribbed. The specimen figured by HYATT (1889, pl. 6, figs. 1, 2) as *P. gmuendense* is less densely ribbed although its whorl section is similar. Another comparable species is *P. trigonatum* (HYATT) (1889, pl. 7, fig. 1) but it has a more depressed whorl section and is less densely ribbed.

Genus *Agassiceras* HYATT, 1875

TYPE SPECIES. — *Ammonites scipionianus* D'ORBIGNY.

Agassiceras scipionianum (D'ORBIGNY)

Pl. VI, figs. 1, 2; fig. 4

1844 *Ammonites scipionianus* D'ORBIGNY, p. 207, pl. 51, figs. 7, 8.

?1881 *Ammonites scipionianus* D'ORB., LUNDGREN, p. 55.

1952 *Agassiceras scipionianum* (D'ORBIGNY), DONOVAN, p. 745.

1956 *Arietites (Agassiceras) scipionianus* (D'ORBIGNY), WALLISER, p. 205.

MATERIAL. — 11 specimens.

REPOSITORIES. — Lund, with plastic molds of the important specimens in the museum of Geologiska Institutet, University of Stockholm; LO 3915, LO 3916 (= plastic mold, G. I. C 1201), LO 3917, LO 3918 (G. I. C 1203, as well as several unnumbered specimens not specifically treated in the text).

PROVENANCES. — Djuramåsa property 12, Döshult, northwestern Skåne.

COLLECTORS. — Unknown.

AGE. — Lower Sinemurian; *scipionianum* subzone of the *semicostatum* zone.

DESCRIPTION. — The collection contains a number of specimens that seem to be typical for the species. Specimen LO 3915 (pl. VI, fig. 1) represents a more strongly ornamented variety and is probably best regarded as transitional to *A. nodulatum* (BUCKMAN). It is slightly distorted but otherwise well preserved. At a diameter of 125 mm there are 28—29 ribs on the last whorl. The ribs are weakly convex inwards and mostly simple; in rare cases a tendency to develop loops in the umbilical area is to be discerned. Occasionally 2 ribs begin together at the umbilical margin where a subtubercle forms; such ribs are of unequal strength. On earlier whorls the ventrolateral tubercles are strong and rounded, but on the last whorl they weaken gradually. The ribs are always strongest in the umbilical third of the side there being a consistent tendency for the ventral sides of the ribs to vanish [such a tendency is not apparent in *Agassiceras nodulatum* (BUCKMAN)]. At the beginning of the last whorl some of the ribs swing forwards on the venter and fade before reaching the keel but on the last half whorl the area between the ventrolateral tubercles and the keel is smooth. The keel is at all stages very prominent and slightly undercut. There are 7 whorls. The whorl section is depicted in fig. 4.

The tendency of the Swedish representatives of the species towards the development of a smooth outer area is shown more emphatically by specimen G. I. C 1201 (plastic mold; original in Lund, LO 3916). This specimen consists of a fragment showing the venter and part of the flank

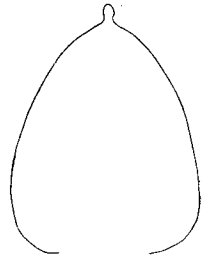


Fig. 4. *Agassiceras scipionianum* (D'ORBIGNY). Whorl section of specimen LO 3915. (× 0.6).

(pl. VI, fig. 2). The keel is high and strong, as in typical specimens, and the surface is ornamented with sinuous growth lines that run up onto the keel and cross it. Another specimen (LO 3916) has 27—28 ribs on the final whorl, which terminates at a diameter of 103 mm; the ribs are strong and tuberculate near the umbilical margin but on the last preserved whorl they fade out towards the venter and at this stage there are no ventrolateral tubercles. HYATT (1889) observed a similar suppression of the tuberculation on large individuals.

As an example of a more ornate variety may be taken specimen LO 3918 (plastic mold G. I. C 1203) in which the ventrolateral sculpture is quite strong, although the umbilical ends of the ribs are weaker. There are 27—28 ribs at a diameter of 120 mm; the growth lines follow closely the course of the ribbing. A somewhat more strongly ornamented specimen LO 3917 from Döshult has slightly fewer ribs at a diameter of 125—130 mm, there being only 25—26.

The specimen marked as being the original to LUNDGREN (1881, p. 55) is badly distorted and can only be doubtfully referred to *A. scipionianum*. It is septate but the suture is not well enough preserved to permit study and reproduction.

In the following table the numbers of ribs and whorls at the maximum diameters of four specimens are shown.

Specimen	LO 3915	LO 3916	LO 3917	LO 3918
Diameter (in mm)	25	103	125—130	120
Number of ribs	28—29	27—28	25—26	27—28
Number of whorls	7	7	6	6

DIMENSIONS. — The measurements of the most complete specimen are presented below.

diameter	= 132	mm	(= 1.00)
thickness	= 39	»	(= 0.30)
umbilicus	= 52	»	(= 0.39)
height of last whorl	= 48	»	(= 0.36) (measured from the umbilical margin).

REMARKS. — The types of variation recorded in the foregoing were also commented on by DONOVAN (1952, p. 746). The umbilicus is about 39—40 percent of the diameter, which agrees well with DONOVAN's figure of 38 percent. It is of interest to note that fully grown Bristol specimens are less than half the size of mature Swedish forms. *A. scipionianum* is more densely ribbed than the related *A. nodulatum* (BUCKMAN).

Agassiceras nodulatum (BUCKMAN)

Pl. II, fig. 2; pl. III, fig. 2; pl. V, figs. 1, a—c

1921 *Aetomoceras nodulatum* BUCKMAN, pl. ccxxii, figs. 1, 2.

1952 *Agassiceras nodulatum* (BUCKMAN), DONOVAN, p. 746.

MATERIAL. — 4 specimens.

REPOSITORIES. — Lund, LO 3914, LO 3913, LO 3912, and Stockholm, G. I. 6026.

PROVENANCES. — Döshult, Djuramåsa, property 12, northwestern Skåne.

COLLECTORS. — Unknown.

AGE. — Lower Sinemurian; *scipionianum* subzone of the *semicostatum* zone.

DESCRIPTION. — The most complete specimen is LO 3914 (pl. V) on which the apertural border is preserved. It is also noteworthy inasmuch as the costation is particularly coarse, there being 18 ribs in the last whorl; the specimen has a maximum diameter of 113 mm. The ribs are strong, undivided and straight; they begin at the umbilical margin at a weak bullate tubercle and continue on to strong, bullate ventrolateral tubercles, some of which are oblique. In the outer third of the flanks some of the ribs weaken and almost fade out (this tendency is much less pronounced than in *A. scipionianum*). The ribs swing sharply forward on the venter and then vanish before reaching the keel. The growth lines follow the course of the ribbing. There are 7 whorls. The apertural border has the same shape as the growth lines and is ventrally drawn out to a point (pl. V, fig. 1 c); it is marked by a constriction after which it flares out.

A single well-preserved fragment (G. I. 6026) shows four very slightly curved strong ribs with bullate ventrolateral tubercles. The ribs sweep sharply forwards on the venter and vanish before reaching the prominent keel. The ribbing of this specimen is finer than that of LO 3914.

Specimen LO 3913 from Döshult is noteworthy in having particularly coarse and widely spaced ribs; the maximum length of the fragment is 49 mm, the whorl height is 30 mm and there are 5 ribs.

Another fragment from Döshult (LO 3912) figured in pl. II, fig. 2 is very coarsely ribbed and resembles rather closely the specimen figured by WRIGHT (1880, pl. 19, figs. 8, 9). The keel is partly damaged. The maximum length of the specimen is 80 mm and the greatest whorl height 24 mm; on this specimen there are 7 ribs. It is septate throughout but

none of the sutures is sufficiently well preserved to permit reproduction. The growth lines are rather prominent; on the flanks they follow the course of the ribbing but sweep strongly forwards on the venter. The altered shell material is about 0.5 mm thick.

DIMENSIONS. — The dimensions of the most complete specimen, LO 3914, are given below.

diameter	= 113 mm	(= 1.00)	
thickness	= 23 »	(= 0.23)	
umbilicus	= 40 »	(= 0.36)	
height of last whorl	= 43 »	(= 0.38)	(measured from the umbilical margin).

REMARKS. — The Swedish specimens of *Agassiceras nodulatum* agree well with the raricostate Cheltenham form figured by WRIGHT (1880, pl. 19, figs. 8, 9), which has about 17 ribs at a diameter of about 70 mm. It also displays the same sort of enfeeblement of the ribbing in the middle of the flanks as shown by the complete specimen here described. DONOVAN (1954, p. 31) referred WRIGHT's specimen to *A. nodulatum* only with hesitation, and then as "aff. *nodulatum*", owing to the coarseness of the ribbing. BUCKMAN's figures of the holotype show it to have weaker ventrolateral tubercles than LO 3914. The specimen figured by REYNÈS (1879, pl. 28, figs. 3, 4), considered by DONOVAN (1955, p. 30) as being a typical representative of *A. nodulatum*, differs from LO 3914 in having more regular ribbing and weaker ventrolateral tubercles, but agrees with G. I. 6026 in both the ribbing and the tuberculation. The umbilicus of specimen LO 3914 takes up about 36 percent of the total diameter and is thus somewhat less than that of *A. scipionianum* (cf. DONOVAN, 1952, p. 746). In the following table the rib densities of *A. scipionianum* and *A. nodulatum* are compared.

Rib densities of *Agassiceras*

	Agassiceras scipionianum					*Agassiceras nodulatum*		
	DONOVAN (1952)	D'ORBIGNY (1844)	LO 3916	LO 3915	LO 3917	BUCKMAN (1921)	WRIGHT (1880)	LO 3914
Diameter (in mm).	30 50	53	103	125—30	125	68?	65	113
Number of ribs . .	18 24	25	27—28	25—26	28—29	23	17	18

Genus *Euagassiceras* SPATH, 1924

TYPE SPECIES. — *Euagassiceras resupinatum* (SIMPSON).

Euagassiceras resupinatum (SIMPSON)

Pl. IV, fig. 2, pl. VI, fig. 3; pl. VII, figs. 1, a—c; pl. VIII, figs. 1, a—b; pl. IX, figs. 1, a—b; pl. X, figs. 1, a—b, pl. XVII, fig. 5; figs. 5, a—b, 9

1843 *Ammonites resupinatum* SIMPSON, p. 15.

1844 *Ammonites Sauzeanus* D'ORBIGNY, p. 304, pl. 95, figs. 4, 5.

1881 *Ammonites Sauzeanus* D'ORB., LUNDGREN, p. 51, pl. 2, figs. 5—7; pl. 3.

1909 *Agassiceras resupinatum* SIMPSON sp., BUCKMAN, p. 6 b, pl. 6.

1951 *Coroniceras sauzeanum* D'ORB. sp., TROEDSSON, p. 240 (in part).

1952 *Euagassiceras resupinatum* (SIMPSON), DONOVAN, p. 742.

1954 *Euagassiceras resupinatum* (SIMPSON), DONOVAN, p. 27.

1955 *Euagassiceras resupinatum* (SIMPSON), DONOVAN, p. 30.

1956 *Arietites (Euagassiceras) sauzeanus* (D'ORB.), WALLISER, p. 202, encl. B, fig. 2; encl. E, fig. 6.

MATERIAL. — More than 50 specimens.

REPOSITORY. — Lund, LO 3919—3928, etc.

PROVENANCES. — Döshult, stream bed at Dompäng, borehole at Oregården (Lund no. 271), Löparehus (in the vicinity of Döshult).

COLLECTORS. — Some of the material was collected by H. SJÖGREN, B. LUNDGREN, and G. TROEDSSON; the other collectors are unknown.

AGE. — Lower Sinemurian; *sauzeanum* subzone of the *semicostatum* zone.

DESCRIPTION. — The abundant material of this species in the present collection permits an accurate description of its characters. The general features are evolute, squarish whorls with low keel and no side furrows, ventrolateral tubercles and single, rather stout ribs. The ventrolateral tubercles may be spinate on mature whorls but are mostly blunt; on young whorls they are often bullate in an oblique direction forwards. There is much variation in the strength of the keel and the ventrolateral tubercles.

Some of the specimens in the collection have portion of their body chambers preserved. Specimen LO 3928 is crushed but appears to have the entire body chamber. The apertural border is preserved; on the last part of the body chamber the ribs degenerate into folds. The last preserved third of a whorl of specimen LO 441 is body chamber.

The ribs may stop bluntly at the umbilical margin thus forming subtubercles. The ribs of specimen LO 441 become broader and flatter on

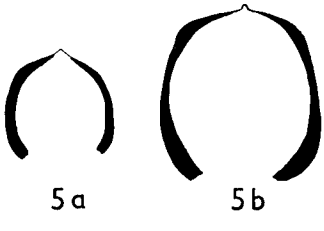


Fig. 5. *Euagassiceras resupinatum* (SIMPSON); a, whorl section of specimen with strongly arched venter and broad, ill-defined keel (LO 3924); b, whorl section of specimen with flatter venter and small though sharp keel (LO 438). (× 0.5).

the body chamber (at a diameter of 176—187 mm). On the final volution the ribs change from being perpendicular to the tangent of coiling and lean backwards, although they remain straight, occasionally a rib may fail to attain full development (see pl. X, fig. 1 b). Specimen LO 3925 has unusually knobbed tubercles on the terminations of the ribs. Specimen LO 3927 from Löparehus shows a remarkable tendency towards flexing of the ribs; it has strong ventrolateral tubercles and consists of six whorls. It could also be established for specimen LO 3919 that it is built up of six whorls. The inner whorls of specimen LO 3920 possess ribs with strong umbilical zones; this does not occur to the same extent on the outer whorls (pl. VII, figs. 1, a—b). The ribs on the last whorl of this specimen are curved slightly convex forwards.

An aragonitically preserved specimen from a depth of 53.0—53.5 m in the Oregården core, diameter about 20 mm, has strong growth lines that roughly follow the course of the costation; the ribs of this specimen are slightly flexed.

Specimen LO 3922 from a depth of 52.9—53.0 m in the Oregården core has the aragonitic shell material retained; it has strongly clavate ventrolateral tubercles with feeble extensions to the keel and in this respect deviates from typical representatives of the species; the ventral striations or growth lines interrupt the feeble keel (cf. DONOVAN, 1952, p. 742). The tubercles of specimen LO 3926 are anomalous; they are sharp and strongly drawn out obliquely on the ventral extensions of the ribs. A fairly complete specimen LO 3923 (pl. VIII, figs. 1, a—b) is one of the more strongly ornate specimens of the collection. Another similar specimen is LO 3920 which is strongly tuberculated throughout, even on the last part of the last preserved whorl, which may be body chamber, although here they become somewhat blunter.

The keel of specimen LO 3923 (pl. VIII, figs. 1, a—b) is not always exactly medianly located; at a diameter of 24 mm the keel of this specimen is stronger than usual for the species. The keel of specimen LO 441 is also stronger than that of the majority of specimens in the collection. A very weak keel is displayed by LO 438 (pl. IX, fig. 1 b). The venter is usually weakly arched; specimen LO 3924, however, has a strongly arched venter (Fig. 5 a).

The largest specimen in the collection is that figured by LUNDGREN (1881, pl. 3) and figured in pl. X, figs. 1, a—b in the present paper. The Swedish representatives of *E. resupinatum* seem generally to reach a larger

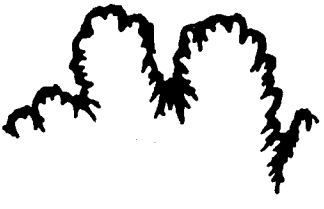


Fig. 6. *Euagassiceras resupinatum* (SIMPSON). Suture line of specimen LO 438. (× 1).

size than is usual for the species, judging from the accounts in the literature. The suture line of LO 438 is figured in fig. 6 (original to LUNDGREN, 1881, pl. 2, figs. 5—7).

REMARKS. — The Swedish representatives of *E. resupinatum* agree well with the figures of this species. BUCKMAN's figure of the holotype (1909, p. 6 b, pl. 6) agrees well with the more strongly ornamented variants in our material. The specimens recorded by WRIGHT (1878, pl. VIII, figs. 4—6) have 20—23 ribs on the last preserved whorl, slenderer ribs than is usually the case and seemingly a higher whorl section and may be transitional to *E. spinaries* (QUENSTEDT). The specimen figured by D'ORBIGNY (1844, pl. 95, fig. 5) is feebly keeled and agrees with the most weakly carinate Swedish specimens; it has strong ventrolateral terminations to the ribs.

DONOVAN (1952, p. 742) noted that the smooth initial stage of the species lasts up to a diameter of about 13 mm. A slightly stronger keel may develop around a diameter of 20 mm and tubercles usually have developed by then; he also drew attention to the common occurrence of small individuals (see above). The rib frequency of his Bristol material is about 15—17 ribs per whorl.

In a large block of ironstone in the present collection a number of identically orientated ammonites are preserved in close proximity to each other. This arrangement suggests that the empty shells drifted ashore (cf. REYMENT, 1958). Sandstone pieces from Löparehus display similar concentrations in a less favorable state of preservation. A specimen from the borehole at Oregården, LO 3922 (pl. XVII, fig. 5) in shale is embedded at right angles to the bedding and must have been buried in an upright position. It would therefore seem that this shell came to rest in mud in the same manner as the nautiloid figured by the writer recently (REYMENT, 1958, pl. II, fig. 1).

DIMENSIONS. — Measurements of some of the specimens of *E. resupinatum*.

	LO 3925	LO 3925 A	LO 441
Diameter	73 mm (= 1.00)	24 mm (= 1.00)	187 mm (= 1.00)
Thickness intercostal	19 » (= 0.26)	10 » (= 0.42)	42 » (= 0.22)
Thickness costal			48 » (= 0.26)
Umbilicus	30 » (= 0.41)	11 » (= 0.46)	82 » (= 0.44)
Height of last whorl	25 » (= 0.34)	8 » (= 0.33)	62 » (= 0.23)
	LO 3924	**LO 438**	**LO 3920**
Diameter	78 mm (= 1.00)	130 mm (= 1.00)	180 mm (= 1.00)
Thickness intercostal	24 » (= 0.31)	36 » (= 0.28)	48 » (= 0.27)
Thickness costal	26 » (= 0.34)		59 » (= 0.33)
Umbilicus	32 » (= 0.39)	58 » (= 0.46)	78 » (= 0.43)
Height of last whorl	28 » (= 0.36)	43 » (= 0.33)	63 » (= 0.35)

Where two measurements occur under "thickness" the first refers to the intercostal thickness and the second to the thickness taken over the ribs. In the table following hereunder the rib densities of several specimens are given. The diameter is taken as being the maximum diameter of the specimen.

Rib densities of *Euagassiceras resupinatum* (SIMPSON)

	LO 3925	LO 3925 A	LO 441	LO 3924	LO 3926	LO 438	LO 3920	LO 3920 A	Figure by D'ORBIGNY 1844, pl. 95, f. 4	SIMPSON'S original in BUCKMAN, 1909 pl. 6
Diameter (mm)	73	24	187	78	43	50	180	42	29	34?
Number of ribs	20—21	14	21—22	19—20	17—18	19—20	19	15—16	15	16

Euagassiceras aff. *resupinatum* (SIMPSON)

Pl. VIII, fig. 2; fig. 7

MATERIAL. — A single specimen.

REPOSITORY. — Lund, LO 3929.

PROVENANCE. — Döshult.

COLLECTOR. — Unknown.

AGE. — Lower Sinemurian; *sauzeanum* subzone of the *semicostatum* zone.

REMARKS. — The specimen referred here resembles *E. resupinatum* as regards general form and appearance but differs in being generally more strongly ornamented. The keel is relatively strong and on either side has broad, shallow furrows, a condition not found in *E. resupinatum*. The ribs are robust and straight and begin at a long umbilical subtubercle and terminate at fairly strong ventrolateral tubercles. From some of the ventrolateral tubercles the ribs continue strongly onto the venter in a direction oblique to the keel; they fade rapidly at the broad sulcus.

The whorl section also seems to be somewhat squarer (fig. 7). The specimen is 80 mm in length and has 6 ribs on the outer whorl fragment (which seems to be body chamber) and 8 ribs on the preserved portion of the second last whorl.

Euagassiceras spinaries (QUENSTEDT) has a tendency to develop faint grooves on larger whorls but differs from the form here recorded in the shape of the whorl section. The ribbing of the inner whorl preserved is

Fig. 7. *Euagassiceras* aff. *resupinatum* (SIMPSON). Whorl section at approximately 52 mm diameter. LO 3929. (× 1).

reminiscent of that of *E. terquemi* (REYNÈS) (REYNÈS, 1879, pl. 19, figs. 9—12) but the specimens are too small to permit comparison with our larger fragment.

Euagassiceras spinaries (QUENSTEDT)

Pl. IX, fig. 2; pl. X, fig. 2; pl. XI, figs. 1, a—b, 2; figs. 8, a—b, 9

1858 *Ammonites spinaries* QUENSTEDT, p. 69, pl. 7, fig. 4.

1883 *Ammonites spinaries* QUENSTEDT, QUENSTEDT, p. 79, pl. 11, fig. 8—10, 12, and possibly 13.

?1889 *Coroniceras sauzeanum* HYATT, pl. 6, fig. 14.

1927 *Paracoronites noduliferus* BUCKMAN, pl. dccxxxvii, A—B.

1952 *Euagassiceras spinaries* (QUENSTEDT), DONOVAN, p. 743.

MATERIAL. — 18 specimens.

REPOSITORY. — Lund, LO 3930—37, and unnumbered specimens.

PROVENANCE. — Döshult, Löparehult.

COLLECTORS. — The specimen from Löparehult was collected by G. TROEDSSON in 1945; the other collectors are unknown.

AGE. — Lower Sinemurian; *sauzeanum* subzone of the *semicostatum* zone.

DESCRIPTION. — Most of the material in the present collection consists of incomplete specimens. The majority are internal molds but specimen LO 3936 (pl. IX, fig. 2) has much of the shell material, though calcitized, preserved. Specimen LO 3935 is the largest fragment in the collection and it has a whorl height of 77 mm. It is here figured in order to show the nature of the coarse ribbing, the coarse growth lines and the degenerate ventrolateral tubercles (see pl. X, fig. 2).

Specimen LO 3936 possesses weakly flexed ribs that are slightly more sinuous than those of the lectotype (here figured in pl. XI, figs. 1, a—b; original to QUENSTEDT, 1883, pl. 11, fig. 8; designated lectotype by DONOVAN, 1952, p. 744; Tübingen Collection Ce 5/11/8). The ribs of

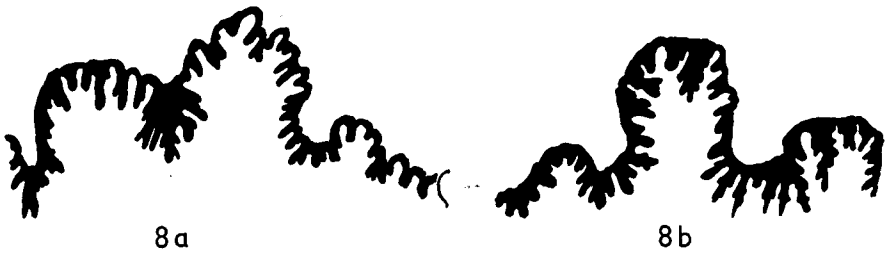


Fig. 8. Sutures of *Euagassiceras spinaries* (QUENSTEDT); a, specimen LO 3930; b, specimen LO 3934. (× 0.9).

LO 3936 are strong and simple and bend forwards on the venter; they are uneven in thickness. The forwards swing of the ribs at the ventrolateral angle and their quick subsequent fade-out is also well shown by specimen LO 3933 (at a whorl radius of about 55 mm). Most large specimens have straight to concave-forwards ribs (for example, the weathered internal mold LO 3937, pl. XI, fig. 2) and in this respect agree with the lectotype.

As most of the material is crushed the properties of the venter could be studied in only a few cases. Specimen LO 3932 has a relatively strong, almost parallel-sided keel with weakly developed ventral furrows; the ventral growth lines are spaced and strong, particularly where they join the keel. This detail is not visible on the steinkern. At a whorl height of 75 mm specimen LO 3931 has a rounded, rather flattish keel with faint, broad side furrows. The strong, sharp, club-shaped ribs swell faintly at the ventrolateral margin, continue a short distance onto the venter in a straight line at right angles to the median plane and then vanish at more than 10 mm from the keel. This specimen is closely comparable with BUCKMAN's (1927) pl. dccxxxvii A; the whorl section shown in fig. 9 also agrees.

Specimen LO 3937 has about 12 ribs to the half whorl (incomplete) at a diameter of 110 mm and LO 3936 (pl. IX, fig. 2) has about 17 ribs at a diameter of 41 mm. There is a clear tendency towards greater rib density with increase in size. By way of comparison the lectotype has about 23 ribs at a diameter of 106 mm whereas BUCKMAN's (1927) specimen has about 28 ribs. DONOVAN (1952, p. 743) noted the number of ribs to the whorl to increase from around 20 at a diameter of 5—6 cm to about 30 at 14—15 cm or more. The tendency of some of the earlier ribs of LO 3936, a small specimen, to divide was not duplicated in the rest of the material; this specimen has also convex-outwards ribs whereas the lectotype and the other specimens in the collection studied have concave-outwards ribs; it would therefore seem likely that there is a change in the direction of curvature during growth.

Specimens LO 3936 and LO 3933 have moderately sharp, pinched-up tubercles at the ventrolateral margin. The last preserved tubercle of the former is developed as a loop.

The ventral growth lines are almost identical with those of *Euagassiceras resupinatum* (SIMPSON); they are poorly visible on steinkerns but strong and ridged where shell material is preserved.

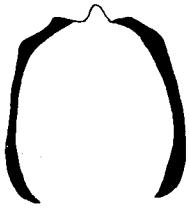


Fig. 9. *Euagassiceras spinaries* (QUENSTEDT). Whorl section of specimen LO 3931. (× 0.5).

In contrast to the other Swedish Lias species suture lines are not uncommonly preserved in *E. spinaries*; those of specimens LO 3930 and LO 3934 are figured in figs. 8, a—b.

DIMENSIONS. —

	LO 3936	LO 3937	lectotype
Diameter	41 mm (= 1.00)	110? mm (= 1.00)	106 mm (= 1.00)
Thickness	?	40 » (= 0.36) 44 » (= 0.40)	34 » (= 0.32) 37 » (= 0.35)
Umbilicus	18 » (= 0.44)	67 » (= 0.61)	49 » (= 0.46)
Height of last whorl	17 » (= 0.42)	46 » (= 0.42)	35? » (= 0.33)

The double measurements under "thickness" refer to costal and intercostal thicknesses. The last part of the lectotype is damaged.

REMARKS. — The species here recorded is like *E. resupinatum* (SIMPSON) but it has a less quadrate whorl section and a tendency towards the development of feeble keel furrows (see also WALLISER, 1956, p. 202). The keel is also more prominent and sharper, at least in the case of the Swedish specimens. QUENSTEDT's (1883, pl. 11, figs. 9, 10) figures of small specimens closely resemble LO 3936 (pl. IX, fig. 2) and have convex-outwards, at times looped, ribs. The ribs of the lectotype are always concave outwards, as far as could be ascertained as the inner whorls are not visible, and the ribs of BUCKMAN's (1927) figure are straight to very slightly concave outwards. No such strong ventral furrows as figured by HYATT (1889, pl. 6, fig. 14) occur on any of our specimens nor on the lectotype (cf. pl. XI, fig. 1 b).

The tendency of the ventrolateral tubercles to degenerate, shown by almost all of the specimens in the present collection may be discerned in the last part of the form figured by BUCKMAN (1927, pl. dccxxxvii, A—B). There is also a tendency for weakening of the tuberculation on the lectotype, but this is not so dominant as in the Swedish material.

It seems likely that *E. spinaries* produced on the one hand *E. resupinatum* by suppression of the keel and enfeeblement of the tubercles and *E. lundgreni* sp. nov. on the other by suppression of the ribbing and the tuberculation but development of the keel and increase in the height of the whorl section.

Euagassiceras lundgreni sp. nov.

Pl. XII, figs. 1, a—b; pl. XIII, fig. 2; figs. 10, 11, a—c

NAME. — B. LUNDGREN.

MATERIAL. — Three specimens.

HOLOTYPE. — Specimen LO 3938 T figured in pl. XII, figs. 1, a—b, and figs. 10, 11, a—c.

Fig. 10. *Euagassiceras lundgreni* sp. nov. Holotype (LO 3938 T). Portion of a suture line. (× 1).

PARATYPES. — LO 3940 t and LO 3941 t.

REPOSITORY. — Lund.

PROVENANCE. — Döshult.

COLLECTORS. — The holotype was collected by H. SJÖGREN, the collectors of the other specimens are unknown.

AGE. — Lower Sinemurian; *sauzeanum* subzone of the *semicostatum* zone.

DIAGNOSIS. — A species of the genus *Euagassiceras* with the following characteristics. Shell size large for the genus, whorl section on inner whorls quadrate becoming much higher than broad on outer whorls; keel always strong and sharp and with broad, shallow side furrows on the inner whorls that almost disappear on the body chamber. Inner whorls with well spaced, stout ribs and feeble bullate ventrolateral tubercles, which weaken and disappear on adult whorls. Growth lines strong. Body chamber at least two thirds of a whorl.

DESCRIPTION. — Specimen LO 3938 is the largest and most complete specimen (diameter = 225 mm; thickness = 47 mm) and was chosen as holotype. It consists of slightly more than half a whorl of the body chamber and much of the inner whorls, which are, however, not well preserved. The body chamber is virtually smooth, although it bears

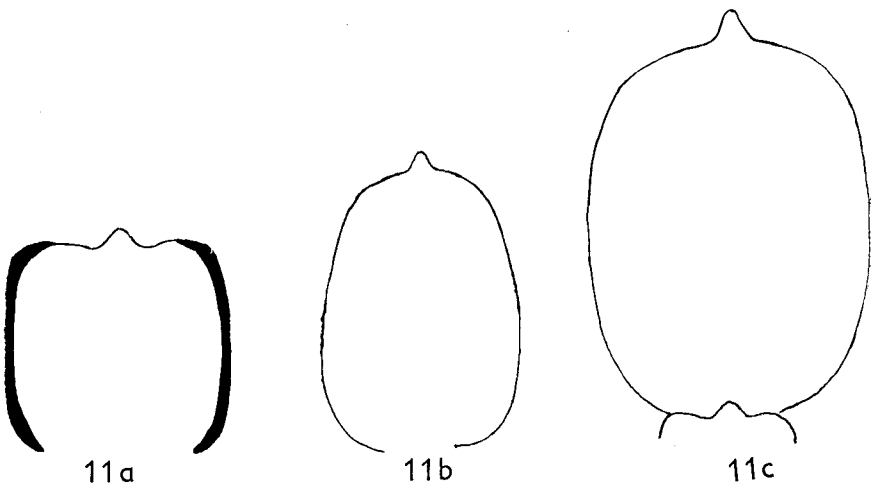


Fig. 11. *Euagassiceras lundgreni* sp. nov. Holotype (LO 3938 T). Figures illustrating the development of the whorl section; a, at a whorl radius of 68 mm; b, at a whorl radius of 108 mm; c, at a whorl radius of 130 mm. (× 0.8).

flattened rib remnants that are strongest near the umbilical margin but which weaken appreciably towards the venter, although they may cause faint bulges at the ventrolateral angle. The surface bears moderately pronounced growth lines that are mainly straight, but which contain a small kink in the middle. The vestigial ribbing of the last preserved whorl weakens progressively towards the apertural end. The whorl section is here high, the venter arched and the keel fairly strong. The ornament of the second last whorl differs strikingly from that of the final whorl; the whorl section is square, the keel is relatively lower and broader with broad, shallow side furrows and there are moderately stout ribs that develop a slight swelling at the ventrolateral margin; these form definite tubercles at the beginning of the second last whorl. There are 10—11 ribs on half of the second last whorl.

Owing to the state of preservation of the innermost whorls no remarks may be made on their ornament. The rib remnants of the final whorl are concave forwards. The development of the whorl section is illustrated in fig. 11; the whorl section changes gradually from quadrate to ovaloid (with a H/B ratio of 1.5 falling to 1.4) with rounded ventral and umbilical shoulders.

Specimen LO 3941 t is a slightly crushed, well preserved half of a body chamber, 212 mm in diameter. It is somewhat more strongly ornamented than specimen LO 3938 T and has rather pronounced rib folds, there being eight on the specimen (see pl. XIII, fig. 2). These folds are irregularly located and of irregular strength, and are stronger towards the apertural end than at the beginning of the fragment. There are swellings at the ventrolateral margin at the terminations of the most pronounced folds. The keel is strong and rounded and has very faint side furrows.

Specimen LO 3940 t is the external mold of part of a large whorl. It indicates that the original specimen was smoother than either of the foregoing and the folds are scarcely discernible.

REMARKS. — *Euagassiceras lundgreni* differs from all other species of the genus by becoming smooth in the adult and by the high whorl section. Amongst related species there is none with which it may be directly compared, although it seems to have been derived from *Euagassiceras spinaries* (QUENSTEDT).

Paracoroniceras nudaries (QUENSTEDT) (1884, p. 113, pl. 14, fig. 5) from the Lower Sinemurian is somewhat similar but the keel is stronger with more definite side furrows, the whorls seem to be more depressed and the coiling is more involute; the riblets on the flanks are more regularly developed and more densely situated.

The most similar form is a homeomorph from the *obtusum* zone of the Upper Sinemurian of Endinger, Germany, *Eparietites undaries* (QUENSTEDT). The original to QUENSTEDT (1884, pl. 20, fig. 2) is here designated as lectotype (Tübingen; QUENSTEDT collection of originals (unnumbered)) and figured (pl. XIII, figs. 1, a—b). Apart from being younger than

Euagassiceras lundgreni it has more angular whorls, the keel is stronger and there are rather deep side furrows and feeble side tubercles; it is also more involute.

SUBFAMILY ARNIOCERATINAE SPATH, 1924

Genus *Arnioceras* HYATT, 1867

TYPE SPECIES. — *Arnioceras cuneiforme* HYATT.

Arnioceras cf. *falcaries* (QUENSTEDT)

Pl. XIV, fig. 5

1858 *Ammonites falcaries* QUENSTEDT, p. 70.

?1881 *Ammonites falcaries* QUENST., LUNDGREN, p. 55, pl. 2, fig. 8.

1884 *Ammonites falcaries* QUENSTEDT, QUENSTEDT, p. 102, pl. 13, figs. 13—15.

1931 *Arnioceras falcaries* QUENSTEDT, JAWORSKI, p. 120, pl. 2, fig. 4; pl. 4, fig. 4; pl. 6, fig. 3.

?1951 *Arnioceras falcaries* QUENST. sp., TROEDSSON, p. 240.

1956 *Arnioceras falcaries* (QU.), WALLISER, p. 207, Encl. E, fig. 10.

MATERIAL. — Four specimens.

REPOSITORY. — Lund, LO 439 (original to LUNDGREN, 1881, pl. 2, fig. 8), LO 3939, LO 3942, LO 3943.

PROVENANCE. — Döshult, borehole at Oregården, 53.0—53.5 m depth.

COLLECTORS. — The specimen figured by LUNDGREN (1881) was collected by H. SJÖGREN, the specimens from Oregården were collected by G. TROEDSSON; the collector of the remaining material is unknown.

AGE. — Lower Sinemurian; *scipionianum* subzone? of the *semicostatum* zone.

DESCRIPTION. — The specimen figured by LUNDGREN is accurately drawn; it is a small fragment of the outer part of a whorl and has a strong, rounded keel (LO 439). There are no side furrows to the keel and the shoulders slope pronouncedly. The keel is a hohlkiel and it is crossed by strong growth lines that swing strongly forwards from the costal terminations; after proceeding straight for about 3 mm they swing obliquely up onto the keel. The ribs are fairly strong; they swing sharply forwards at the ventrolateral margin and then rapidly fade out; they are flared at the ventrolateral shoulder.

Specimen LO 3939 is a smaller though more complete example (pl. XIV, fig. 5). There are about 17 ribs at a diameter of 16 mm; these are slightly sigmoid on the flanks and at the ventrolateral angle they flare slightly then sweep sharply forwards. They do not reach the strong, rounded keel. The second last whorl of the small specimen is smooth, apart from faint folds in the middle portion.

Similar fragments occur in the cores from the borehole at Oregården at a depth of about 53 m and are referred here for the time being. The specimens from the cores still retain the aragonitic shell material (e. g. LO 3942), whereas LO 3939 has much calcitized shell preserved; LO 439 is a steinkern.

REMARKS. — The essential features considered by QUENSTEDT to mark *Arnioceras falcaries* are, the sigmoidal ribbing, the lack of keel furrows, and the nature of the whorl section. The original specimen on which the species was founded is missing and JAWORSKI (1931, p. 121) proposed the original to pl. 13, fig. 13 as neotype (inadvertently termed lectotype). The Swedish fragments are all too small to permit accurate determination; nevertheless they suggest at least close affinity, if not identity, with the species in question. In both, the ribs always form a concave-outwards arch and swing forwards at almost a right angle on the venter, but fail to reach the keel. The venters are moreover strongly arched.

As regards the rib density of the species it is noteworthy that the neotype is more densely ribbed than other specimens placed with it by JAWORSKI (1931, pp. 122, 123). For example, at a diameter of 36.5 mm one of the forms has 19 ribs compared with the 27 of the neotype, and another example has on its last whorl 17 ribs, where the neotype possesses 23 (cf. 17 ribs at a diameter of 16 mm for specimen LO 3939).

The ventrolateral flares of the Swedish specimens do not occur in any of the typical forms, as far as the writer could ascertain and the apparent rib thickenings shown in QUENSTEDT's (1884) pl. 13, fig. 13 are actually sites of damage.

Arnioceras sp. indet.

Pl. XIV, figs. 1, a—b

MATERIAL. — One specimen.

REPOSITORY. — Stockholm, G. I. C 1024.

PROVENANCE. — Beach at Hittarp (cf. map), northwestern Skåne.

COLLECTOR. — The author.

AGE. — Sinemurian; *Arnioceras* species range from the top of the *bucklandi* zone to the top of the *semicostatum* zone.

DESCRIPTION. — The sides of the whorls are smooth up to a diameter of 12 mm when faint ribs appear. These become later a little sharper, straight and radially orientated. The venter is smooth up to a diameter of 12—13 mm after which a feeble, blunt keel develops; the keel becomes gradually sharper and somewhat more prominent. No ventral grooves occur up to a diameter of 25 mm.

The whorl section is almost circular up to a diameter of 8 mm after which it becomes subquadrate and at around a diameter of 15 mm the sides become slightly convergent. At a diameter of 22 mm there are

14 ribs to the half whorl. The maximum diameter of the specimen is roughly 35 mm; it is septate throughout.

Two other specimens that are probably conspecific with G. I. C 1024 come from a depth of 53.0—53.5 m in the borehole at Oregården. They are figured in pl. XIV, figs. 1, 3 (nos. LO 3943, LO 3947). The crushed, aragonitically preserved shell of LO 3943 consists of three whorls and it has a maximum diameter of approximately 14 mm. The ribs are sharp and radial and there are about 11 of them to the half whorl. LO 3947 is a cast with four whorls and somewhat less dense ribbing than LO 3943.

DIMENSIONS. — The dimensions, as far as ascertainable, of G. I. C 1024 are given below:

(1)	diameter	= 35 mm (= 1.00)	(2)	diameter	= 26 mm (= 1.00)
	umbilicus	= 17 » (= 0.49)		umbilicus	= 12 » (= 0.47)
				whorl thickness	= 8 » (= 0.31)

REMARKS. — The fragmentary specimen from Hittarp is of considerable stratigraphic importance as it is the only ammonite yet found in the beach section between Hittarp and Hälsingborg and, apart from *Arnioceras*? sp. indet. from Kulla Gunnarstorp (see p. 152), the only ammonite from the beach section. Owing to the fragile nature of the specimen and the danger attending the removal of the coarse, gritty matrix it was forwarded to Dr. D. DONOVAN, Bristol, for preliminary examination. The author wishes here to express his thanks to Dr. DONOVAN for the time and trouble expended on the specimen and for the valuable comments furnished thereon.

The inner whorls bear some resemblance to the first stages of certain *Gyrophioceras* from the *angulatum* zone as regards the straight ribbing, but no representatives of this genus are known that display the initial smooth development of the present specimen; their whorls are moreover narrow and increase slowly in height and the umbilicus is also wider than in this specimen.

It differs also from the slightly similar inner whorls of the genera *Metophioceras* and *Primarietites*, both as regards the smooth stage and the lack of ventral furrows from a very early phase in the development.

The earliest possible age then for the outcrop in the beach at Hittarp is the uppermost part of the *bucklandi* zone (*bucklandi* subzone).

The Hittarp specimen was found in a course, gravelly sediment containing abundant plant fragments and it seems likely that it drifted ashore to be eventually cast inland by a storm (see REYMENT, 1958, p. 163).

Arnioceras? sp. indet.

Pl. IX, fig. 3

MATERIAL. — One specimen.

REPOSITORY. — Lund, LO 3944. Mold in the collection at the University of Stockholm.

PROVENANCE. — Spit on the northern side of the streamlet at Kulla Gunnarstorp.

COLLECTOR. — G. TROEDSSON.

AGE. — Sinemurian; *Arnioceras* species range from the top of the *bucklandi* zone to the top of the *semicostatum* zone.

DESCRIPTION. — The present specimen consists of the internal mold of a form of maximum diameter of 20 mm. The whorls are subquadrate with slightly inflated sides and with a rounded, arched venter. The ribs are straight, radial and with a tendency to widen towards the venter. As far as could be ascertained, the keel is weak, there are no side furrows and the ribs do not reach the keel. The inner whorls are smooth. There are about 21—22 ribs on the last preserved whorl, which is septate at its end.

DIMENSIONS. —

diameter	= 20	mm	(= 1.00)
umbilicus	= 8	»	(= 0.40)
whorl height	= 6	»	(= 0.30)

REMARKS. — The present specimen is important as it is the only ammonite from the beach section to the north of Hittarp. It differs from the specimen described in the foregoing as *Arnioceras* sp. indet. in having more rounded whorls, blunter and more numerous ribs, and a narrower umbilicus. As the venter could not be satisfactorily studied no definite generic assignation is attempted.

SUBFAMILY ASTEROCERATINAE SPATH, 1946

Genus *Eparietites* SPATH, 1924

TYPE SPECIES. — *Ammonites tenellus* SIMPSON.

Eparietites sp. indet.

Pl. XV, figs. 2, a—b

1951 *Arietites* (s. l.) sp., TROEDSSON, p. 241, pl. 24, fig. 11.

MATERIAL. — One specimen.

REPOSITORY. — Lund, S. G. U. 1024.

PROVENANCE. — Kattslösa (TROEDSSON's bed 8).

COLLECTOR. — G. TROEDSSON.

AGE. — Upper Sinemurian; *denotatus* subzone of the *obtusum* zone.

DESCRIPTION. — The fragmentary specimen bears six ventral terminations of ribs that bend over sharply and fade out at the ventrolateral margin. The keel is high and sharp with concave areas on either side. The whorl section is highly compressed with slightly convergent sides. The ribs run

together as they fade out at the ventrolateral shoulder and form thereby a sort of subkeel. The overall length of the specimen is 16 mm.

REMARKS. — The narrow venter and high keel with concave zones on either side of this specimen clearly indicate it to belong to *Eparietites*. Although the fragment is too small to permit a definite specific assignation it may be compared with *Eparietites denotatus* (SIMPSON) (WRIGHT, 1881, pl. 22) but it has much more compressed whorls and the ventral bends of the ribs are less strong and more sudden.

With the recognition of the present specimen as an *Eparietites* and the reference of TROEDSSON's "*Coroniceras sauzeanum*" to the genus *Promicroceras* there is no conclusive evidence left for his assignation of the lower part of the Kattslösa sequence to the *semicostatum* zone (cf. TROEDSSON, 1951, p. 118).

As therefore none of the ammonites known from the Lower Sinemurian (*semicostatum*) Döshult formation have yet been found in the Kattslösa section it may be concluded that this sequence, as studied by TROEDSSON, begins chronologically in the *obtusum* zone. It is conceivable, that higher Upper Sinemurian ammonites will be found, and TROEDSSON's record of Pliensbachian is in itself possible, on the basis of the present evidence, although the fragments identified by him (TROEDSSON, 1951, p. 241) as "*Uptonia jamesoni*?" have not yet been traced.

The specimen in question was referred by TROEDSSON (1951, p. 241) to *Arietites* (s. l.) and compared with *Arnioceras falcaries* (QUENSTEDT), and also with *A. geometricum* (OPPEL); it has, however, nothing in common with any species of *Arnioceras* as evinced by the strong forward bend of the ribs. On *Arnioceras* species the ribs are straight at small diameters and curves may only be developed at advanced stages of growth.

SUBFAMILY CYMBITINAE BUCKMAN, 1919

Genus *Cymbites* NEUMAYR, 1878

TYPE SPECIES. — *Ammonites globosus* ZIETEN.

REMARKS. — The genus *Cymbites* was proposed by NEUMAYR (1878, p. 64) for small shells with rounded whorls, a body chamber of from half to two thirds of a whorl and with a characteristic rostrum. Species of the genus also have strongly depressed inner whorls that later become rather compressed and may even be higher than broad. The venter is rounded and usually arched on the body chamber and provided with a feeble, rounded keel in some cases. The surface of the shell may be smooth but it is usually ornamented with feeble, flattish striae that tend to group into bundles on flat folds.

Cymbites striaries (QUENSTEDT) would seem to be a primitive representative of the genus which has not yet lost all the attributes of the euagassiceratid ancestor. In the Dorset sequence *C. striaries* occurs below the earliest horizon with *C. laevigatus* (SOWERBY), which further strengthens

this standpoint (cf. DONOVAN, 1957, p. 417). Species of the genus also occur in the *turneri* zone and up to the *stellare* subzone of the *obtusum* zone. *Euagassiceras personatum* (SIMPSON) provides a possible link between *Euagassiceras* and *Cymbites* (cf. BUCKMAN, 1920, pl. 187); it occurs in the *scipionianum* subzone of the *semicostatum* zone.

RANGE. — Lower Sinemurian (*sauzeanum* subzone) up to the Upper Sinemurian *stellare* subzone).

Cymbites striaries (QUENSTEDT)

Pl. XV, figs. 1, a—b; 3—5; figs. 12, a—c; 13

1858 *Ammonites striaries* QUENSTEDT, p. 70, pl. 8, fig. 5.

1881 *Ammonites striaries* QUENSTEDT, LUNDGREN, p. 54, pl. 2, fig. 9.

1884 *Ammonites striaries* QUENSTEDT, QUENSTEDT, p. 105, pl. 13, fig. 24.

1952 *Euagassiceras striaries* (QUENSTEDT), DONOVAN, p. 745.

MATERIAL. — Four specimens.

REPOSITORY. — Lund, LO 440, LO 3943—5.

PROVENANCE. — Dompäng, marl pit at Döshult, borehole at Oregården at a depth of about 53 m.

COLLECTORS. — Two specimens were collected by H. SJÖGREN and G. TROEDSSON, the other collectors are unknown.

AGE. — Lower Sinemurian; *sauzeanum* subzone of the *semicostatum* zone.

DESCRIPTION. — Specimen LO 440, the original to LUNDGREN (1881, p. 54, pl. 2, fig. 9) is a fairly complete specimen with the aperture preserved (see pl. XV, fig. 5). The figure given by LUNDGREN is accurate in all respects. The flanks of the inner whorls are ornamented with faint umbilical bulges but these are entirely absent on the last half whorl. Strongly falcoid striae cover the flanks; they curve sinuously on the sides of the shell and sweep sharply forwards on the venter to the weakly defined keel. The venter is acutely rounded and the flanks almost parallel and only slight inflated. The growth lines cross the keel. There are no side furrows. The apertural margin follows the course of the growth lines but its ventral part is extended into a rostrum. These striae on the last few millimeters of the venter are crowded and finer than their predecessors. A slight constriction sets off the apertural margin; it is confined to the flanks and shallows out before reaching the ventrolateral margin. The body chamber occupies about two thirds of the last whorl.

Fig. 12. *Cymbites striaries* (QUENSTEDT); a, whorl section of LO 440, drawn off just behind the aperture (× 1); b, whorl section of LO 3945 (× 3); c, whorl section of the last preserved part of LO 3943 (× 1).

Specimen LO 3943 is an almost complete, although in places crushed, representative of the species. It is composed of four whorls, as also is LO 440, there are umbilical bulges on the inner whorls but none on the last half whorl. The specimen is figured in pl. XV, fig. 5.

LO 3945 displays the inner whorls. At a diameter of 12 mm they are strongly depressed (see fig. 12 b). There are relatively broad, flat striations on the flanks and crossing the venter and there is no keel, nor are the striations strongly sigmoidal or grouped in bundles.

LO 3944 (pl. XV, fig. 4) is the crushed impression of the aperture and part of the body chamber of a specimen from the borehole at Oregården.

DIMENSIONS. —

	LO 440	
diameter	= 24 mm	(= 1.00)
thickness	= 6 »	(= 0.25)
umbilicus	= 9 »	(= 0.37)
height of last whorl	= 8 »	(= 0.33)

REMARKS. — The Swedish material agrees fairly well with the original (here refigured; pl. XV, figs. 1, a—b). Comparison of our specimens with the holotype at Tübingen showed that the whorls of the latter are somewhat broader, although not as quadrate as depicted in QUENSTEDT's fig. 24 m. QUENSTEDT's figure is idealized and does not show that the striae cross over the feeble keel. The rostrum is incorrectly reconstructed and the last part of the body chamber is not preserved (cf. QUENSTEDT, 1884, pl. 13, fig. 24 and this paper, pl. XV, figs. 1, a—b). The Pforen specimen is composed of five whorls (LO 440 has four, LO 3943 has four) of which about two thirds of the last is body chamber. The subcostate bundling of the striae, already remarked upon in the foregoing description, is also apparent on QUENSTEDT's specimen. Concerning the bundling of the striae QUENSTEDT (1884, p. 105) observed, "Die Streifen treten recht deutlich hervor, bündeln sich sogar stellenweis, als wollten sie sich zu feinen Rippen entwickeln".

It is of interest to note that the umbilici of the Swedish specimens are of the same relative proportion as that of the holotype, namely, 38 pct, whereas that of the specimen referred to the species by DONOVAN (1952, p. 745) is 43 pct. Despite the slightly squarer whorls of the German specimen there are sufficient points of agreement to warrant inclusion of our material in the species. The type is from the Lower Sinemurian of Pforen.

Fig. 13. *Cymbites striaries* (QUENSTEDT). Suture line of specimen LO 3943 at a diameter of 11 mm. (× 5).

DONOVAN (1952, p. 745) chose as lectotype of the species in question the specimen figured by QUENSTEDT (1884, pl. 13, fig. 24) noting at the same time its probable identity with the original figure (QUENSTEDT, 1858, pl. 8, fig. 5).

The figures given by DONOVAN (1957, figs. 1—8) of *Cymbites laevigatus* (SOWERBY) indicate that this species, although similar in form, tends to be only about half the size of *C. striaries*. The apertural rostrum of *C. striaries* is long and straight and the apertural constriction is much less strongly developed (pl. XV, fig. 5); the venter is more strongly and angularly arched on the last whorl of *C. laevigatus* and the species lacks a vestigial keel.

SPATH (1942, p. 267) subdivided the *sauzeanum* subzone into an upper division with *Euagassiceras* spp. and a lower typified by the occurrence of *Cymbites striaries* (QUENSTEDT). These two subdivisions may be of only local English validity for in Sweden, both at Oregården and Döshult, *C. striaries* occurs together with *Euagassiceras resupinatum* and *E. spinaries*. The specimen attributed by HYATT (1889, pl. 9, fig. 14, 15) to *C. striaries* (as "*Agassiceras striaries*") does not seem to belong to this species.

FAMILY OXYNOTICERATIDAE HYATT, 1875

Genus *Oxynoticeras* HYATT, 1875

TYPE SPECIES. — *Ammonites oxynotus* QUENSTEDT.

Oxynoticeras? sp. indet.

Fig. 14, a—b

MATERIAL. — 11 specimens.

REPOSITORY. — Stockholm, Geologiska Institutet, G. I. C 1207—10, plus unnumbered specimens.

PROVENANCE. — Kulladal, southeastern Skåne.

COLLECTOR. — The author.

AGE. — Upper Sinemurian; *oxynotum* subzone of the *oxynotum* zone.

REMARKS. — Several fragments with sharp inner whorls that eventually develop subacute venters are referred provisionally to *Oxynoticeras*. The specimens are all ferruginized casts with smooth sides.

The whorl shape shown, namely, sharp inner whorls becoming rounder suggests that the specimens referred here may be related to *Fastigiceras*

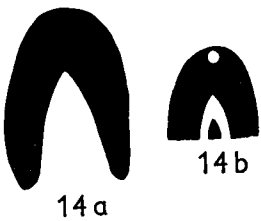


Fig. 14. *Oxynoticeras*? sp. indet.; a, whorl section of G. I. C 1207; b, whorl section of G. I. C 1208. (× 2).

BUCKMAN, 1919, which is characterized by a more rounded venter than in true *Oxynoticeras*. Another genus with a similar venter is *Metoxynoticeras* from the Lower Pliensbachian, of which *Fastigiceras* seems to be the forerunner, and the dwarf *Cheltonia*, contemporary with *Oxynoticeras*, is also comparable.

The subgenus *Gleviceras* BUCKMAN of *Oxynoticeras*, which usually has a sharp keel capping the rounded venter, is in some species similar to our form. For example, *O. (G.) subguibalianum* PIA (cf. DONOVAN, 1958, pl. 1) has no keel on the rather broadly rounded venter.

FAMILY EODEROCERATIDAE SPATH, 1929

Genus *Promicroceras* SPATH, 1925

TYPE SPECIES. — *Ammonites planicosta* SOWERBY.

Promicroceras sp. juv.

Pl. XIV, fig. 4

1951 *Coroniceras sauzeanum* (D'ORBIGNY), TROEDSSON, p. 241.

MATERIAL. — Two specimens.

REPOSITORY. — Lund, nos. 561, 565.

PROVENANCE. — Lower part of the Kattslösa section.

COLLECTOR. — G. TROEDSSON.

AGE. — The range of the genus *Promicroceras* is from the topmost subzone of the Lower Sinemurian (*birchi* subzone of the *turneri* zone) to the lower part of the Upper Sinemurian (*stellare* subzone of the *obtusum* zone).

REMARKS. — Two fragmentary specimens from near Gantofta in the Kattslösa section are referred here. They have quadrate whorls, blunt ribs and no distinct tubercles, although there is a slight swelling at the ventrolateral margin. The ribs flatten somewhat on the venter. There is no keel. The resemblance with *Euagassiceras resupinatum* is slight and at the diameter of the present specimens *Euagassiceras* species are either quite smooth or just feebly ribbed with another type of costation.

Promicroceras sp. juv. occurs immediately below *Eparietites* sp. in the lower part of the sequence at Kattslösa. As the genus *Eparietites* is indicative of the *denotatus* subzone at the top of the *obtusum* zone it seems likely that the beds with *Promicroceras* are the chronologic equivalents of the *stellare* subzone.

FAMILY POLYMORPHITIDAE HAUG, 1887

Genus *Polymorphites* HAUG, 1887

Subgenus *Polymorphites* s. str.

TYPE SPECIES. — *Ammonites polymorphus* QUENSTEDT.

Polymorphites (Polymorphites) spp. indet.

MATERIAL. — Several fragments.

REPOSITORY. — Stockholm, G. I. C 1211.

PROVENANCE. — Kurremölla area, southeastern Skåne.

COLLECTOR. — The author.

AGE. — Lower Pliensbachian; *polymorphus* subzone of the *jamesoni* zone.

REMARKS. — Several fragments in the collection seem to be referable to *Polymorphites* s. str. They are all pieces of small ammonites with a squarish whorl section, more or less straight and radial ribs and spinate ventrolateral tubercles. Owing to the state of preservation of the material the ventral ornament could not be satisfactorily studied. As stated further on, study of the inner whorls of *Uptonia* indicate that *Polymorphites* and its subgenus are identical at comparable diameters, as regards the external morphology at least. Inasmuch as the present fragments appear to be parts of the body chamber of small, but fully grown individuals, they are referred to the smaller group of *Polymorphites*.

The typical development of true *Polymorphites* occurs somewhat earlier than that of subgenus *Uptonia* and it would seem that there is evidence for the *polymorphus* and *jamesoni* subzones in southeastern Skåne.

Subgenus *Uptonia* BUCKMAN, 1898

TYPE SPECIES. — *Ammonites jamesoni* SOWERBY.

REMARKS. — The name *Uptonia* was proposed by BUCKMAN (1898, p. 453) for ammonites in which the spinous stage is never strongly developed, the ventrolateral tubercles vanishing at some stage during the development. The strong ribbing was regarded as a prominent feature of the group. DONOVAN (1954, p. 16) placed *Uptonia* as a subgenus of *Polymorphites;* the differences between the two are slight and the inner whorls are inseparable. Nor does there seem to be any good reason for separating *Jamesonites*, which was erected for forms that are more feebly ribbed and slightly more strongly tuberculated than *Uptonia jamesoni*, even subgenerically from *Uptonia* and *Polymorphites* (cf. ARKELL et al., 1957, p. L 249).

In this paper, therefore, *Jamesonites* BUCKMAN, 1923 (type species *J. reticulatus* BUCKMAN) is regarded as synonymous with *Uptonia* BUCKMAN, 1898; *Uptonia* is placed as a subgenus of *Polymorphites* HAUG, 1887.

Polymorphites (Uptonia) jamesoni (SOWERBY)
Pl. XVI, figs. 2, a—b

1827 *Ammonites jamesoni* SOWERBY, pl. 555, figs. 1, 2.

1882 *Aegoceras Jamesoni* SOWERBY, WRIGHT, p. 352, pl. 51, figs. 1, 2, ?3.

?1884 *Ammonites Jamesoni costosus* QUENSTEDT, pl. 31, fig. 11.

1925 *Uptonia jamesoni* (SOWERBY), TUTCHER & TRUEMAN, p. 646, fig. 15a.

1954 *Polymorphites (Uptonia)* aff. *jamesoni* (J. DE C. SOWERBY), DONOVAN, p. 42.

Not *Ammonites Jamesoni* in MOBERG, 1888, p. 68, pl. 3, figs. 1—3.

MATERIAL. — One specimen (in two pieces).

REPOSITORY. — LUND, LO 3946.

PROVENANCE. — Outcrop near the abandoned mill dam, Kurremölla, southeastern Skåne.

COLLECTOR. — J. C. MOBERG.

AGE. — Lower Pliensbachian; *jamesoni* subzone of the *jamesoni* zone.

DESCRIPTION. — A single, large specimen is referred here. It consists of parts of the inner whorls and a small part of what is probably the final whorl. At a whorl radius of 28 mm the specimen is ornamented with moderately strong but sharp ribs that begin inside the umbilicus and which run in almost a straight line to the venter where they thicken slightly. They are very slightly concave forwards. At this radius there are 15 ribs over a whorl length of 35 mm.

The ribbing on the last preserved whorl at a whorl radius of about 55 mm is rather coarser and the ribs are a little more definitely concave forwards. The material filling the air chambers has in part fallen out so that the internal structure of the cameral contacts with the shell wall are to be seen (see pl. XVI, figs. 2, a—b). The whorl section agrees with those of the few figured specimens of the species in being broadest near the umbilical margin and converging slightly towards the venter.

REMARKS. — The specimen here referred to *U. jamesoni* differs from other Swedish specimens of the genus in the development of the ornament and the dimensions of the umbilicus. Although found by MOBERG it was not recorded by him in his monograph (1888). The principal difference between *P. (U.) jamesoni* and *P. (U.) angustus* (QUENSTEDT) lies in the denser ribbing of the latter and the slightly more compressed and flat-sided whorls.

Polymorphites (Uptonia) angustus (QUENSTEDT)

Pl. XVI, figs. 1, a—b; pl. XVII, figs. 1, a—b, 2

1845 *Ammonites Jamesoni* SOWERBY, *angustus* QUENSTEDT, p. 89, pl. 4, fig. 8.

1882 *Aegoceras Jamesoni* SOWERBY, WRIGHT, p. 352, pl. 51, fig. 4.

1888 *Ammonites Jamesoni* SOWERBY, MOBERG, p. 68, pl. 3, figs. 1—3.

1951 *Uptonia jamesoni* (SOWERBY), TROEDSSON, p. 241.

1954 *Polymorphites (Uptonia) angusta* (QUENSTEDT), DONOVAN, p. 42.

MATERIAL. — Three specimens.

REPOSITORIES. — Lund, LO 844; S. G. U., Stockholm, (unnumbered specimen) cast in the museum of Geologiska Institutet, G. I. C 1205 (the original specimen is marked as original in MOBERG's handwriting). A third, unnumbered specimen from Lund was broken up completely in connection with its dissection. The plastic mold figured in the present paper (pl. XVII, fig. 2) bears a fairly close resemblance to MOBERG's figure in pl. 3, fig. 1 of his paper and it seems likely that this is a reconstruction based on the external impression. A specimen from the collection at the Paleontological Institute, Tübingen is selected as neotype, No. Ce 1158.

NEOTYPE. — Specimen No. Ce 1158, Tübingen University, from Kirchheim, Württemberg, Germany, figured in pl. XVI, figs. 1, a—b. During the author's visit to Tübingen in June, 1958, a search was made for the original specimen figured by QUENSTEDT in 1845, but without success. With Professor H. HÖLDER's friendly assistance a topotype specimen was selected as neotype to replace the lost original.

COLLECTORS. — J. C. MOBERG; a fourth specimen that may belong to *U. angustus* but which is too small and too poorly preserved for identification was collected by the author from the beds at Kurremölla.

AGE. — Lower Pliensbachian; *jamesoni* subzone of the *jamesoni* zone.

DESCRIPTION. — Specimen LO 844 is the inner whorls of a larger specimen (pl. XVII, figs. 1, a—b); it is made up of two whorls and has a diameter of 11 mm. There are 16 ribs on the last half whorl and 30 on the entire second whorl. The ribs are flat and are broader at this stage than the intercostal spaces. They begin abruptly at the umbilical margin and then run straight to the ventrolateral margin where they form a relatively prominent, rounded tubercle; they then continue onto the venter where they incline forwards to form chevrons. In the middle they develop faint thickenings (cf. *Dayiceras*). Specimen LO 844 is the original specimen to MOBERG (1888, pl. 3, fig. 3).

Specimen G. I. C 1206 with a diameter of 20 mm was broken up to permit study of the development of the inner whorls. The last preserved whorl had 29 ribs, the venter was arched and there were faint median swellings of the chevrons on the venter. The ribs terminated at spinate ventrolateral tubercles and although they continued onto the venter, were very much weaker there. On breaking back the specimen it was found that the ventrolateral tubercles weakened and at a diameter of about 10 mm, were of the same strength as those of specimen LO 844. The ribs were observed to be single, straight and changing from rounded on the innermost whorls to sharp on the last preserved whorl; the rib density was the same throughout, namely 29—30 ribs per whorl.

The original to MOBERG's pl. 3, fig. 1 according to the label written by MOBERG is a poorly preserved impression in ferruginous sandstone,

a rubber mold of which is figured in pl. XVII, fig. 2. MOBERG's figure has about 65 ribs on the last whorl and this costal frequency agrees well with that of the cast.

The neotype here selected has about 58 ribs in the last whorl at a diameter of approximately 150 mm; it agrees well in its proportions with the Swedish specimens.

DIMENSIONS. —

	LO 844	G. I. C 1026
diameter	= 11 mm (= 1.00)	20 mm (= 1.00)
thickness	= 4 » (= 0.36)	5.5 » (= 0.27)
umbilicus	= 3.5 » (= 0.32)	9 » (= 0.45)
height of last whorl	= 3.5 » (= 0.32)	6.5 » (= 0.33)

REMARKS. — The ribbing of the specimens referred here is much finer (ribs about double as numerous in the case of *P. (U.) angustus*) than that of *P. (U.) jamesoni* and the ribs of the latter species are also more coarsely developed.

As already noted above, the density of costation of the neotype and our material agrees closely. The specimen figured by WRIGHT (1882, pl. 51, fig. 4), which seems generally to agree with *P. (U.) angustus* has fewer ribs per whorl and may be a transitional form between *jamesoni* and *angustus*, and there seems to be good reason for regarding the two species as close relatives.

FAMILY DACTYLIOCERATIDAE HYATT, 1867

Genus *Dactylioceras* HYATT, 1867

TYPE SPECIES. — *Ammonites communis* SOWERBY (cf. ARKELL et al., 1957, p. L252; SYLVESTER BRADLEY, 1958).

Dactylioceras cf. *tenuicostatum* (YOUNG & BIRD)

Pl. IX, fig. 4; pl. XII, figs. 2, 3; pl. XVII, fig. 3

1822 *Ammonites tenuicostatus* YOUNG & BIRD, p. 247, pl. 12, fig. 8.

1884 *Stephanoceras annulatum* SOWERBY, WRIGHT, p. 475, pl. 84, figs. 7, 8.

1920 *Dactylioceras tenuicostatum* YOUNG & BIRD sp., BUCKMAN, pl. 157.

1954 *Dactylioceras tenuicostatum* (YOUNG & BIRD), DONOVAN, p. 17.

MATERIAL. — 9 well preserved aragonitic fragments.

REPOSITORY. — Lund, LO 3948—50 as well as unnumbered specimens.

PROVENANCE. — Core taken from 170—170.5 m in the borehole at Vilhelmsfält, northwestern Skåne (see TROEDSSON, 1951, p. 30).

COLLECTOR. — The author.

AGE. — Lower Toarcian; the *tenuicostatum* zone.

DESCRIPTION. — The fragments all seem to belong to the same species. Specimen LO 3950 consists of about the first two and a half whorls (pl. XII, figs. 2, a—b). On the last preserved half whorl there are about 24 principal ribs with about a little less than half of the ribs undivided. The forked ribs fork either in the inner third or in the outer third although the proportions seem to vary with the result that a few ribs fork in the middle of the flank. The bifurcation takes place in such a manner that one part of the rib continues without deviation while the other swerves to the side and then runs parallel to the principal rib. Exactly the same sort of division is shown by BUCKMAN (1920, pl. 157, fig. 2). The ribs are slightly flexed and seem to become somewhat stouter on the venter. Most of the ribs seem to fork in the outer third of the flank. Fine sutures are to be seen beneath the shell material, but they are too indefinite to permit reproduction.

Specimen LO 3949 is a fragment of a larger whorl (pl. XII, fig. 3, a—b); it indicates that the ribbing becomes more robust at greater diameters and that most of the forked ribs divide in the middle or outer part of the flank. The shell material is also thicker than in the case of the inner whorls. There is still a certain degree of irregularity in the costation of the same nature as shown by the inner whorls.

Specimen LO 3948 is a fragment of a middle-sized whorl (pl. IX, fig. 4). By this stage the ornament has become more stabilized, the aragonitic shell material is coarser and the ribbing more uniform and a little less dense than on the innermost whorls. The whorl height of our specimen is 8 mm and the length of it 11 mm. On this fragment there are 21 ribs of which two or three are simple (regarding in this case a bifurcated pair as one rib entity); there is, however, no regularity in the appearance of divided ribs. The ribs are usually stronger at the umbilical margin where they pass into the umbilicus; they are sloped and slightly sigmoidal. Most ribs divide in the inner third of the flank, a few in the middle; they are hollow (see pl. XII).

REMARKS. — The fragments here described are characterized by very densely located, flexed, bifurcated ribs. The most closely comparable species is *Dactylioceras tenuicostatum* (YOUNG & BIRD), which differs slightly, however, in having the majority of the bifurcations in the vicinity of the ventrolateral margin and not in the middle of the side or even nearer the umbilicus, but this may be due to size differences. *Dactylioceras commune* (SOWERBY) is also similar but the ribbing is coarser. Another finely costate species is *D. directum* (BUCKMAN) but it differs mainly in having straight ribs.

D. cf. *tenuicostatum* is the youngest Jurassic ammonite yet found in Sweden. Its occurrence at a depth of 170 m in the borehole at Vilhelmsfält also clearly suggests the possibility of still younger finds. Besides this form, other Middle and Upper Liassic forms were found at a depth of around 180 m in the same borehole. Dr. HOFFMANN, Hannover, has

recognized at this depth fragments belonging to the following genera. — *Dactylioceras* (Toarcian), *Onychoceras* (Toarcian), and *Pleuroceras* (Upper Pliensbachian). From a nearby borehole at Pankarp he obtained forms indicative of an Upper Sinemurian age.

In the international zonal scale *Dactylioceras tenuicostatum* is the zonal fossil for the *tenuicostatum* zone, the lowermost subdivision of the Toarcian. Less finely ornamented *Dactylioceras* are also found at higher levels in the Toarcian.

SUMMARY OF THE ZONAL STRATIGRAPHY OF THE LIAS OF SKÅNE

In the following chapter the reasons for the age assignations used in the systematic section are given. As a basis, the standard English scheme is adhered to in which the French and German successions also are largely incorporated. Unfortunately, natural sections do not occur in Skåne, where the Lias is poorly exposed and the material comes from isolated outcrops and boreholes. Luckily, many well known guide fossils occur and this has enabled an accurate correlation with areas with better known sequences. Owing to the fact that previous workers on the Swedish Jurassic have principally used the stage divisions currently in employment in Germany it was deemed advisable, where possible, to also refer the sequence in Skåne to the German succession. The possibilities of exact correlation with the English Lias have been greatly increased by recent publications by ARKELL, DONOVAN, and SPATH. The ammonite assemblages are dealt with in ascending order beginning with the lowermost stage of the Lias.

HETTANGIAN

No ammonites belonging to this stage have yet been found in Skåne. TROEDSSON (1951 and earlier) made a close survey of the plant-bearing beds and revised much of the earlier zonal scheme proposed by LUNDGREN (1881) and NATHORST (1880, 1894) (see TROEDSSON, 1951, p. 14). TROEDSSON's field observations indicated the presence of a disconformity just above the zone with *Lepidopteris Ottonis* (GOEPP.) SCHIMPER (TROEDSSON, 1951, p. 14), which he considered to mark the boundary between Trias and Jurassic (see also LUNDBLAD, 1949, p. 1). *Lepidopteris Ottonis* is considered to be an important zonal fossil in the European Rhaetic and it has also been found at 1450—1485 m in the borehole Höllviken II, Skåne (cf. LUNDBLAD, 1949, p. 7); there can therefore be little doubt that the beds with *L. Ottonis* are of Upper Triassic age. It should be mentioned that TROEDSSON regarded the Rhaetic as being the basal part of the Jurassic (TROEDSSON, 1951, p. 16) and quoted Dr. W. J. ARKELL as one of his authorities for this viewpoint. However, ARKELL has repeatedly stated

the Rhaetic to be of Upper Triassic age (for example, ARKELL, 1956, pp. 38, 172) and he also placed the Swedish Rhaetic in the Trias (ARKELL, 1956, p. 465).

TROEDSSON (1955, p. 605) considered the four plant-bearing subzones belonging to the *Thaumatopteris* zone of paleobotanists, and the four pelecypod levels *(Mytilus-, Cardinia-, Cyclas nathorsti-* and *Pullastra-)* to correspond to Lias α_1 and the "*Ostrea*" level, and possibly also the *Avicula* level to be the equivalent of the Lias α_2.

In Denmark, beds with ammonites were encountered in the borehole Gassum I (FREBOLD in GREGERSEN & SORGENFREI, 1951) amongst which *Schlotheimia angulata* (SCHLOTHEIM) and *Psiloceras* sp. were found to occur. Both are typical of the Hettangian. In Skåne this stage is represented by coal measures (termed the Helsingborg Stage by TROEDSSON, see this author, 1951, p. 121) in which plant remains are common and occasional levels with pelecypods occur. On the basis of these fossils the beds were correlated by TROEDSSON with the Hettangian or Lias α_1—α_2 of the German succession.

SINEMURIAN

In order to facilitate comparison with the German sequence the Sinemurian is here discussed under two sections, the Lower Sinemurian and the Upper Sinemurian (Lotharingian). The Lower Sinemurian corresponds to the Lias α_3 of the German succession and embraces the *bucklandi* and *semicostatum* zones. The zonal evidence for the former in Skåne is not strong but the latter is fully developed.

The *bucklandi* zone. — The three subzonal indices of this zone are as follows:

Arietites bucklandi
Coroniceras rotiforme
Coroniceras conybeari

expressed in order of increasing age downwards.

Whilst there is no ammonite evidence at all for the lower two subzones, there seems to be a certain possibility for the presence of the *bucklandi* subzone, although the guide fossil is not known. As already pointed out, the fossils come from isolated outcrops and the relative positions of the subzones can only be inferred by analogy with the sequences in standard profiles. *Megarietites meridionalis* (REYNÈS) is a rather common form in the collection. Although regarded as a typical species of the *gmuendense* subzone by DONOVAN (1955, p. 14), in a later paper he noted (DONOVAN, 1956, p. 203) that *Megarietites* occurs in the *bucklandi* subzone and ranges into the lower part of the *gmuendense* subzone. In conclusion we may say that although it is not decisively proved that the *bucklandi* subzone is represented in the marine sequence of the Döshult area, there is nevertheless a strong possibility that such is the case.

The *semicostatum* zone. — This zone is completely developed in the Swedish Lias and in fact the majority of the specimens in the collection come from it. Forms appertaining to the *semicostatum* zone were the first to be discovered and LUNDGREN's monograph is entirely concerned with species of this age. The three subzones of the *semicostatum* zone are:

Euagassiceras sauzeanum
Agassiceras scipionianum
Coroniceras reynesi (= gmuendense)

with the youngest subzone at the top.

The evidence for the presence of the last-named subzone is strong and besides the leading form, *Coroniceras (Primarietites) reynesi* (SPATH), the following species also occur:

Paracoroniceras charlesi DONOVAN
Paracoroniceras crossi (WRIGHT)
Megarietites cf. *meridionalis* (REYNÈS)

The genus *Arnioceras* also makes its first appearance in this subzone. It is of interest to note that SPATH (1956, p. 161) recorded that this genus was found as early as in the top of the *bucklandi* zone in the boring at Stowell Park, England. The subzone is represented at Djuramåsa and Dompäng and seems to be the least well developed of the three.

The *scipionianum* subzone is well represented by not only the guide fossil, *Agassiceras scipionianum* (D'ORBIGNY), but also the closely related *Agassiceras nodulatum* (BUCKMAN). Other species are: *Arnioceras* cf. *falcaries* (QUENSTEDT), and some indeterminate species of *Arnioceras*. Some fragments of *Arnioceras* from the borehole at Oregården that were included under *A. falcaries*? in the descriptive portion of the paper, seem to be rather like some figures of juvenile whorls of *Arnioceras semicostatum* (YOUNG & BIRD); for example, the fragment figured in pl. XII, fig. 3. Other finds of *Arnioceras* of stratigraphic importance are that in the sandstone outcrop on the spit at Kulla Gunnarstorp and that in the plantiferous grit exposed in the beach at Hittarp. Unfortunately, neither of the specimens could be specifically determined and no close information on the dating can therefore be supplied, apart from the fact that these ammonites prove that the beds at the two localities cannot be older than the upper part of the *bucklandi* zone. This subzone is represented in the borehole at Oregården, Djuramåsa, and Döshult.

The *sauzeanum* subzone, which should now be called the *resupinatum* subzone owing to the priority of SIMPSON's name over that of D'ORBIGNY's, is, as regards number of individuals, the best developed subzone of the Swedish Lias and the guide fossil is present in large quantities. The following species occur in this subzone:

Euagassiceras resupinatum (SIMPSON)
Euagassiceras spinaries (QUENSTEDT)
Euagassiceras lundgreni sp. nov.

Cymbites striaries (QUENSTEDT)
Arnioceras spp.

The subzone is developed in the borehole at Oregården, in most of the Döshult area, but in particular at Dompäng and Löparehus in this district.

The *semicostatum* zone was not encountered in southeastern Skåne and in fact seems to be confined to the area in northwestern Skåne north of Hälsingborg, near Viken and up to Oregården. In the holes drilled in Jutland no ammonites belonging to the zone were found.

It is of interest to note that at the type locality of the Sinemurian at Semur, France there is a slight difference in the ammonite sequence as compared with northern Europe (including England) (ARKELL, 1956, p. 67). There, *Euagassiceras resupinatum* (SIMPSON) does not mark the absolute top of the *semicostatum* zone there being two *Arnioceras* "horizons" recognized above it.

Another very important point in connexion with the type Sinemurian is that *Megarietites meridionalis* (REYNÈS) occurs as a leading form, together with *Coroniceras kridion* (ZIETEN), in the upper part of the *bucklandi* zone and below the "horizon" of *Arietites bucklandi* (SOWERBY). This is another piece of evidence that suggests that the occurrence of *Megarietites meridionalis* in Skåne may indicate the presence of beds of upper *bucklandi* age. As regards the already noted full development of the *resupinatum* (= *sauzeanum*) subzone in northwestern Skåne it is worth pointing out, that SPATH (1956, p. 154) recorded a similar feature for the borehole at Stowell Park, England. He noted that whereas the *resupinatum* part of the sequence is fully represented the *scipionianum* subzone does not seem well developed. This also seems to be true of Skåne.

The boundary between the Lias α_3 (Lower Sinemurian) and the Lias β (Upper Sinemurian) is often placed between the *semicostatum* and *turneri* zones (see, for example, HOFFMANN, 1949, p. 114). SPATH (1942) placed it between the *turneri* and *obtusum* zones in accordance with the original definition. There is as yet no faunal evidence available for the presence of the *turneri* zone, although the lowermost part of the Gantofta—Kattslösa sequence may belong here, as also part of the subsurface succession in the Pankarp—Vilhelmsfält area.

The *obtusum* zone. — This zone comprises the following three subzones (youngest at the top):

Eparietites denotatus
Asteroceras stellare
Promicroceras planicostum

TROEDSSON (1951, p. 68) applied the name "Katslösa Stage" to part of a temporarily exposed sequence in the Kattslösa—Gantofta district (he consistently spelled the place name as Katslösa; the Official Survey Department spelling is Kattslösa). On the basis of the occurrence of two am-

monites, identified by TROEDSSON (1951) as *Coroniceras sauzeanum* (D'ORBIGNY)? (TROEDSSON, 1951, p. 241, not figured) and *Arietites* sp. (TROEDSSON, 1951, p. 241, pl. 24, fig. 11) he referred the lower part of the section to the Lower Sinemurian (Lias α_3) and correlated these beds with the middle to upper part of the Döshult formation (at its type locality), principally of *semicostatum* age (TROEDSSON, 1951, p. 69), although he tentatively realized the possibility of at least the presence of basal Upper Sinemurian (TROEDSSON, 1951, pp. 114, 117). The middle and upper parts of the sequence were placed in the Lower Pliensbachian (Lias γ) (cf. TROEDSSON, 1951, p. 16). This assignation was grounded to a considerable extent on the evidence supplied by the identification of a doubtful ammonite fragment as "*Uptonia jamesoni*", but also on the presence of certain belemnite fragments.

The present investigation has shown, however, that the two ammonites from the lower part of the succession should be referred to the genera *Eparietites* and *Promicroceras*. Species of the genus *Eparietites* are confined to the subzone of *Eparietites denotatus* at the top of the zone of *Asteroceras obtusum*. Species of the genus *Promicroceras* appear first in the top *birchi* subzone of the *turneri* zone and continue through the two lower subzones of the *obtusum* zone, the subzones of *Promicroceras planicostum* and *Asteroceras stellare*.

The *obtusum* zone is consequently known at present only from the lower part of the Kattslösa sequence. It seems possible that *turneri* zone forms may eventually be encountered in the beds underlying that part of the sequence as was treated by TROEDSSON in 1951. The *Eparietites* was found at a stratigraphical position slightly above that of the *Promicroceras* and the latter in all probability represents the *planicostum* subzone or the *stellare* subzone.

In the opinion of the present writer there is a strong possibility that the uppermost part of the Kattslösa—Gantofta succession is also of Upper Sinemurian age. Unfortunately, the specimen identified by TROEDSSON as *Uptonia jamesoni* cannot be found. In conclusion it may be emphasized that the writer is in full agreement with TROEDSSON as regards the recognition of a separate rock unit for the Kattslösa area. Summing up we may say of this entity that it is younger geologically than the Döshult formation and that it embraces the entire section excavated and shown schematically in the sketch map published by TROEDSSON (1951, p. 67) and in more detail in the map on p. 69 and the sections on p. 72. The age of the Kattslösa formation is here considered to be Upper Sinemurian (Lias β).

The *oxynotum* zone. — There is no ammonite evidence for this zone in northwestern Skåne, although FREBOLD (1951, in GREGERSEN & SORGENFREI) tentatively recorded *Oxynoticeras* from the Gassum I borehole, Jutland. At Kulladal in southeastern Skåne numerous fragments of *Oxynoticeras*? sp. indicate the possible presence of this zone,

and would thus mark the oldest Lias of this area. The ammonite fragments are small and resemble in appearance ferriferous concretions that occur in the same bed, particularly since they too occur as ironstone steinkerns. Close study shows them to have inner whorls preserved and one has the trace of a suture. Some of the steinkerns display a sort of concretionary banding; this is also common in the ammonites from northwestern Skåne, particularly those preserved in ironstone. These specimens are all strongly ornamented and there can be no doubt of their origin. The banding seems to be of secondary origin and to have arisen by weathering. It may here be mentioned, that Lower Cretaceous ammonites collected by the writer from lateritized sediments in West Africa also display an identical type of banding.

There is as yet no concrete evidence for the top Sinemurian *raricostatum* zone in Skåne, although a cursory perusal of new borehole material obtained from a drilling put down in Öresund between Hälsingborg and Helsingör (June, 1958) disclosed the presence of fragments of what may prove to be echioceratids. Unfortunately, this interesting borehole collection, preserved at Sveriges Geologiska Undersökning, is not yet available for paleontologic study. Part of the sequence at Vilhelmsfält may be referable to this zone and some of the ammonite fragments studied by FREBOLD from the Gassum I borehole may be indicative of it.

PLIENSBACHIAN

The boundary between the Sinemurian and the Pliensbachian runs between the *raricostatum* and *jamesoni* zones, which also delineate the Lias β from the Lias γ. There is good reason to believe that the majority of the zones of the stage are developed in Skåne.

The *jamesoni* zone. — This zone comprises the following four zones (youngest at the top):

Polymorphites jamesoni
Platypleuroceras brevispinum
Polymorphites polymorphus
Phricodoceras taylori

The lowest subzone has not yet been encountered but the *polymorphus* subzone occurs in the Fyle valley sequence where *P. (Polymorphites)* sp. is occasionally to be found. *Polymorphites* s. l. was also recorded by FREBOLD (1951, in GREGERSEN & SORGENFREI) from the borehole Gassum I, Jutland. No definite *brevispinum* species have yet been met with in Skåne or Denmark, but the uppermost *jamesoni* subzone is fairly widely distributed in the Fyle valley where the index species *P. (Uptonia) jamesoni* (SOWERBY) occurs, as well as *P. (Uptonia) angustus* (QUENSTEDT).

The *ibex* zone. — The *ibex* zone is developed on Bornholm where *Phricodoceras bornholmiense* (HÖHNE), *Tragophylloceras numismale* (QUENSTEDT) and *Acanthopleuroceras* spp. occur. It seems likely that beds

of this age exist in the Pankarp—Vilhelmsfält area, but no conclusive evidence is yet available.

The *davoei* zone. — This zone marks the top of the Lias γ and it is represented in the Gassum I borehole, Jutland, by *Androgynoceras capricornum* (SCHLOTHEIM) according to FREBOLD (1951, in GREGERSEN & SORGENFREI). Dr. K. HOFFMANN has identified a fragment of *Oistoceras* in samples from about 180 m depth in the Vilhelmsfält borehole, thus indicating the presence of the top *davoei*, *figulinum* subzone in northwestern Skåne.

The *margaritatus* and *spinatum* zones. — These are discussed together as they constitute the Lias δ of the German classification (Upper Pliensbachian). The zones occur in the subsurface strata at Vilhelmsfält, although no ammonite evidence for the Lower Pliensbachian *jamesoni* zone has yet come to light. During a recent visit to Hannover (June, 1958) the author was shown a collection from a depth of 180 m in the Vilhelmsfält borehole presented to the Amt für Bodenforschung by Dr. E. BÖLAU, Hälsingborg, in which Dr. K. HOFFMANN has identified certain fragments as *Amaltheus* spp. and *Pleuroceras* sp. indet. *Pleuroceras spinatum* (BRUGUIÈRE) and *Amaltheus margaritatus* (DE MONTFORT) were reported by FREBOLD (1951, in GREGERSEN & SORGENFREI) from the Gassum I borehole, Jutland, and *Pleuroceras* sp. occurs on Bornholm. The Lias δ may therefore be regarded as well developed and widespread in Southern Scandinavia.

TOARCIAN

The youngest Lias for which ammonite evidence is available in Scandinavia was penetrated at a depth of 170 m in the borehole at Vilhelmsfält. The well preserved, aragonitic ammonite fragments are referred here to *Dactylioceras* cf. *tenuicostatum* (YOUNG & BIRD) and we have thus conclusive evidence for the presence of the basal Toarcian *tenuicostatum* zone (lower part of the Lias ε). In England, *D. tenuicostatum* (YOUNG & BIRD) is taken as the upper subzone of this zone. The *tenuicostatum* zone is characterized by the occurrence of finely ribbed *Dactylioceras*, the more coarsely costate species of the genus generally occurring higher up in the Toarcian.

TROEDSSON (1951, p. 30) reported the presence of ammonites in the Vilhelmsfält core at depths of 180 and 240 m, but did not attempt to identify them. BÖLAU sent these to HOFFMANN in 1956 for identification, the results of which have in brief been commented on in the foregoing. The present writer studied the remnants of the core preserved in the borehole archive at the Geological Department, University of Lund, in July, 1958, and succeeded in discovering a third ammonite level in plant-rich shales at a depth of 170 m. The part of the core above these fossils was found to be devoid of ammonites, although pelecypods and abundant

Correlation of the Swedish Lias sequence with the standard stages and ammonite zones of northwestern Europe.

Stage name	German symbol	Zonal index	Subzonal index	Sweden	Denmark (Bornholm and Jutland)
Toarcian		*Lytoceras jurense*			
	ε	*Hildoceras bifrons*			
		Harpoceras falcifer			
		Dactylioceras tenuicostatum		Depth of 170 m in the borehole at Vilhelmsfält: *Dactylioceras* cf. *tenuicostatum* (Y. & B.)	
Pliensbachian	δ	*Pleuroceras spinatum*		Part of the sequence encountered in the Vilhelmsfält borehole below 170 m	Gassum I borehole: *P. spinatum* (BR.) Bornholm: *Pleuroceras* sp.
		Amaltheus margaritatus		»	Gassum I borehole: *A. margaritatus* (MONT.)
	γ	*Prodactylioceras davoei*		»	Gassum I borehole: *Androgynoceras capricornu* (SCHLOT.)
		Tragophylloceras ibex		?	Bornholm: *Phricodoceras bornholmiense* (HÖHNE) *Acanthopleuroceras* *Tragophylloceras numismale* (Q.)
		Polymorphites (Uptonia) jamesoni	*P. (U.) jamesoni*	Upper part of Fyle valley sequence: *Uptonia* spp.	
			Platypleuroceras brevispinum	Possibly part of the Fyle valley sequence	
			P. (Polymorphites) polymorphus	Part of the sequence in the Fyle valley: *P. (Polymorphites)* spp.	Gassum I borehole: *Polymorphites* s. l. sp.
			Phricodoceras taylori		
Sinemurian	β	*Echioceras raricostatum*			Gassum I borehole: »*Promicroceras*»? sp.
		Oxynoticeras oxynotum		Lower part of the Fyle valley sequence?: *Oxynoticeras*? sp. indet. (Kulladal)	Gassum I borehole: *Oxynoticeras*? sp.

Stage name	German symbol	Zonal index	Subzonal index	Sweden	Denmark (Bornholm and Jutland)
		Asteroceras obtusum	*Eparietites denotatus*	Lower part of the Kattslösa sequence: *Eparietites* sp. Part of the subsurface sequence at Vilhelmsfält? Sequence at Brandsberga and Kolleberga possibly (no conclusive evidence)	
			Asteroceras stellare	Probably the bottom beds of the Kattslösa sequence with *Promicroceras*. Part of the subsurface succession at Vilhelmsfält	
			Promicroceras planicostum (= *obtusum* s. str.)	»	
		Euasteroceras turneri		No ammonite evidence	
	α 3	*Arnioceras semicostatum*	*Euagassiceras sauzeanum*	Marine sandstones, clays and marls (Döshult formation): *Euagassiceras resupinatum* (S.), *E. spinaries* (Q.), *E. lundgreni* nov., etc.	
			Agassiceras scipionianum	Döshult formation: *Agassiceras scipionianum* (O.), *A. nodulatum* (B.), etc.	
			Coroniceras reynesi (= gmuendense)	Döshult formation: *C. reynesi* (SPATH), *Paracoroniceras* spp.	
		Arietites bucklandi	*Arietites bucklandi*	Possibly lowermost Döshult sequence: *Megarietites meridionalis* (REYNÈS)	
			Coroniceras rotiforme	No ammonite evidence	Possibly the beds with *Aviula* in NW Skåne
			Coroniceras conybeari	No ammonite evidence	
Hettangian	α 2	*Schlotheimia angulata*		No ammonites; principally represented as non-marine beds. Hälsingborg formation with coal measures, plants and pelecypods (*Mytilus-*, *Cardinia-Cyclas nathorsti-* and *Pullastra* levels; also the »*Ostrea* bank»)	Gassum 1 borehole: *S. angulata* (SCHLOTHEIM)
	α 1	*Psiloceras planorbis*			Gassum 1 borehole: *Psiloceras* sp.
Rhaetic				Coal measures with *Lepidopteris Ottonis* (GOEPP.) at the top	Gassum 1 borehole: marine beds with pelecypods

The table is based on the information put forward in the present paper as well as publications by ARKELL (1956, 1957), HÖHNE (1933), FREBOLD (in GREGERSEN & SORGENFREI, 1951, and NÖRVANG, 1957), HOFFMANN (1949), and TROEDSSON (1951).

plant remains occur. The age of these fossils is not yet known, but they must represent Upper Toarcian, at least, and possibly even younger Jurassic.

The Toarcian of northwestern Skåne, and overlying Jurassic sediments, owe their preservation to tectonic causes and there seems little likelihood of their occurring much outside the Vilhelmsfält—Ängelholm area.

THE OCCURRENCES OF AMMONITES WITH PLANT FOSSILS

Occurrences of ammonites with plant fossils have been twice noted in the descriptive section. It is here proposed to examine these collectively in the light of the conclusions recently presented in a paper by the writer (REYMENT, 1958).

As already mentioned, fragments of *Dactylioceras* were found at a depth of 170 m in the Vilhelmsfält borehole, together with plant remains and beautifully preserved pelecypods. The rock is a light grey, fine-grained, coarsely laminated shale with poor and grossly uneven cleavage. The mollusc shells are all preserved unaltered as aragonite. The ammonites occur as slightly crushed (the accompanying pelecypods are uncrushed) whorl fragments and, in two cases, as entire innermost whorls. The mollusc shells occur in bands or heaped-up ridges that mark the furthest line of sweep of a wavelet. The pelecypods were strand dwellers while the shells of the ammonite species concerned floated ashore and were broken up. The shell of *Dactylioceras* cf. *tenuicostatum* (YOUNG & BIRD) is, in fact, unusually fragile. The plant material, probably derived from watercourses emptying in the neighborhood, consists mostly of small fragments that seem to have been intimately sedimented with the muddy material that flocculated on meeting the seawater (see REYMENT, 1958, p. 165), as the plant debris is relatively evenly distributed throughout the rock. Larger fragments occur in the shell concentrations.

The aragonite preservation of the shells supplies strong evidence for rapid burial and the absence of calcium carbonate in the sedimentation environment during and after burial and fossilization (cf. REYMENT & ECKSTRAND, 1957, p. 97).

The ammonite found at Hittarp was buried in another environment and while the first described occurrence reflects an exclusively marine milieu, that at Hittarp is suggestive of a transitional environment, possibly that of a back-beach nature (REYMENT, 1958, p. 163). The ammonite, *Arnioceras* sp. indet., occurs in a coarse, gravelly sandstone that contains abundant, often coalified remnants of plants, frequently of a comparatively large size. Both this ammonite and the *Dactylioceras* have buoyant, evolute shells (REYMENT, 1958, p. 118). The explanation of the presence of the *Arnioceras* in a sediment not of purely marine origin would seem to be

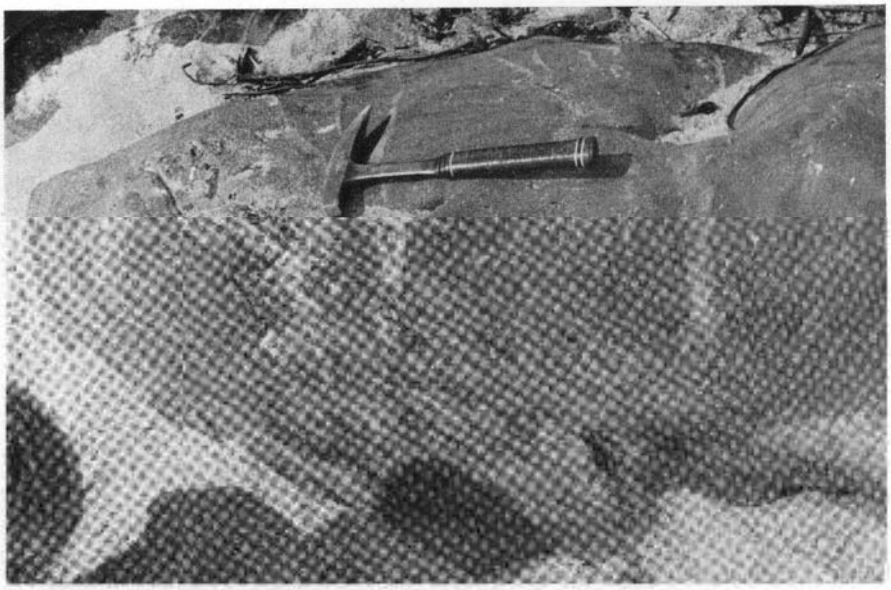


Fig. 15. Photographs of two outcrops in the beach section between Hälsingborg and Kulla Gunnarstorp; a, ferruginous sandstone with well developed jointing and showing ripple marks; b, coarse, gravelly sandstone with abundant coalified plant remains; the specimen of *Arnioceras* sp. was collected from the plant layer immediately below the blunt end of the hammer. Both pictures were taken on the beach below Hittarp and Laröd, fig. 1, b being located about 150 m north of the locality shown in fig. 15 a.

that the drifting shell was swept inland by an unusually severe storm (cf. TROEDSSON, 1938, p. 515). The sandflats above highest mean tide in the backshore of tidal flats frequently contain the remains of truly marine animals, embedded in sediment with non-marine plants, that were carried in by storms, particularly in connection with spring tides.

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EXPLANATION TO THE PLATES

All specimens were whitened with ammonium chloride prior to being photographed, apart from the Tübingen ammonites, which were photographed in the natural state by the staff photographer, Geological Department, University of Tübingen. The Swedish fossils were all photographed by Mr. L. KUTNAR, Geologiska institutet, University of Stockholm. None of the pictures has been retouched.

PLATE I

Fig. 1. *Coroniceras (Primarietites) reynesi* (SPATH). Side aspect of specimen LO 3904; the inner whorls are slightly crushed in places. Much of the calcitized shell material is preserved. (× 0.5).

Fig. 2. *Paracoroniceras charlesi* DONOVAN; a, ventral view; b, side view. LO 3910. (× 2.1).

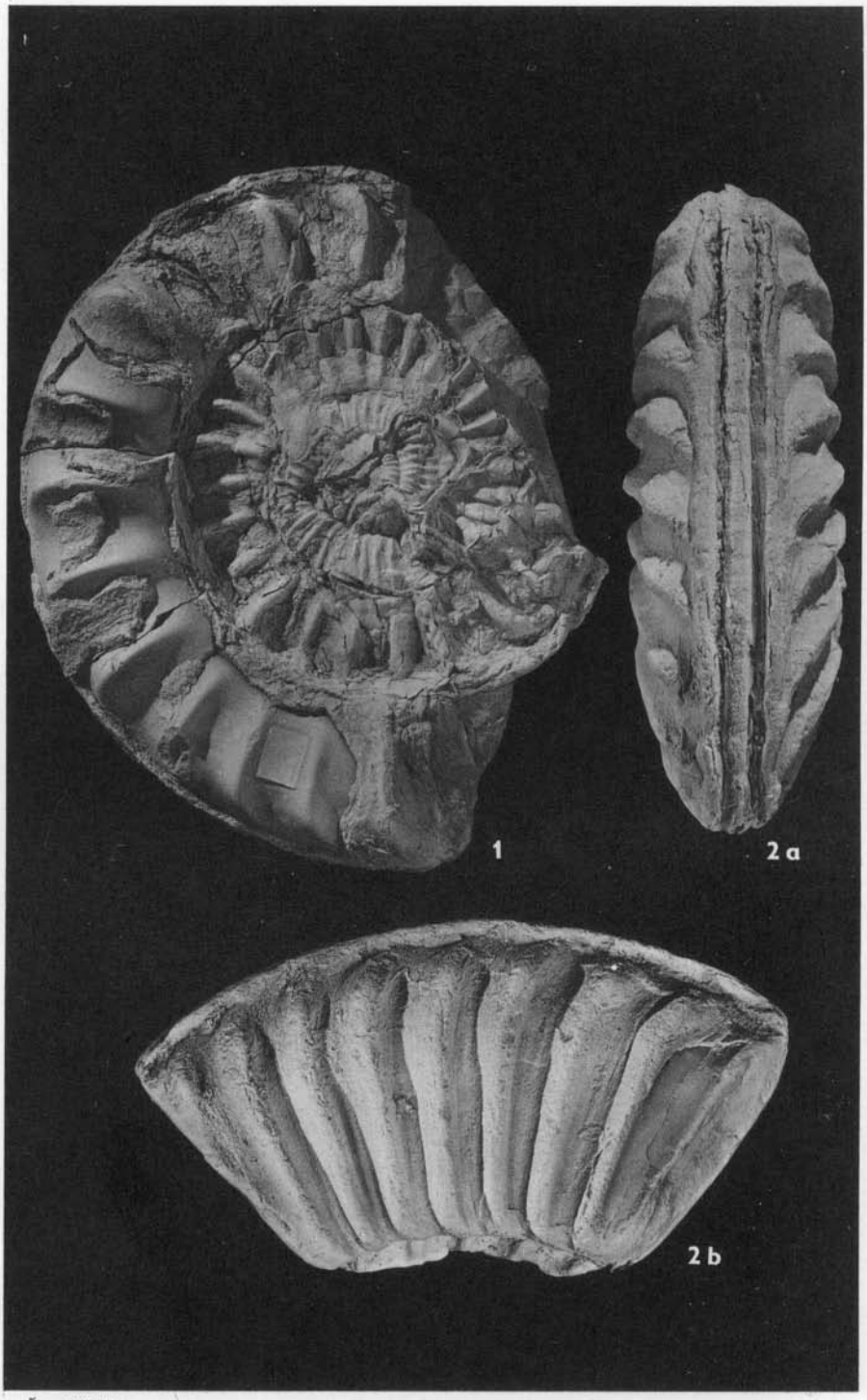

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PLATE II

Fig. 1. *Megarietites meridionalis* (REYNÈS); a, side view; b, ventral view. LO 3905 (× 0.9).

Fig. 2. *Agassiceras nodulatum* (BUCKMAN). Side view of a large fragment. Part of the calcitized shell material is preserved. LO 3912. (× 1.3).

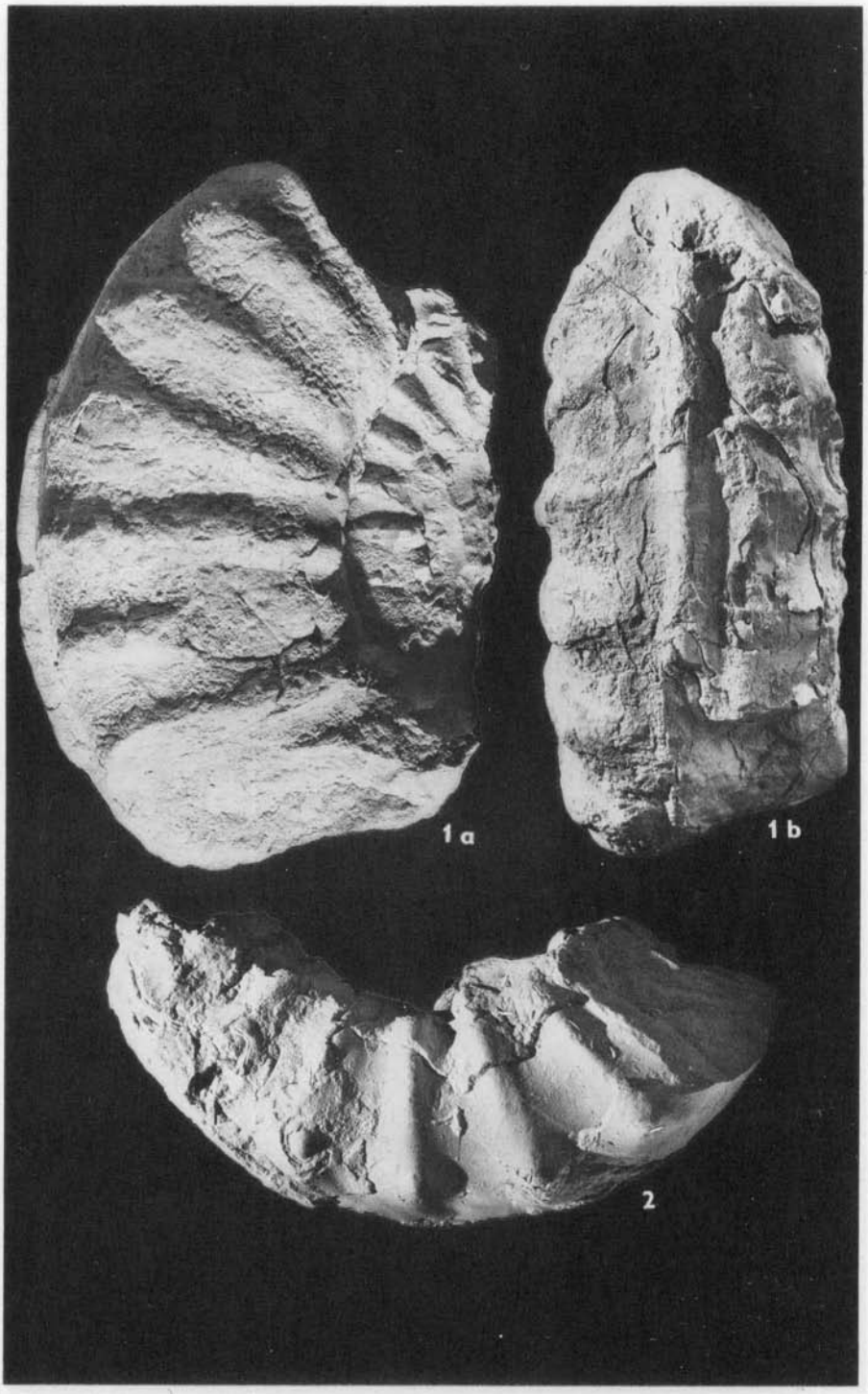

1 a
1 b
2

PLATE III

Fig. 1. *Megarietites meridionalis* (REYNÈS); a, view of the tricarinate venter of an inner whorl and profile of the last-preserved, subtricarinate whorl (with strong median keel and almost obsolete side keels); b, ventral view of the last-preserved whorl fragment. LO 3906. (× 0.9).

Fig. 2. *Agassiceras nodulatum* (BUCKMAN). Side view of portion of a body chamber? G. I. 6026. (× 1.3).

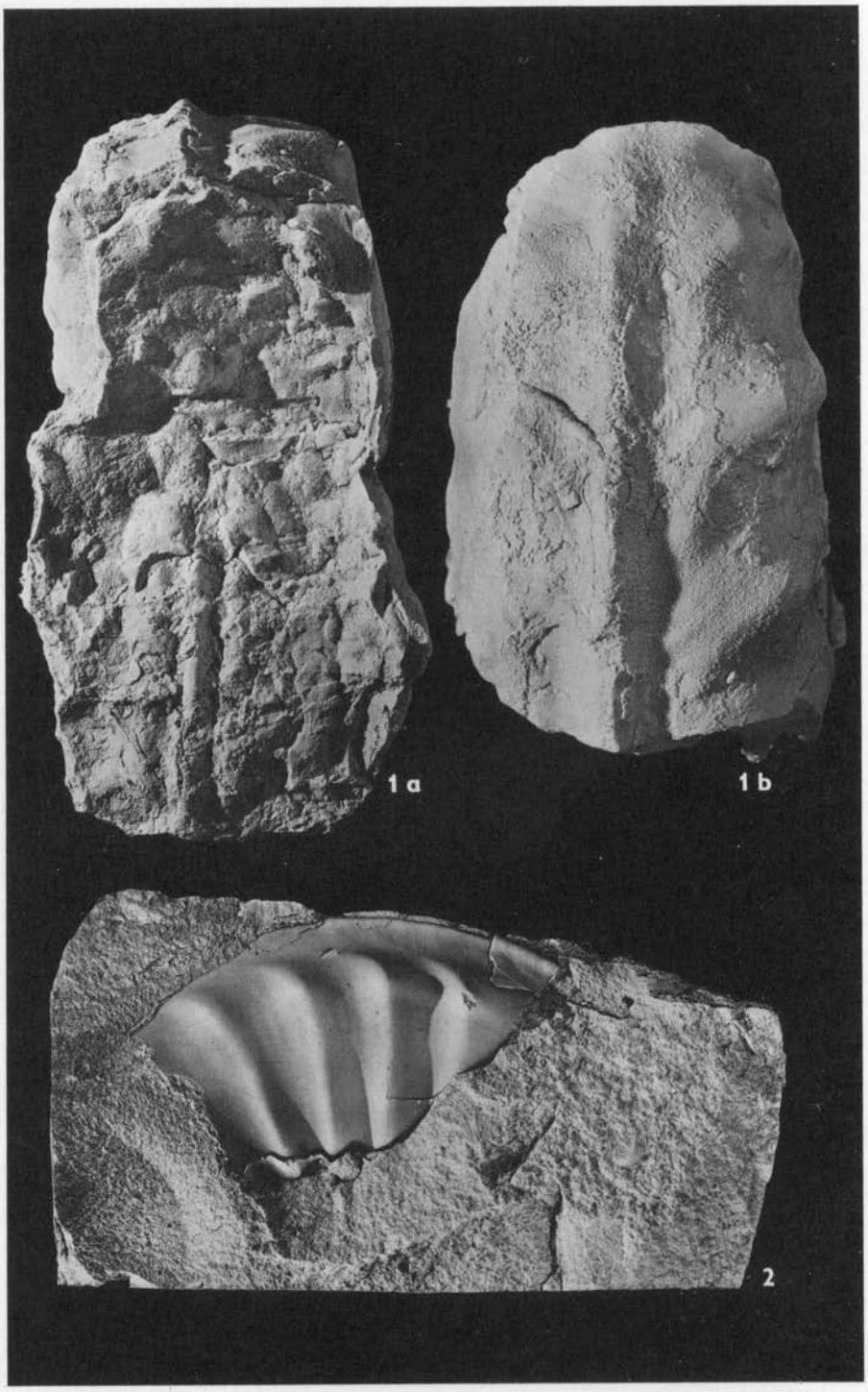

1 a
1 b
2

PLATE IV

Fig. 1. *Paracoroniceras crossi* (WRIGHT). Side view of large specimen. LO 3911. (× 0.35).

Fig. 2. *Euagassiceras resupinatum* (SIMPSON). Side view of an unusually strongly ornamented specimen. LO 3921. (× 1.6).

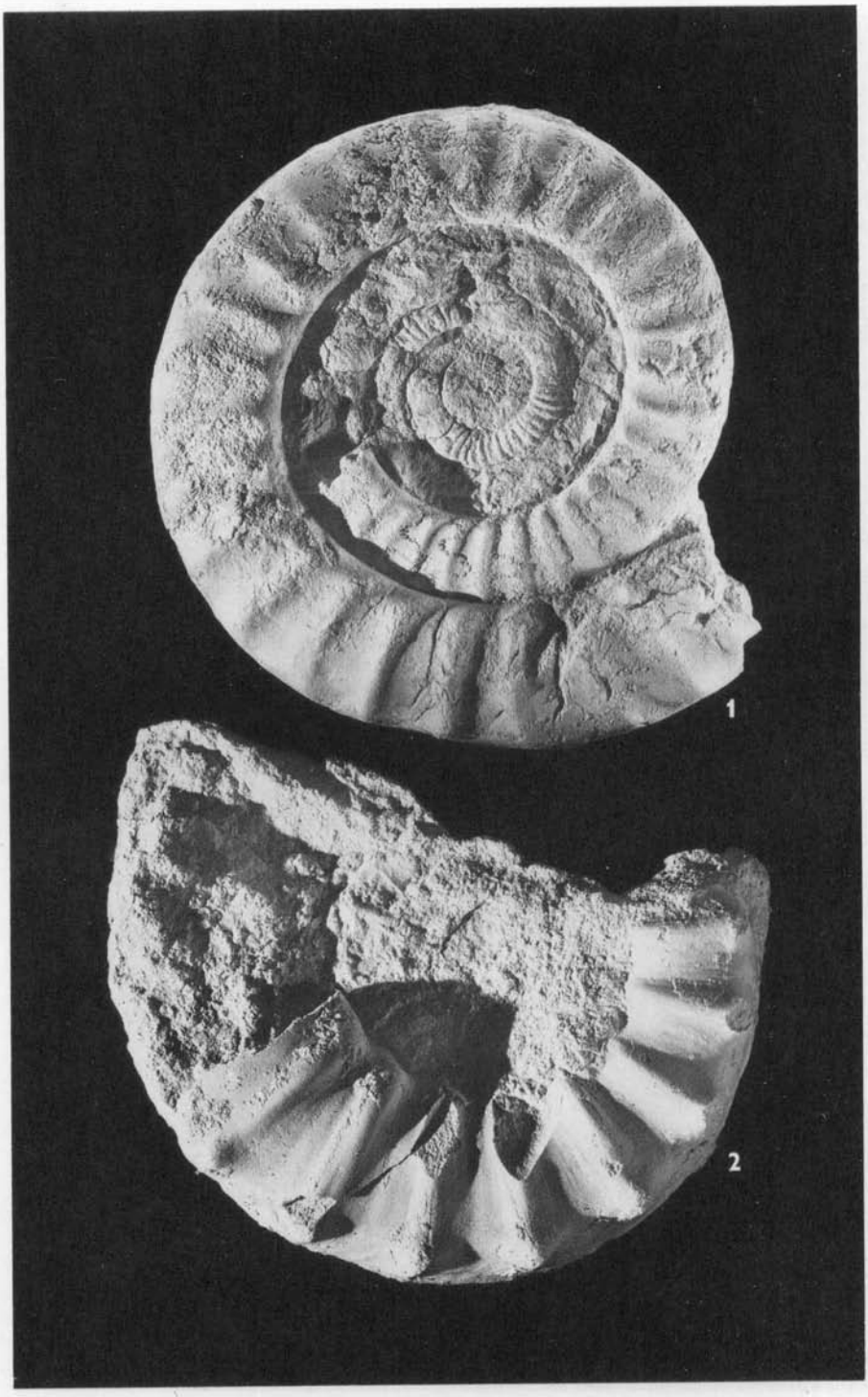

1
2

PLATE V

Fig. 1. *Agassiceras nodulatum* (BUCKMAN); a, side view of complete specimen with fully preserved body chamber, (× 0.9); b, ventral view, (× 1); c, view of the last part of the last whorl removed from the matrix, showing the apertural margin to be preserved (× 1). LO 3914.

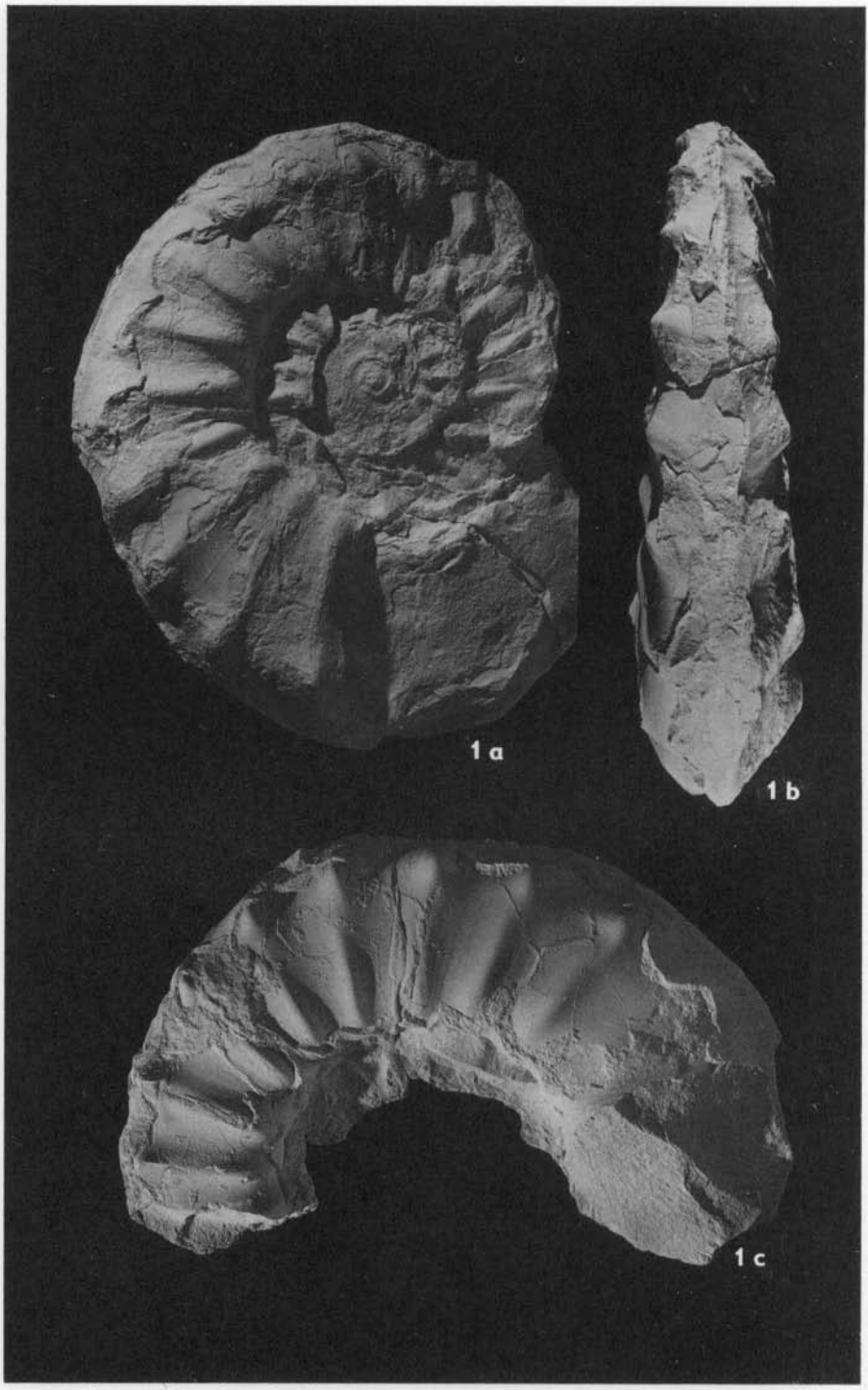
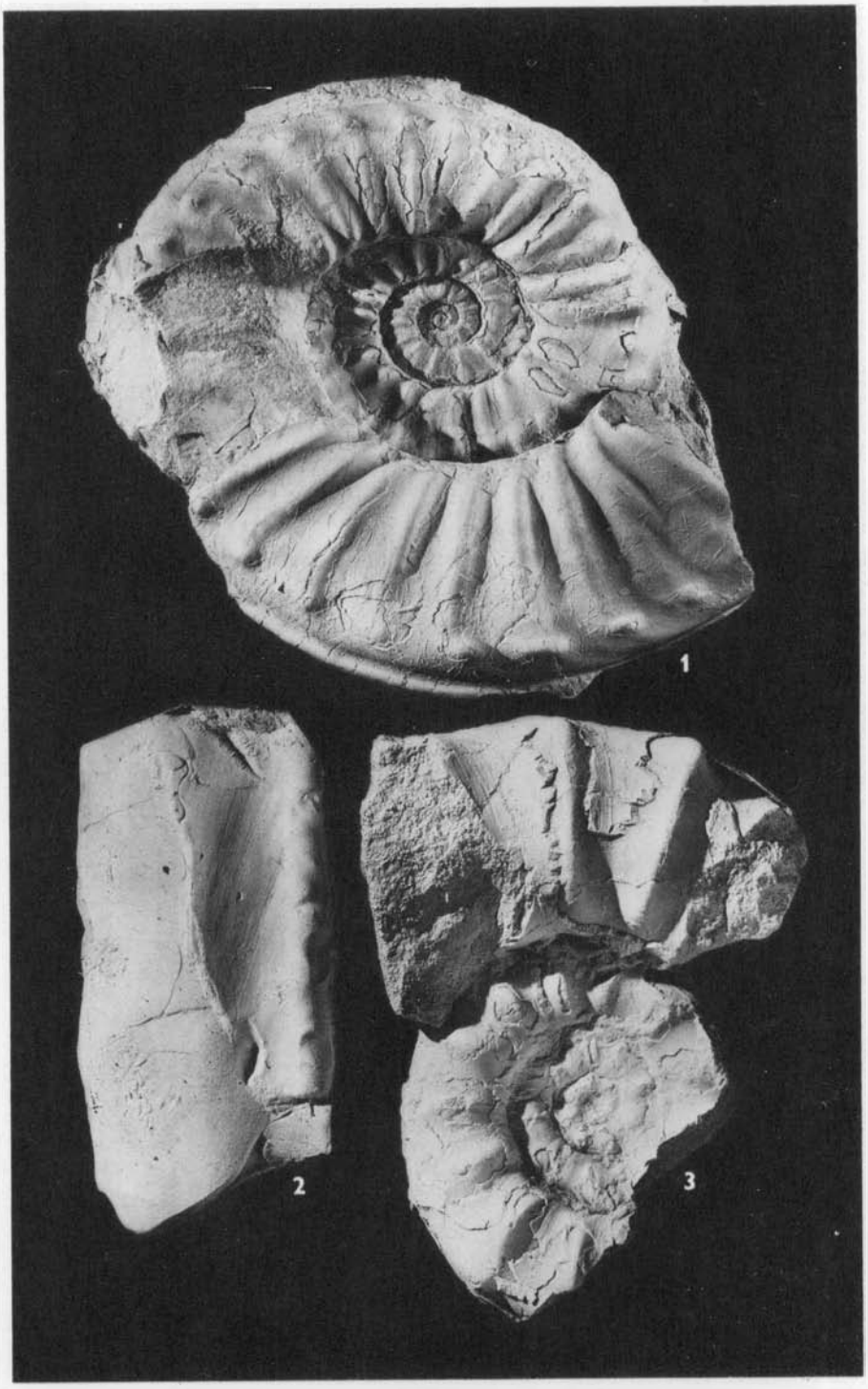

1 a
1 b
1 c

PLATE VI

Fig. 1. *Agassiceras scipionianum* (D'ORBIGNY). Slightly distorted, otherwise well preserved specimen with much of the shell material preserved as calcite. LO 3915. (× 0.9).

Fig. 2. The same species. Photograph of a plastic mold showing the smooth ventrolateral area. LO 3916 (mold, G. I. C 1201). (× 1.7).

Fig. 3. *Euagassiceras resupinatum* (SIMPSON). Side view of a small specimen showing part of the body chamber and sutures on the inner whorls; six whorls are represented. LO 3919. (× 2.5).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2
3

PLATE VII

Fig. 1. *Euagassiceras resupinatum* (SIMPSON); a—b, two side views of the same specimen; c, ventral view. LO 3920. (× 0.6).


1a
1c
1b

PLATE VIII

Fig. 1. *Euagassiceras resupinatum* (SIMPSON); a, ventral aspect; b, side view. LO 3923. (× 1.2).

Fig. 2. *Euagassiceras* aff. *resupinatum* (SIMPSON). LO 3929. (× 1.2).

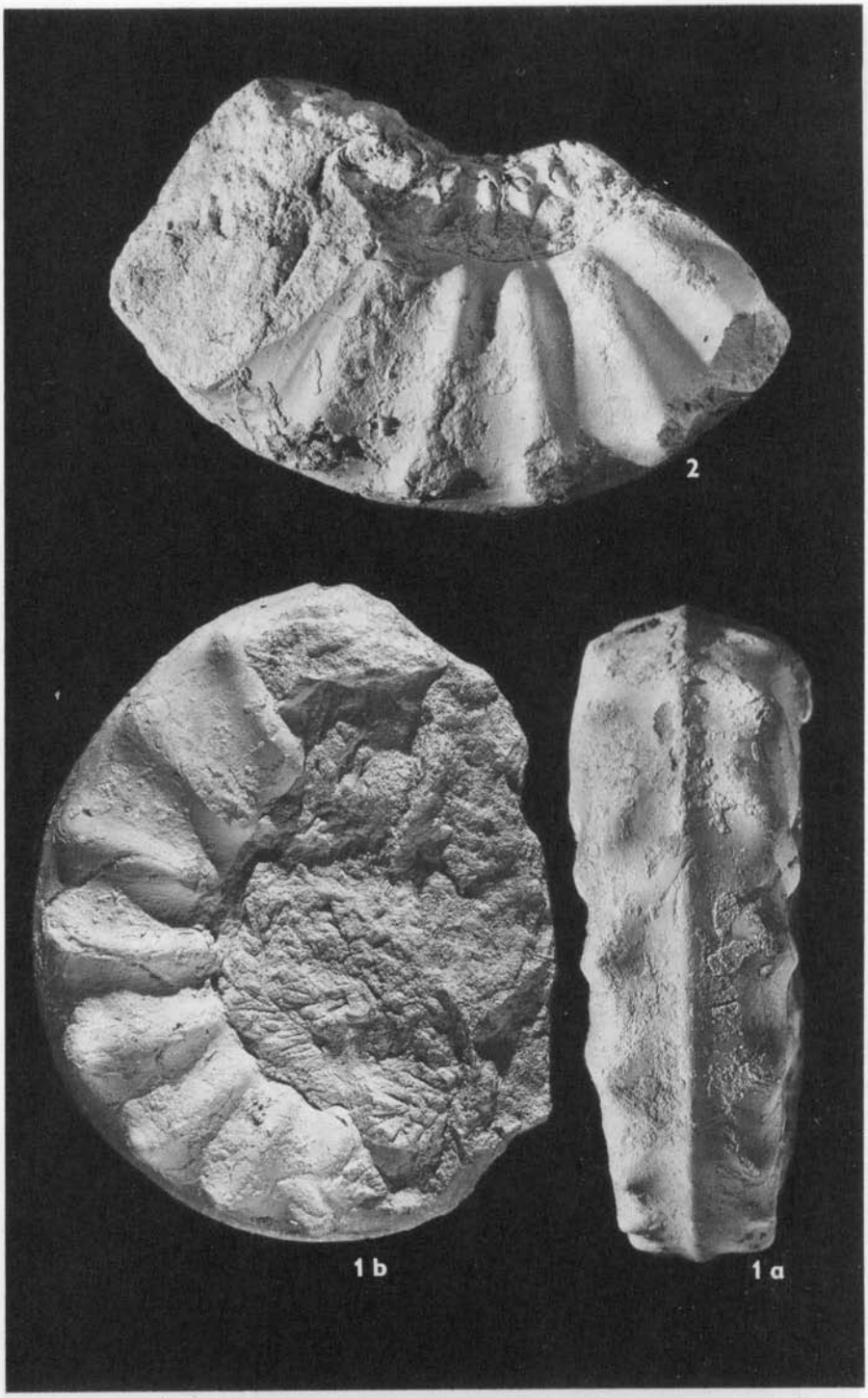

2
1 b
1 a

PLATE IX

Fig. 1. *Euagassiceras resupinatum* (SIMPSON); a, side view; b, ventral aspect. LO 438. (× 0.8).

Fig. 2. *Euagassiceras spinaries* (QUENSTEDT). Side view of small specimen with much altered shell material preserved. LO 3936. (× 1.8).

Fig. 3. *Arnioceras* ? sp. indet. Side view of a plastic mold. LO 3944. (× 2.5).

Fig. 4. *Dactylioceras* cf. *tenuicostatum* (YOUNG & BIRD). Fragment with aragonite shell preserved. LO 3948. (× 3.1).

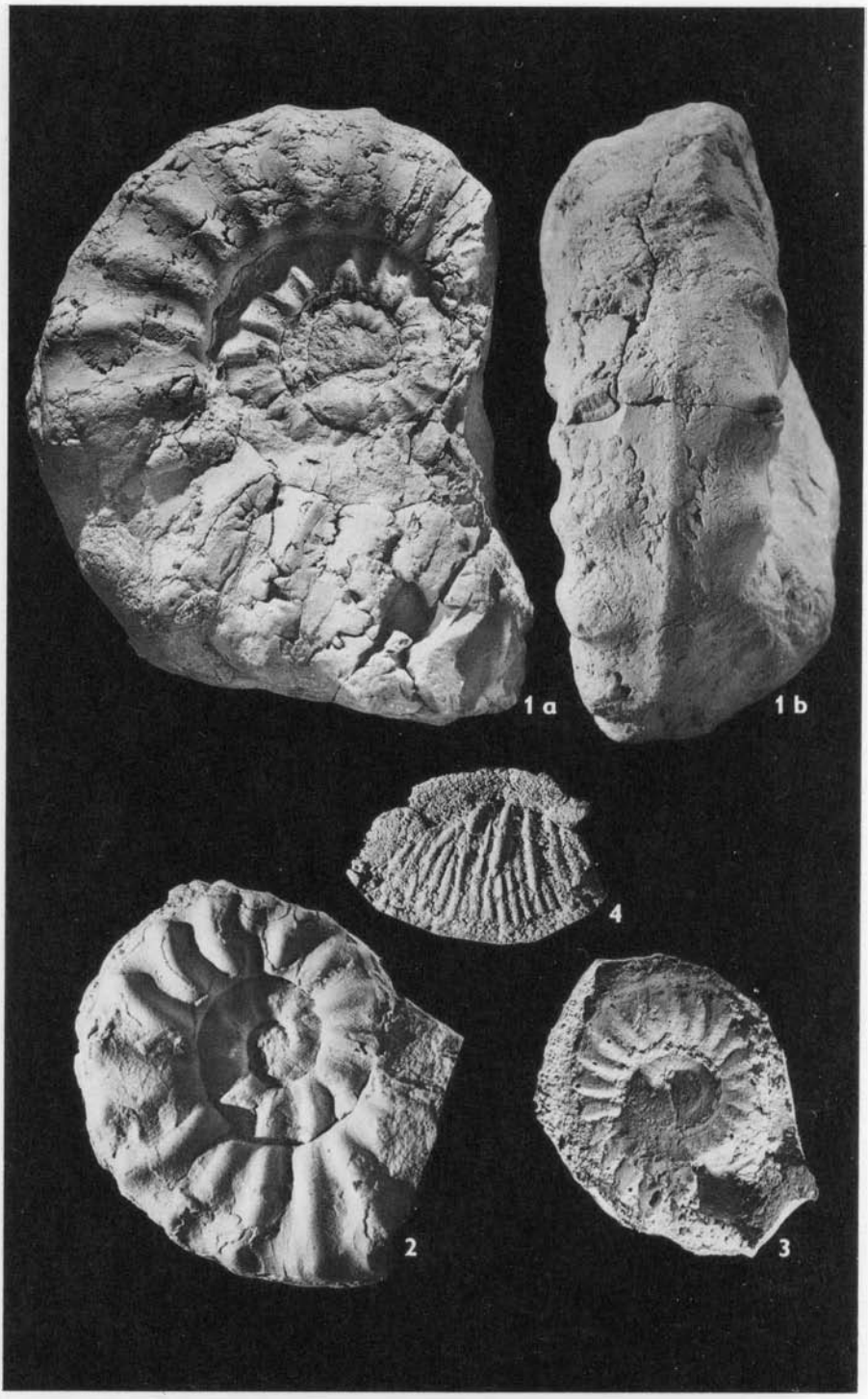

1 a
1 b
4
2
3

PLATE X

Fig. 1. *Euagassiceras resupinatum* (SIMPSON); a, ventral aspect; b, side view. LO 441. (× 0.5).

Fig. 2. *Euagassiceras spinaries* (QUENSTEDT). Body chamber fragment of a once large specimen. LO 3935. (× 0.7).

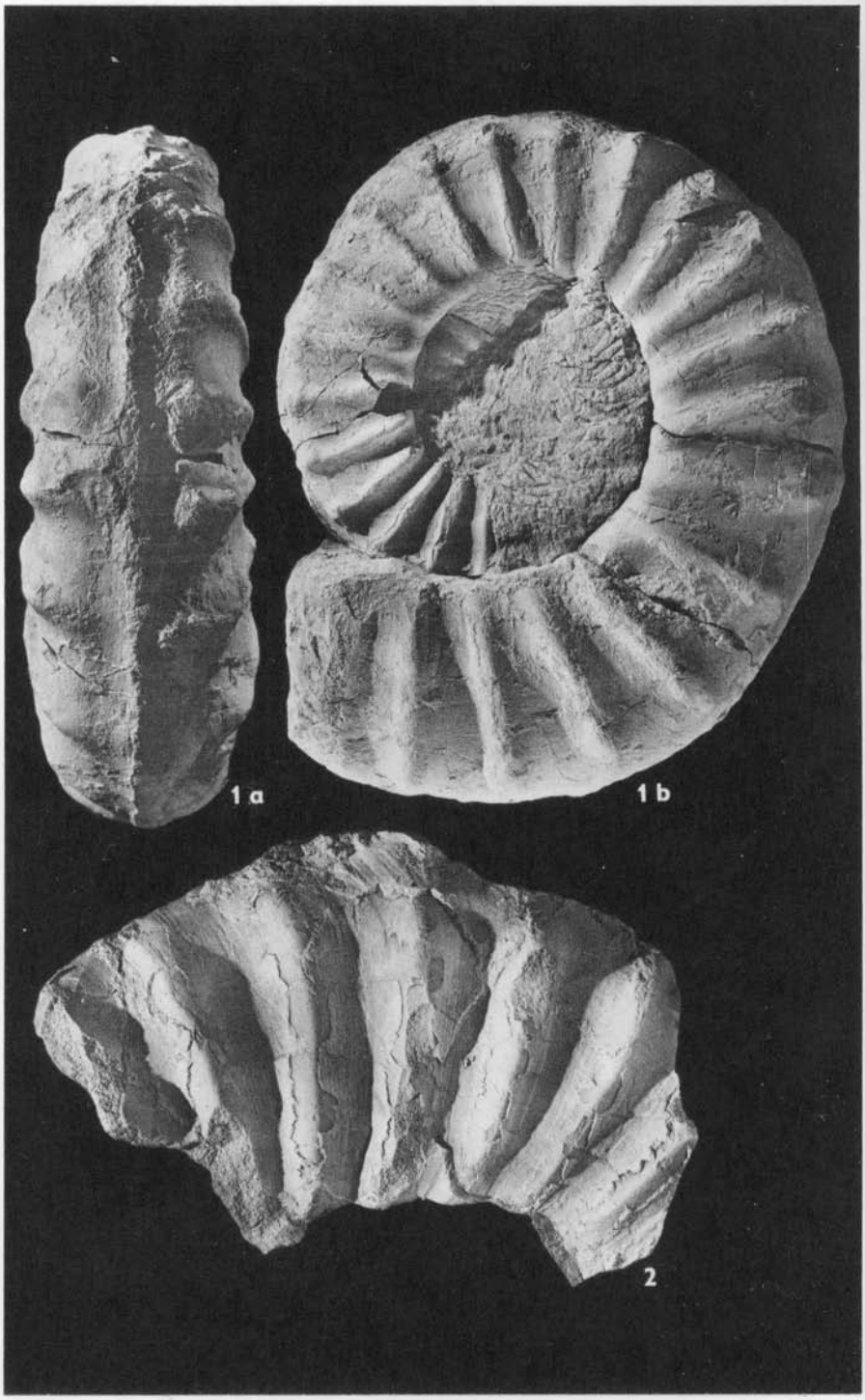

1a
1b
2

PLATE XI

Fig. 1. *Euagassiceras spinaries* (QUENSTEDT); a, side view; b, ventral view. Lectotype (Betzgenrieth, Germany). Tübingen Ce 5/11/8. (× 1).

Fig. 2. The same species. Side aspect of a weathered specimen. LO 3937. (× 0.8).

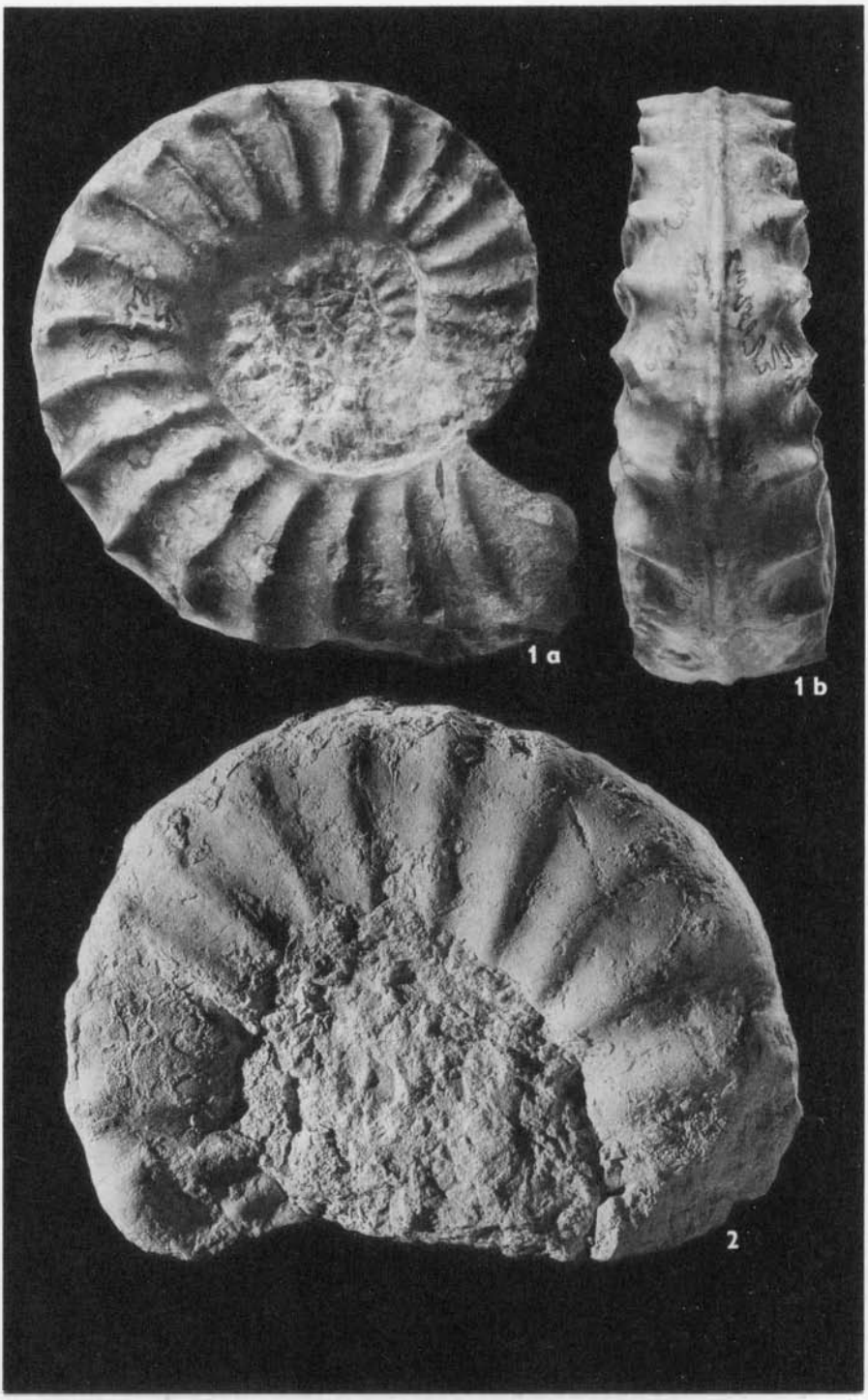

1 a
1 b
2

PLATE XII

Fig. 1. *Euagassiceras lundgreni* sp. nov.; a, side view; b, ventral view. Holotype. LO 3938 T. (× 0.5).

Fig. 2. *Dactylioceras* cf. *tenuicostatum* (YOUNG & BIRD); a, slightly crushed specimen with the aragonite shell preserved (× 3); b, impression of the same specimen showing the position of the slightly displaced first whorls and the sharp intercostal areas (× 4). LO 3950.

Fig. 3. The same species; a, impression showing preserved aragonitic shell material and the internal aspect of the ornament (× 4); b, plastic mold with the aragonite shell material adhering (× 3). LO 3949.

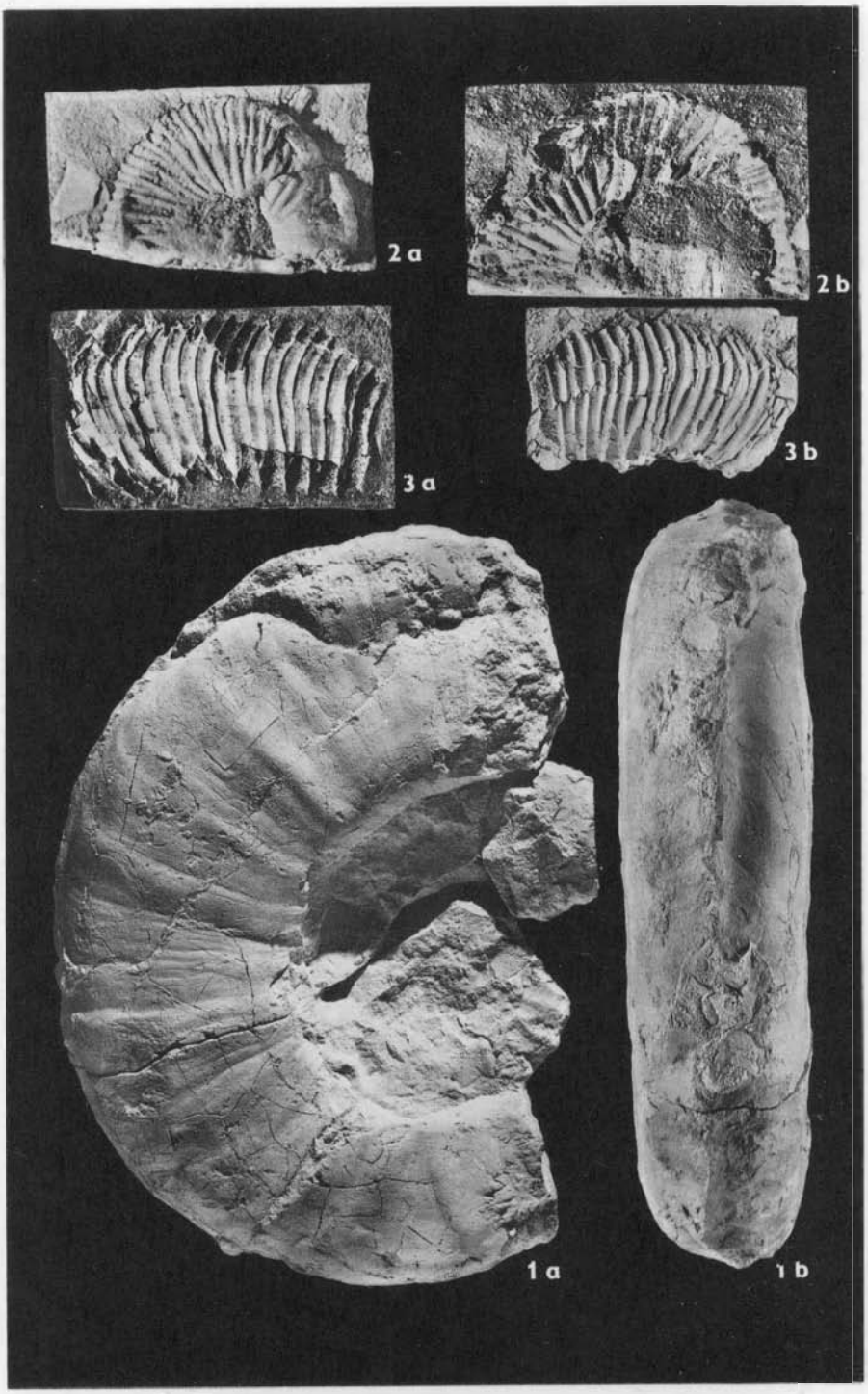

2 a
2 b
3 a
3 b
1 a
1 b

PLATE XIII

Fig. 1. *Eparietites undaries* (QUENSTEDT); a, side view; b, ventral aspect. Lectotype. Tübingen QUENSTEDT collection (original to QUENSTEDT, 1884, pl. 20, fig. 2), Upper Sinemurian, *obtusum* zone, Endingen, Germany. (appr. × 0.5).

Fig. 2. *Euagassiceras lundgreni* sp. nov. Side view of a paratype. LO 3941 t. (× 0.6).

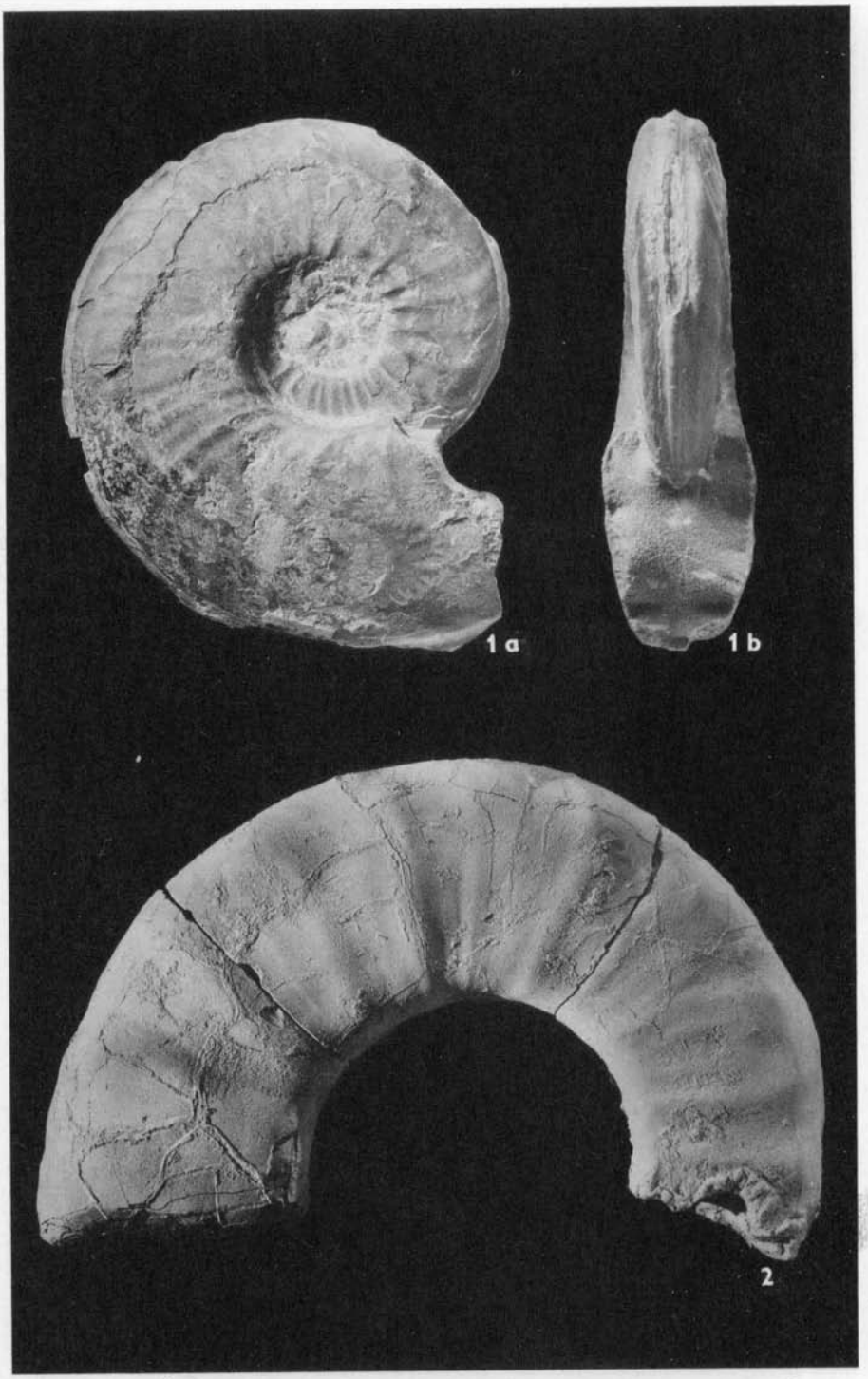

1 a
1 b
2

PLATE XIV

Fig. 1. *Arnioceras* sp.; a, part of last preserved whorl and impression of second last whorl (× 1.4); b, portion of an inner whorl (× 10). G. I. C 1024.

Fig. 2. *Arnioceras* sp. Crushed aragonitic borehole specimen. LO 3943. (× 1.7).

Fig. 3. *Arnioceras* sp. Plastic mold of sparsely ribbed borehole specimen. LO 3947. (× 1.7).

Fig. 4. *Promicroceras* sp. juv. Lund (TROEDSSON collection 565). (× 3).

Fig. 5. *Arnioceras* cf. *falcaries* (QUENSTEDT). LO 3939. (× 2).

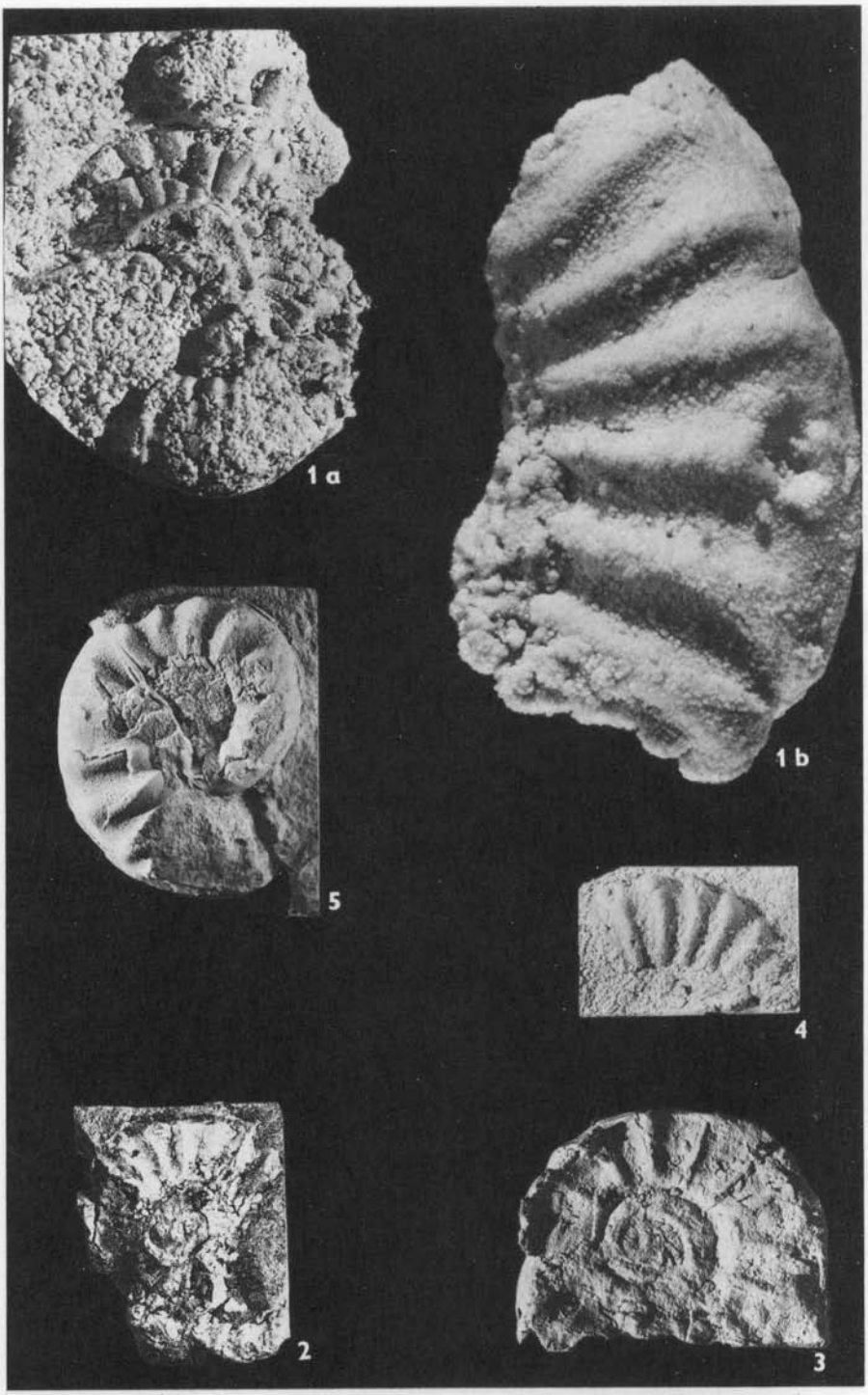

1 a
1 b
5
4
2
3

PLATE XV

Fig. 1. *Cymbites striaries* (QUENSTEDT); a, side view; b, ventral view. Lectotype. Tübingen collection Ce 5/13/24. (× 1).

Fig. 2. *Eparietites* sp.; a, ventral aspect; b, side view. S. G. U. 1024. (× 7).

Fig. 3. *Cymbites striaries* (QUENSTEDT). Side view of a slightly damaged specimen. LO 3945. (× 1.7).

Fig. 4. The same species. Fragment of a body chamber from a borehole showing the typical striate ornament and the long rostrum. LO 3944. (× 1.7).

Fig. 5. The same species. Specimen showing the typical striate ornament and the rostrum. LO 440. (× 1.7).

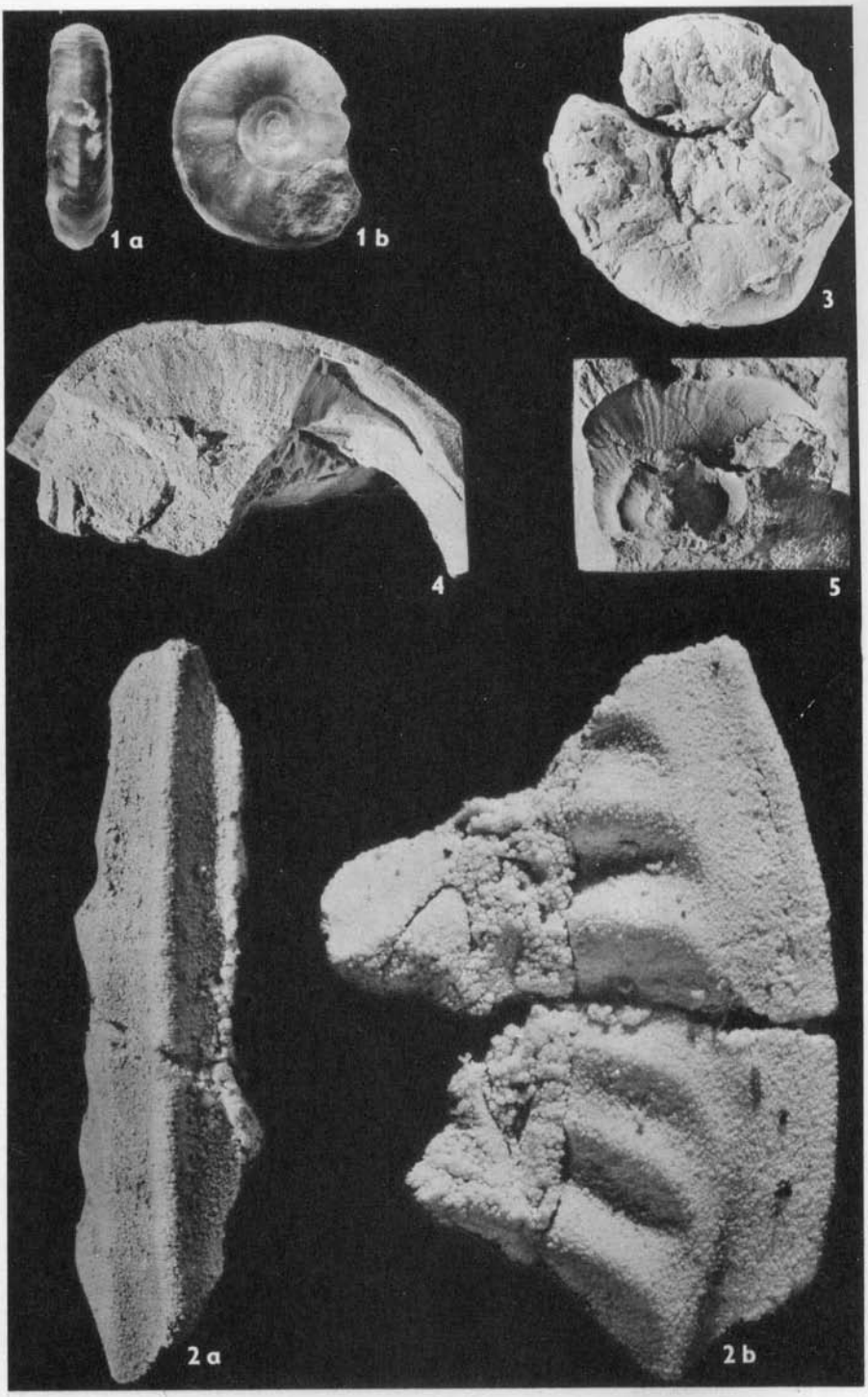

1 a
1 b
3
4
5
2 a
2 b

PLATE XVI

Fig. 1. *Polymorphites (Uptonia) angustus* (QUENSTEDT); a, side view; b, ventral view. Neotype. Topotype specimen from Kirchheim, Württemberg, Germany. Tübingen Ce 1158. (× 0.5).

Fig. 2. *Polymorphites (Uptonia) jamesoni* (SOWERBY); two parts of the same specimen showing the external ornament and some of the septa. LO 3946. (× 0.8).

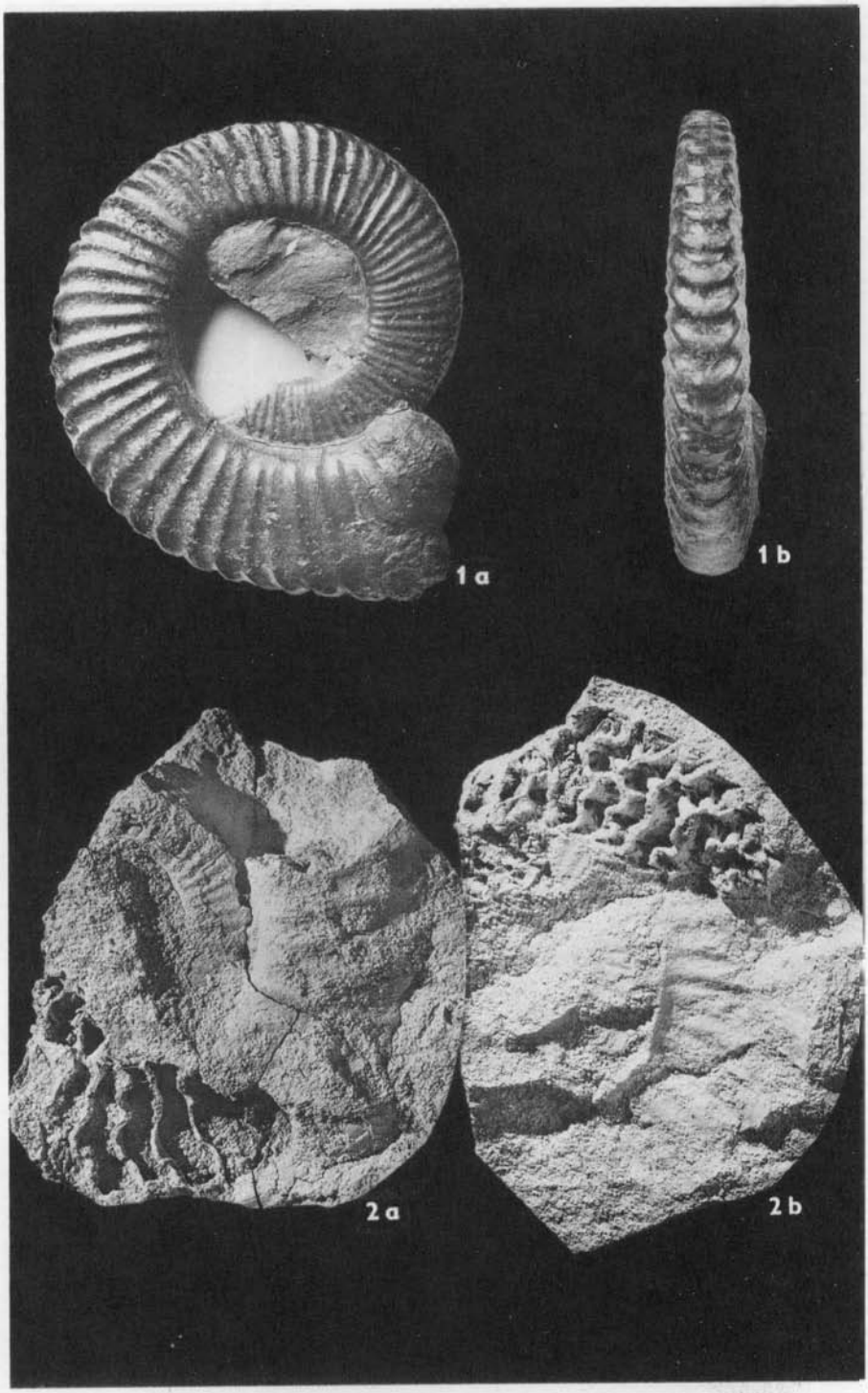

1 a
1 b
2 a
2 b

PLATE XVII

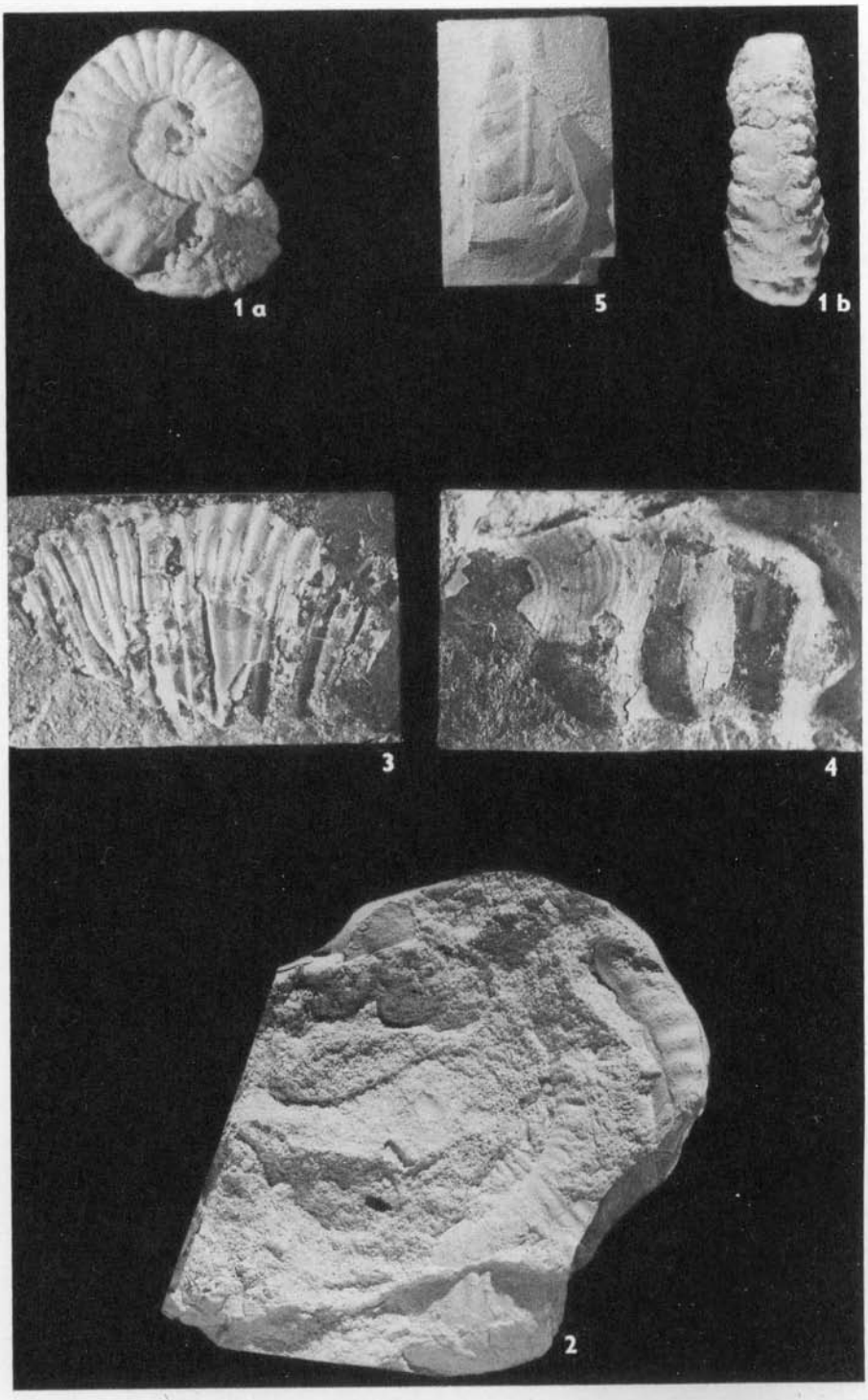
Fig. 1. *Polymorphites (Uptonia) angustus* (QUENSTEDT); side view; b, ventral view. LO 844. (× 10).

Fig. 2. The same species. Side view of a rubber cast. G. I. C 1205. (× 1).

Fig. 3. *Dactylioceras* cf. *tenuicostatum* (YOUNG & BIRD). Fragment of impression displaying the internal appearance of the aragonitic shell material. LO 3948. (× 4.1).

Fig. 4. *Arnioceras* aff. *falcaries* (QUENSTEDT). Fragment of an aragonitically preserved borehole specimen. LO 3942. (× 3).

Fig. 5. *Euagassiceras resupinatum* (SIMPSON). Specimen from the borehole at Oregården showing the ventral aspect; the aragonitically preserved shell material discloses the form of the ventral growth lines and the tubercular terminations of the ribs. LO 3922. (× 1).


1 a
5
1 b
3
4
2