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THE SWEDISH ORDOVICIAN AND LOWER SILURIAN LICHIDAE

BY

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WITH 14 PLATES AND 1 FIGURE IN THE TEXT

COMMUNICATED DECEMBER 1ST 1937 BY C. WIMAN AND E. STENSIÖ



STOCKHOLM
ALMQVIST & WIKSELLS BOKTRYCKERI-A.-B.
1939

Introduction.

For the preparation of this monograph the collections in all the Swedish palaeontological museums have been at my disposal and I have also had the privilege of using those in the Palaeontological Museum of Oslo. For comparison I have been allowed to borrow some specimens from the Sedgwick Museum, Cambridge. For the courtesy shown me by the authorities of these institutions I tender my most respectful thanks. I am especially indebted to the Keeper of the Palaeozoological Department of the State Museum of Natural History, Stockholm, Professor ERIK STENSIÖ, who has allowed me the use of the technical resources of the Department; for this advantage and for the interest he has shown in my work I am deeply grateful to him.

The photographs reproduced have been taken with the assistance of a member of the Department staff, Preparator R. RETTIG or Mrs. M. FERM. Most of them have been taken with Zeiss Tessar 1:63, F. 25, a few with Zeiss Tessar 1:4,5, F. 16. For some the Ilford filters Micro No. 5 or Gamma have been used. For all negatives Ilford special rapid panchromatic plates have been used.

Most of the photographs have been slightly retouched by Mrs. A. STENSIÖ, some by Mr. S. EKBLÖM, a few have not needed any retouching.

This monograph deals only with species originating from strata of Ordovician and Lower Silurian age. A separate monograph of the younger Lichidæ of Sweden (from Gothland chiefly) is in preparation. The terms Ordovician and Silurian are not used here in quite the same sense as in my work: The Trilobites of the Leptæna Limestone of Dalarne (1925). Recent investigations (cf. THORSLUND 1935) seem to have proved that the Dalmanites etage, which earlier had generally been referred to the Ordovician, should be regarded as representing the lowest Silurian, and the Staurocephalus Shales and equivalent strata the uppermost Ordovician. The Staurocephalus Shales have formerly often been placed in the Dalmanites etage but in the light of the new investigations it is clear that they don't belong there but in the Trinucleus (or Tretaspis) etage. THORSLUND's (op. cit.) investigations appear to have proved that in Dalarne the Boda (= Upper Leptæna or Younger Reef) Limestone was formed during two different periods interrupted by a period when no reef-building took place. Only the lower part is now considered to belong to the Ordovician [upper part of the Trinucleus (or Tretaspis) etage] the upper, and chief, part to the Silurian (Dalmanites etage). Most of the

fossils, which have been collected apparently originate from the Silurian part. It has been proposed that the old, unsuitable name Leptæna Limestone should be dropped and the terms Kullberg and Boda Limestone have been introduced as substitutes for Lower respectively Upper Leptæna Limestone. I accept those new terms, but I have thought it best to give here the old, and better known names too, as synonyms.

In addition to the species found in the Swedish Ordovician strata, those from the North and the Middle Baltic areas found in boulders and now in our collections have been included.

As regards several species, material from the East Baltic area has been available and used for comparison. When the descriptions have been partly drawn up from such specimens this is stated. In the spring of 1931 I had the opportunity of visiting Oslo and examining the collection in the Palaeontological Museum there. Of the Norwegian material I have figured (Pl. 12 figs. 10—12) some specimens of *Platylichas laxatus* (M'COY) (ANGELIN's original of his *Lichas sexspinus*) and the description of that species is partly based on those and other Norwegian specimens, which in some respects are better preserved than the Swedish ones, the latter in most cases being pressed. Below under the headings of the respective species is noted which of them are represented by Norwegian specimens in the Oslo Museum.

The species from the Boda and Kullberg (Leptæna) Limestones of Dalarne described by me in 1925 are not redescribed here, but a diagnosis of each species is given¹. In several cases new material from Dalarne has rendered it possible to supplement my old descriptions and figures, and figures are also given of specimens found elsewhere in Sweden. The other old species are redescribed; the Swedish holotypes as far as I have been able to find or recognize them, the chosen lectotypes and most of the other cotypes and other Swedish specimens figured by earlier writers are refigured, and in most cases I have been able to give figures of other specimens as well.

The terms used in the description of the trilobites in my work of 1925 and explained in the chapter on Terminology (p. 1) are with some alterations adopted in this paper.

The term carapace — inappropriate in the meaning dorsal shield of trilobites — is not used.

Glabella is used in the same sense as before, not including the occipital lobe.

Some special terms are needed for the designation of certain parts of the Lichidae-cranidium on account of its unusual and complicated structure. The interpretation given by REED in 1902 (p. 64) regarding the lobes and furrows of the cranidium and their homologous parts in less modified forms with three pairs of lateral glabellar furrows and lobes appears to me to be correct. As in my work of 1925 the naming of the parts is based on this interpretation. According to it in all Lichidae the pair of lateral glabellar furrows that

¹ A considerable part of the material described by me in 1925 belonged at that time to Dr. O. ISBERG, but is now in the Uppsala Museum.

corresponds to the middle pair in these other less-modified forms has become obsolete, the two anterior lateral lobes on each side have coalesced, and there is either a pair of bi-composite lobes more or less distinctly defined from the basal lateral lobes or, where the latter have coalesced with the portions in front and like them are limited from the median lobe of the glabella, a single pair of tri-composite lateral lobes is present; the small lobes behind the lateral glabellar lobes, present in several forms, are believed to belong to the occipital segment and are called the occipital lobes.

A term is needed to include both the frontal lobe of the glabella and the portion behind it and between the lateral lobes. I have earlier — like some other writers — used the terms median or central lobe in this sense, but I do not think them suitable. Here this portion is called the fronto-median lobe. When only the part behind the real frontal lobe is referred to, the term median lobe is sometimes used. The furrows which distally bound the fronto-median lobe — or the greater part of it — are here called the prolonged anterior lateral glabellar furrows.

Some authors have objected to the numbering of the furrows and lobes of the glabella from the anterior to the posterior, since by this method it does not seem possible in all cases to give homologous furrows and lobes the same numbers, and they have therefore instead numbered these structures from the posterior. R. RICHTER introduced this method in 1912 (p. 248) in describing the Proetidae calling the furrows; »letzte», »zweitletzte» etc. Recently some writers in the English language have applied the same method but used the bare numbers, calling the hindmost pair of furrows the first, the pair nearest in front the second, etc. This latter does not appeal to me, partly because it is contrary to what seems natural and what is the rule in palaeozoology as well as in neozoology to call a posterior portion the first and those in front the second, the third, etc. and partly because the consequence must be that while the furrows and lobes of the glabella are numbered in this way, the method cannot be applied to all other portions, e. g. the different parts of the pygidium, and all this may cause confusion. I admit that terms corresponding to the German »zweitletzte, drittletzte» etc. in most languages would be too heavy, but one might perhaps agree upon some special abbreviated terms which should be used when a counting from the posterior is preferable (something like; 1 p., 2 p., etc. or 1 a p., 2 a p., etc., meaning first, second etc. from the posterior).

However, with regard to families of which no members are known that have more than three pairs of glabellar lateral furrows, and in which the furrows as developed are easy to homologize, it seems unnecessary to use this method and preferable, not to number the lobes from the anterior, but to use the terms anterior, middle, and basal or posterior (cf. R. & E. RICHTER — 1926, p. 126 — who as regards the Phacopidae use corresponding terms).

In 1925 I used the term rostrum — used in this sense by several earlier writers — for the plate found in most trilobites on the underside of the cephalon and separated by sutures from the cranidium and the doublures of

the free cheeks. Since it is not a structure of the nature generally implied by the term rostrum, the name is not suitable, and I have here used the term rostral shield instead, a term used by some authors, and apparently free from objections. Some authors call it the epistoma (or epistome), but this term I have avoided, because it has been used by some writers to indicate other parts of the trilobites. Its use might perhaps be preferable if there could be a general agreement as to the terminology.

The term hypostoma (or hypostome) ought, I think, to be dropped, although it is in general use. The name is misleading, and since the portion seems to be homologous with the labrum found in several crustaceans I think this latter term should be used and have adopted it here.

Finally I consider that the old terms rachis and dorsal furrows are preferable to axis and axial furrows respectively. The term axis is often needed in its usual sense, a straight line (e. g. the longer axis).

When only detached cranidia are available and those, as is the case in several of the Lichidae, are strongly convex, it is difficult to know exactly how one ought to place them in relation to the horizontal plane so as to get a true dorsal, or a true frontal aspect of them, and to get a true conception of the real length, the steepness of the anterior and posterior slopes etc. Sometimes the question can, it appears, be roughly decided by study of the occipital ring, which, however, may slope. Better help can often be got from the posterior borders of the cranidium, when they are flattened, since we have a right to presume that at least their proximal portions and the proximal portions of the thoracic pleurae, were horizontally extended in the longitudinal direction. When these borders are very narrow they are of less help. As regards the specimens described below I have found that the best way of solving the question has in most cases been by means of the palpebral lobes, when they are preserved, or partly preserved. It seems as if in trilobites with normally developed eye-lobes the upper boundaries of the eyes, except near the extremities, were horizontally extended in the longitudinal direction, and consequently also the median parts of the palpebral lobes in forms — such as most of the Lichidae — in which these portions have flattened surfaces.

In the descriptions of the species and in the tables of measurement, »length» means the length as projected on to the horizontal plane, when not otherwise stated. Often it seems to be of more importance to know the distance between the anterior and the posterior margin of certain portions, and in such cases this measure is given, but it is not called the length. »Length of the pygidium» of course excludes the articulating half-ring. »Width» in reference to the lateral glabellar lobes means the distance between the proximal and the distal margin, and it is noted that it does not mean the projected width in those cases where there is a measurable difference between the two quantities.

The following abbreviations of the names of Museums are used in the explanations of the plates and sometimes in the text.

- R.M. = State Museum of Natural History, Stockholm.
U.M. = Museum of the Palaeontological Institution of Uppsala.
S.G.U. = Museum of the Geological Survey of Sweden.
St.H. = Geological Museum of the University of Stockholm.
L.M. = Museum of the Geological Institution of Lund.
O.M. = Palaeontological Museum of Oslo.
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Family Lichidæ CORDA.

The earliest named member of the family Lichidæ and the genotype of *Lichas* is *L. laciniatus* (WAHLENBERG). The pygidium of this species was originally described and figured by WAHLENBERG in 1818 (p. 34, Pl. 2, fig. 2³) under the name of *Entomostracites laciniatus*. In 1827 (p. 278) DALMAN introduced the term *Lichas*, which by all later writers — earliest by HOLL (1829) — has been used as a generic designation, although DALMAN himself did not regard WAHLENBERG's species as representing a distinct new genus but with a sign of interrogation placed *Lichas* as a sub-section of *Asaphus*.

During the years up to 1852 a good number of other species belonging to this family were described by different authors. Some of those species were placed in *Lichas*, but for several new names were used. The family name was introduced by CORDA in 1847 (p. 11) in the form Lichades. Most later writers have used the term Lichadidæ, but recently R. RICHTER (1932, p. 142) has pointed out that the correct form is Lichidæ. (This form has also been used earlier, e. g. by SCHMIDT, 1885, 1907.)

In his work of 1852 BARRANDE gave a summary of what had till then been published concerning the Lichidæ and placed all the earlier described forms and some new ones in the one genus *Lichas*. Already two years later ANGELIN described several new species which he referred to *Lichas* and in addition erected a new genus, *Platymetopus* ANGELIN, 1854 (= *Amphilichas* RAYMOND, 1905), which he placed in the same family. In 1877 DAMES described *Hoplichas* and *Conolichas* as two new sub-genera of *Lichas*. SCHMIDT (1885) placed all the Lichidæ, including *Platymetopus* ANG., in *Lichas* and was the first to attempt a more general sub-division of the genus s. lat., as represented in the East Baltic area, into a number of distinct groups or sub-genera. Several of his groups have been recognized as natural divisions by later writers, others have been further sub-divided, and several new divisions have been established. In the beginning of this century two important papers dealing with the classification of the whole family (or genus s. lat.) were published, one by GÜRICH in 1901, the other by REED in 1902. A second paper on the same subject was published by REED in 1923.

Both GÜRICH and REED have followed BARRANDE and SCHMIDT in placing all the members of the family in the one genus LICHAS, and the sub-divisions

that they recognize are regarded as subgenera. Several other writers, however, have given those sub-divisions generic rank. As previously pointed out by me (1925, p. 254) they appear in the main to be as well defined as several other groups of trilobites which generally have been regarded of generic value. Some of them seem to be even better defined than many other recognized genera. It appears unpractical and even unnatural to place together in one genus so many distinct groups, most of which include a great number of species. It is true that they seem to constitute a well-defined systematic unit, but this fact is expressed when they are placed in the same family and genus should not be identified with family. Naturally some groups are not as isolated as others and it is not improbable that in some cases it will prove appropriate to place two or several of them together in the same genus — in fact, it does not seem as if all the divisions proposed could stand even as distinct sub-genera (cf. below).

In the most recently published work on the classification of the Lichidæ, PHLEGER, FRED. B. JR.: *Lichadian Trilobites* (1936), the group is designated a superfamily, the Lichadacea, and divided into two families and several sub-families, and in addition to 25 old genera recognized as such not less than 17 new ones are proposed. A new interpretation of the morphology of the glabella is also given. This interpretation I believe to be wrong and the classification is not satisfactory. The author states that »a large part of the information has been obtained from published descriptions of figures and genera» and »that these data have been supplemented by the study of specimens in the collection of the Museum of Comparative Zoology» (Cambridge, Mass.). It does not appear as if he had had the opportunity to study many of the forms dealt with or as if he had a very great knowledge of trilobites in general. To undertake a revision of the classification of a group such as the Lichidæ and to determine which characters should be used for subdivision without having studied a vast material including numerous specimens of at least some of the forms and without an »intimate personal acquaintance» with a very great number of genera and species, must be an exceedingly difficult task, and it is hardly to be wondered at if the result is not a success. Moreover, it does not appear as if PHLEGER had studied the works listed by him under references very carefully; if he had done so some mistakes might have been avoided. As it is, the genera are generally very badly defined, in some cases wrongly; the work has not been carried out consistently — in accordance with the author's conception of the characters of generic importance — in which case additional new genera should have been erected to include several adequately defined species; and it is not mentioned which species in addition to the genotypes are considered referable to the various genera. Of the new genera proposed a few are perhaps valid, but need a new and proper definition; the others I think must be rejected, since they are based on characters which do not appear to be of generic value (such as the possession or non-possession of spines or projections, the degree of convexity of the glabella etc.).

It is not my intention to enter here into a discussion of the classification of the whole family Lichidæ, but a few further remarks on some of the genera which will be dealt with below appear appropriate.

In the Swedish Ordovician and Lower Silurian the following groups, here regarded as genera, are represented:

Lichas, DALMAN 1827 [= *Metopolichas* GÜRICH 1901; *Metopolichas* + *Autolichas* nom. nov., REED 1923; *Lichas* + *Metopolichas*, PHLEGER 1936].

Conolichas DAMES, 1877 [= *Conolichas* + *Homolichas* FR. SCHMIDT (1885), GÜRICH 1901, REED 1923; *Conolichas* + *Homolichas* + *Cypolichas* n. gen., PHLEGER 1936].

Hoploichas DAMES, 1877 [= *Hoploichas* + *Hoplolichoides* n. gen. + *Cyranolichas* n. gen., PHLEGER 1936].

Platylichas GÜRICH, 1901 [= *Platylichas* + *Metalichas* REED (1901) pars., REED 1923; *Platylichas* + *Lingucephalichas* n. gen., PHLEGER 1936].

Dicranopeltis CORDA, 1847 [= *Trachylichas* GÜRICH, 1901; *Dicranopeltis* + *Dicranopeltoides* n. gen. + *Makromuktis* n. gen., PHLEGER 1936].

Leiolichas FR. SCHMIDT, 1885.

Amphilichas RAYMOND, 1905 [= *Platymetopus* ANGELIN (1854), GÜRICH 1901; *Acrolichas* FOERSTE (1919); *Amphilichas* pars. + *Metalichas* REED (1902) pars. + *Acrolichas*, REED 1923; *Amphilichas* + *Acrolichas* + *Tetralichas* n. gen. + *Kerakephalichas* n. gen. + *Probolichas* n. gen., PHLEGER 1936].

Trochurus Beyrich, 1845 [= *Cordyocephalus* CORDA (1847), REED 1923; *Plusiarges* GÜRICH, 1901].

Dicranogmus CORDA, 1847 [= *Liparges* GÜRICH, 1901].

The genus *Lichas*, as here restricted, was originally recognized as a distinct group or sub-genus of *Lichas* s. lat. by SCHMIDT in 1885 (p. 30). To this group SCHMIDT applied the name *Metopias* EICHWALD (1842) (antedated by *Metopias* GORY, 1832). He referred to it among other species the genotype of *Lichas*, *Lichas laciniatus* (WAHLENBERG, 1818), but as its types he regarded the two species described and figured by EICHWALD in 1842 (p. 62, Pl. 3, figs. 21—22; p. 63, Pl. 3, figs. 23 a—b) as *Metopias Hübneri* and *M. verrucosus*. In 1901 (p. 521) GÜRICH substituted the term *Metopolichas* for *Metopias* as sub-generic designation for this group and in 1902 REED made EICHWALD's *Metopias Hübneri* the type of the sub-genus. Later, when GÜRICH's and REED's sub-generic groups were given generic rank, it became customary among American authors to assign to the »genus *Metopolichas*» several American Silurian species which show close relationship to *Lichas laciniatus* (cf. FOERSTE 1920, p. 35).

It is clear that the term *Metopolichas* cannot be used either as a generic or as a sub-generic designation for the group for which it was introduced by GÜRICH, since this group includes the genotype of *Lichas*. If the group is given sub-generic rank only, as done by GÜRICH, its name must be *Lichas* (*Lichas*), not *Lichas (Metopolichas)* (International rules of zoological nomenclature, Art. 9). Only if it should prove necessary to refer the type of *Metopolichas* to a separate genus or sub-genus can the term be kept, and, as I

have previously (1925, p. 255) stated, this does not appear very likely to me. Other writers have, however, expressed a different opinion.

FOERSTE in 1920 (p. 35) stated that in his opinion »the American species referred to *Metopolichas* belong to typical *Lichas*, with *Lichas laciniatus* WAHLENBERG as genotype.» He did not, however, regard *Metopolichas* GÜRICH as identical with *Lichas* DALMAN, but as a separate genus. Having no knowledge of the pygidium of *L. Hübneri* (the type of *Metopolichas*) he evidently did not believe that it was of the same type as the pygidia of the American species in question (and that of *L. laciniatus*), nor did he think that the cranidium on account of »the straightness of the posterior part of the glabellar furrows» indicated a generic relationship to those species. In typical species of *Lichas* those furrows bend outwards posteriorly. This, however, is evidently the case in *L. Hübneri* also, as stated in SCHMIDT's description of the species and indicated in his figure of the holotype viewed in dorsal aspect (SCHMIDT, 1885 p. 66, Pl. 1, fig. 13 a) and very clearly shown in EICHWALD's (1842, Pl. 3, fig. 21) figure. The outline drawing given in FOERSTE's paper (Pl. 4, fig. 1), which does not show this feature, is said to be made after SCHMIDT's figure, but it is not a true copy.

In his paper of 1923 REED¹ has followed FOERSTE; from the sub-genus *Metopolichas* »the group of *Lichas affinis*» (in which *Lichas laciniatus* is included) is removed and for the reception of this »group» a new sub-genus is erected. This new sub-genus is called *Autolichas* and *L. affinis* ANG. is said to be the sub-genotype. It should have been called *Lichas (Lichas)*, and *L. laciniatus* is the type. As a matter of fact, the two figures² (ANGELIN, 1854, Pl. 36, fig. 2 a, Pl. 38, fig. 4 b) quoted by REED (op. cit. p. 458) after ANGELIN as representing *L. affinis*, illustrate pygidia belonging to *L. laciniatus* (cf. WARBURG, 1925, p. 299 ff. and below under *L. laciniatus*).

According to REED's (op. cit. pp. 457, 458) diagnoses of the two sub-genera these differ in the following characters: »*Metopolichas*. — Cranidium with . . . fourth lateral» (basal lateral glabellar) »lobes large», »Pygidium with three pairs of pleuræ, all . . . ending in free points on margin.» »*Autolichas*. — Cranidium with . . . fourth lateral lobes very small, nearly squeezed out», »Pygidium . . . simply pointed or rounded behind; the first two pleuræ ending in free points projecting beyond margin, the third pair without free points, not projecting at all.»

It is true that in *L. Hübneri*, as well as in the other species that REED apparently would keep in *Metopolichas* (cf. below), the basal lateral glabellar lobes are large, while those of *L. laciniatus* and *L. affinis* are small (but I should hardly describe the latter as very small, and certainly not as being nearly squeezed out). This difference, however, does not appear to be of generic — or sub-generic — importance. That the geologically younger forms

¹ This paper I had not seen until after my work of 1925 was printed.

² One of them (ANGELIN, 1854, Pl. 38, fig. 4 b) is copied in outline in REED's paper of 1902, p. 73.

(*L. laciniatus* and *L. affinis*) should differ in this feature from the older ones, is only what might have been expected.

In REED's diagnosis of *Metopolichas* the part concerning the pygidium is not based on *L. Hübneri* and is not relevant. Evidently REED was not aware of the fact that the pygidium of that species had been recognized and was described and figured by SCHMIDT in 1907 (p. 38, Pl. 2, fig. 7). It has not been found in direct association with the cranidium, but it agrees with the latter in the rather unique ornament of the test (cf. below) and there does not seem to be any reason to doubt that it really belongs to that species. This pygidium agrees in its general structure (cf. below) with the pygidia of typical species of *Lichas*. It is rounded behind and the third pair of pleuræ are without free points. Other species placed by REED (and others) in *Metopolichas* differ in this respect from the type of *Lichas*, but this difference does not either appear to be of generic importance.

FOERSTE's and REED's reasons for keeping a genus or sub-genus *Metopolichas* are evidently not valid.

PHLEGER (1936, p. 600), too, regards *Metopolichas* as a separate genus, which, according to him, »differs from *Lichas* in having the glabella strongly arched anteriorly, and a pygidium with a notch in the post-axial area.» Evidently he also, has overlooked the fact that the pygidium of the genotype had been recognized and does not fit this description; the degree of convexity of the glabella is of course not a character of more than specific importance. It may be worth mentioning that the glabella of *Lichas laciniatus*, the genotype, is rather more strongly arched anteriorly than what can be seen in ANGELIN's figure, reproduced in outline by PHLEGER, and that *L. affinis* ANG., which often has been confounded with *L. laciniatus*, has a rather strongly convex glabella. It may also be mentioned that the pygidium figured by PHLEGER (fig. 4), after ANGELIN, does not belong to *L. laciniatus*, but to *L. affinis*, as I have already pointed out in my work of 1925, where there is also a text-fig. (p. 298 text-fig. 20) of the holotype (a pygidium) of *L. laciniatus*.

In papers of 1925 (pp. 13—15) and 1930 (p. 27) ÖPIK has advanced some other grounds for keeping *Metopolichas* distinct from *Lichas* s. str. In these papers he only mentions the one genus *Lichas* and regards *Lichas* (*Lichas*) and *Metopolichas* as subgenera. In a later work¹, not yet published, but of which he has had the kindness to send me a proof-sheet of the part dealing with *L. Hübneri*, this question is further discussed. Here he owns that the opinion that the name *Metopolichas* is to be regarded as a synonym of *Lichas* is well grounded, but proposes to keep the name *Metopolichas* GÜRICH by restricting the subgenus. He points out that the type, *Metopol. Hübneri*, differs from *Lichas* (*Lichas*) in having a punctate — not tuberculate — test and in the shape of the pygidium, which has a rounded margin on which none of the pleuræ projects. In addition to the genotype *L. Wimani* A. ÖPIK (ÖPIK, 1925, p. 13, Pl. 2, figs. 4—6) and a new species are referred to subgenus

¹ ÖPIK, 1937; published after my work was sent in to the Academy of Science.

Metopolichas. The characters mentioned do not appear to be of great systematic value, but perhaps sufficient as subgeneric characteristics if they really go together in several species. This we do not know, however, since only in the genotype the pygidium is known.

To judge from his statements in the published papers, it appears as if ÖRIK considered the difference, from *Lichas*, in the ornament of the test to be the more important character, but it must be remembered that in many Lichidæ both tubercles and punctæ occur, tubercles on the dorsal parts and punctæ on the labra, or sometimes both punctæ and tubercles on the labra, and that at least in one species, *Amphilichas lineatus* (ANG.) (cf. below), both kinds are found on the dorsal surface. Moreover, in that species small and large specimens show great differences in this respect. In the small ones the cranidia are tuberculate all over except just in front, in the somewhat larger the tubercles have disappeared anteriorly where the test is punctate, in still larger ones tubercles are only found posteriorly and punctæ on other parts, and in the largest ones there are punctæ all over and no tubercles, or perhaps some on the occipital ring. The hollows on the ventral surface of the test corresponding to the tubercles on the outside disappear more slowly, so that in specimens where on the dorsal surface of the test there are no tubercles on the glabella, it may be seen if the test is removed that on the interior casts the posterior part appears tuberculate. ÖRIK denies that *Lichas Hübneri* is ever tuberculate but SCHMIDT was of an other opinion, and it is open to doubt, I think, whether the species may not in this respect resemble *Amphilichas lineatus* to some extent.

It seems as if ÖRIK had only a single cranidium of the species and as if he had not seen the holotype. EICHWALD (1842, p. 62) had originally described *L. Hübneri* as having a pitted surface. In his work of 1885 (p. 65) SCHMIDT referred to this species in addition to the holotype a second cranidium, belonging to the PHALEN collection, and gave a new description in which he »corrected» EICHWALD and stated that the surface was not pitted but covered with low, rounded tubercles. Later (1907, p. 37), however, he admitted that he himself had been mistaken and gave the following informations regarding the ornament of the test: »das Eichwald'sche Stück zeigt deutlich auf der Oberfläche eingedrückte Punkte und keine flache gerundete Tuberkel, während das Phalen'sche wiederum nur die genannten Tuberkel zeigt. Aber wir erkennen an abgeriebenen Stellen des Eichwald'schen Originals, dass in einer tieferen Schalenschicht allerdings nur flache Tuberkel und keine eingedrückte Punkte vorhanden waren. Es kommt also auf einen Wechsel verschieden beschaffener Schalenschichten heraus. In f. 6 unsrer Tafel II habe ich ein neuerdings gefundenes Schalenstück der Glabella abgebildet, das wiederum nur eingedrückte Punkte zeigt. Ebenso finden sich auf dem Pygidium (T. II, f. 7), dem ersten derartigen Exemplar unsrer Art, nur eingedrückte Punkte.»

The group for which SCHMIDT in 1885 introduced the name *Homolichas* has been recognized by later writers as having the same rank as the other sub-divisions of *Lichas* sens. lat., and as type *L. depressus* (ANG.) was elected

by REED (1902). In my opinion this is not correct; *Homolichas* should be united with *Conolichas* DAMES, 1877, since the characters in which the members of the two groups differ do not appear to be of generic — and hardly of sub-generic — value. The chief difference is in the shape of the glabella. In most of the species which have been placed in *Homolichas* the glabellar lobes are without or have only slight independent convexity, whereas in the typical *Conolichas* the fronto-median glabellar lobe has a dorsal or anterior protuberance and is depressed posteriorly. There are, however, forms which show intermediate characters [e. g. *Conol. deflexus* (ANG.); cf. below].

It has been believed that typical *Homolichas* differed from *Conolichas* in having a pygidium with only the two anterior pairs of pleuræ ending in free points and with the posterior margin evenly rounded. This would not, if true, be of great systematic value, and as a matter of fact, in all the species in which those portions are known, the third pair of pleuræ end in free points, or [»*Homolichas*» *Eichwaldi* (NIESZKOWSKI); cf. below] the points are at least indicated. About ANGELIN'S species *Lichas depressus* we know very little — the holotype, a fragmentary cranidium, is lost — in fact we know so little that the name must be dropped, at least for the present. But we know this [cf. below under *Conol. Peri* n. sp. and *Conol. deflexus* (ANG.)]: that the pygidium attributed to this species by ANGELIN belongs to *Conol. deflexus* (ANG.), and that its basal pleuræ end in free points, as was shown when it was properly cleaned from matrix; that the same character is shown in complete pygidia belonging to the form described and figured by SCHMIDT [1885, p. 95, Pl. 4, figs. (1) 2—5] as *Lichas depressus* (ANG.) — our *Conolichas Peri* n. sp. (cf. below) — and that, according to SCHMIDT'S own statement (p. 96), his material did not show the character of the hindmost portions of the pygidium. SCHMIDT'S fig. 4, illustrating a fragmentary pygidium with most of the missing parts restored in outline, (which has been reproduced to illustrate the characters of the type of *Homolichas*) gives a false impression.¹

The fact that *Metalichas* REED, 1902 has no real basis, since the genotype *Lichas cicatricosus* SCHMIDT (non LOVÉN) is a »composite species» I have already pointed out in my work of 1925 (p. 257), and likewise (p. 256) my reasons for rejecting *Acrolichas* FOERSTE, 1919. That the latter genus was erected was owing to a mistake, not made by FOERSTE, but by SCHMIDT, who (1885) to the type of *Amphilichas*, *Amphil. lineatus* (ANG.), and also to *Amphil. Holmi* (SCHMIDT) had erroneously attributed pygidia apparently belonging to species of *Conolichas* [the pygidium attributed to *Amph. lineatus* probably belongs to *Conol. angustus* (BEYR.)]; FOERSTE'S genus was to include species earlier referred to *Amphilichas* which had pygidia of another type.

PHLEGER splits *Amphilichas* into five genera. He considers that only the genotype, *Amphilichas lineatus* (ANG.) (cf. WARBURG, 1925, p. 326 ff., Pl. 8,

¹ Since this was written I have received Professor ÖPIK'S paper on »Trilobiten aus Estland», in which he places both *Homolichas* and *Conolichas* as sub-genera of *Hoplolichas*. I think, however, as expressed above, that *Conolichas*, with *Homolichas* included, will stand as a genus.

fig. 39—40), should be left in *Amphilichas*. It must be owned that there appear to be some reasons for this. The species differs from most others referred to *Amphilichas* in the character of the prolonged anterior glabellar furrows which do not reach the occipital furrow and only anteriorly are sharply impressed. The impressions made in the internal casts generally extend farther backward than the real furrows on the surface of the test. The postero-lateral boundaries of the median lobe is, however, indicated, at least in internal casts, by slight impressions, and it is evident that the species has descended from forms with better impressed prolonged anterior glabellar furrows, reaching the occipital furrow. Conceivably the obliteration of the furrows posteriorly — and the disappearance of the tubercles in older, and larger, individuals — is connected with a thickening of the test; and it seems doubtful whether a feature like that should be considered to have great systematic importance. The labrum, found in situ in an Eastbaltic specimen (SCHMIDT, 1885, Pl. 6, fig. 5) is of the same type as that of other species referred to *Amphilichas*. Unfortunately the pygidium is not known. If that is of the same type as the pygidia of other species which have been placed in the genus, I hardly think there is sufficient ground to split up the genus, but if it should be proved that it is of another type those other species must be removed from *Amphilichas*, and FOERSTE'S *Acrolichas* be reerected. PHLEGER restricts *Acrolichas* to its type species *Amphil. cucullus* (MEEK and WORTHEN), because it differs from other species of *Amphilichas* in the shape of the glabella, a difference which, in my opinion, is only of specific importance. PHLEGER'S new genus *Tetralichas*, erected to include the majority of the species earlier referred to *Amphilichas*, I must consequently reject.

The other new genera proposed by PHLEGER to include species earlier referred to genera represented in the Swedish Ordovician or Lower Silurian, I think must also be rejected, since they are all based on characters, which do not appear to have generic value.

Genus *Lichas* DALMAN, 1827.

Genotype: *Lichas laciniatus* (WAHLENBERG, 1818).

Synonyms: *Entomostracites* WAHLENBERG 1818 pars. — *Paradoxides* BROGNIART 1822 pars. — *Asaphus (Lichas)* DALMAN 1827. — *Lichas* auctt. pars. — *Metopias* EICHWALD 1842. — *Lichas (Metopias)* SCHMIDT 1885. — *Lichas (Metopolichas)* GÜRICH 1901, REED 1902. — *Metopolichas* WELLER 1907. — *Lichas + Metopolichas* FOERSTE 1920. — *Lichas* (subg. *Autolichas + Metopolichas*) REED 1923. — *Lichas + Metopolichas* PHLEGER 1936.

Diagnosis. — Cranium with complete dorsal furrows; prolonged anterior lateral glabellar furrows not reaching occipital furrow; basal lateral glabellar furrows partly or completely obliterated; occipital lobes well defined. Pygidium with prolonged dorsal furrows not reaching posterior margin; rachis with two ring furrows and sometimes traces of a third, indistinctly defined behind, continued by relatively broad post-rachial piece; pleural portions composed of

three pairs of furrowed pleurae, two anterior pairs completely defined and with free points, basal pair posteriorly confluent with post-rachial piece, with or without free points.

Lichas laciniatus (WAHLENBERG 1818).

Pl. 9, figs. 1—7, fig. 8?

1818. *Entomotrachites laciniatus*, WAHLENBERG, p. 34 (pars), Pl. 2, fig. 2* (non fig. 2).
 1822. *Paradoxides laciniatus*, BROGNIART, p. 35 (pars), Pl. 3, fig. 3 (excl. cranium; copy after WAHLENBERG).
 1827. *Asaphus (Lichas) laciniatus*, DALMAN, p. 278 (pars), Pl. 6, fig. 1?¹
 1837. *Lichas laciniatus*, HISINGER, p. 17 (pars), Pl. 3, fig. 7? (copy after DALMAN).
 1846. » *laciniatus* α , LOVÉN, p. 55, Pl. 1, fig. 7 a.
 1845. » *laciniata*, BEYRICH, p. 26, Pl. , fig. 17.
 1846. » » » p. 6, Pl. 1, fig. 5 (fig. 5 a?).
 1854 et 78. *Lichas laciniatus*, ANGELIN, p. 69 (pars), Pl. 36, fig. 1 (excl. pygidium), fig. 1 a.
 1854 et 78. » *affinis*, ANGELIN, p. 69 (pars), Pl. 36, fig. 2 a (non figs. 2, 2 b), Pl. 38 fig. 4 b (figs. 4—4 a?).
 1854 et 78. *Lichas conformis*, ANGELIN, p. 74, Pl. 38, fig. 5.
 1896. *Lichas affinis*, REED, p. 427 (pars?).
 1896. » *conformis* var. *keisleyensis*, REED, p. 427, Pl. 21, fig. 10.
 1902. » *affinis*, REED, p. 73, fig. 5 (copy after ANGELIN).
 1925. » *laciniatus*, WARBURG, p. 295, Pl. 8, figs. 14—18, 20, fig. 19?; text-fig. 20.

Diagnosis. — Cephalon gently convex, with moderately strong furrows. Glabella somewhat longer than wide, broadly rounded in front, flattened posteriorly, curved downwards in front, the strong downward slope commencing at about two-thirds the distance from posterior to anterior margin; fronto-median lobe rather strongly convex and wide anteriorly, with obtusely rounded antero-lateral extremities, becoming very gently convex posteriorly and lower than posterior parts of bi-composite lobes, narrowing to opposite middle of palpebral lobes, here narrower than bi-composite lobes, then generally widening slightly to opposite inner extremities of those lobes, expanding suddenly at base, here with slight independent convexity in both directions; bicomposite lobes sub-oval, with gentle independent convexity; basal lobes small. Occipital lobes elongated sub-oval, extending considerably farther outwards than base of glabella, but not as far as main portion of occipital ring. Pygidium with moderately strong furrows, sub-triangular, with fulcrum distant from rachis by about five-sixths its width; rachis extending fully one-third the length and anteriorly rather less than one-third as wide as entire pygidium, rather strongly raised, with flattened sides and obtusely pointed apex, posterior slope from latter rather steep; posterior portions of dorsal furrows sub-parallel (or bent very slightly outwards); anterior two pairs of pleurae ending in rather short, backwardly directed free points, their lateral margins straight, those of anterior pair directed nearly at right angles to anterior margin; third pair without free points. Surface not very coarsely tuberculate, with rather large to

¹ DALMAN's figure seems to have been drawn from, at least, two different specimens, one belonging to this species the other to *L. affinis* ANG. (cf. below p. 16).

medium-sized, pointed tubercles relatively sparsely distributed, between them a large number of small and minute ones.

Remarks. — The holotype (Pl. 9, fig. 1) of this species and some specimens from Borenhult are figured below. The large pygidium (R.M. Ar. 6079) from Borenhult (fig. 2) is the real original of LOVÉN's (1846, Pl. 1, fig. 7 a) *Lichas laciniatus* α , but some details seem to have been drawn from the small specimen (R.M. Ar. 6080) from the same locality (fig. 4).

Horizons and Localities. — Dalmanites Shales. — Västergötland: Mösseberg at Bestorp (holotype, pygidium, U.M.; WAHLENBERG 1818, Pl. 2, fig. 2*; below, Pl. 9, fig. 1), Ålleberg. Östergötland: Borenhult. — Boda (= Upper Leptaena) Limestone. — Dalarne: Lissberg, Boda, Osmundsberg, Skålberget.¹

Keisley Limestone. — England: Keisley.

Lichas affinis ANGELIN 1854.

Pl. 9, figs. 13—15.

1846. *Lichas laciniatus* β , LOVÉN, p. 55, Pl. 1, fig. 7 b.

1854 et 78. *Lichas affinis*, ANGELIN, p. 69 (pars), Pl. 36, figs. 2, 2 b (non fig. 2 a).

1854 et 78. » *laciniatus*, ANGELIN, p. 69 (pars), Pl. 36, fig. 1 (excl. cranidium).

1854 et 78. » *cicatricosus*, ANGELIN, p. 74 (pars), Pl. 38, figs. 6—6 a (non fig. 6 b).

1884. *Lichas affinis*, TÖRNQUIST, p. 33, Pl. 1, fig. 31.

1925. » » WARBURG, p. 302, Pl. 8, figs. 1—6, 8, 11—13, 21, fig. 7?, fig. 23?

Diagnosis. — Cranidium with moderately strong furrows. Glabella wider than long, rather broadly rounded in front, strongly convex longitudinally, curving steeply downwards anteriorly, the downward slope commencing considerably nearer posterior than anterior margin, gently convex from side to side posteriorly; fronto-median lobe anteriorly strongly convex and wide, with pointed antero-lateral extremities, becoming more gently convex posteriorly, narrowing to inner extremities of bi-composite lobes, expanded at base, here generally with slight independent convexity in both directions, everywhere higher and wider than lateral lobes; bi-composite lobes sub-oval, with gentle independent convexity; basal lobes small. Occipital lobes sub-ovate, extending considerably farther outwards than base of glabella, but not as far as main portion of occipital ring. Pygidium with moderately strong furrows, semi-elliptical with broadly rounded antero-lateral angles, rounded behind, fulcrum distant from rachis by less than two-thirds its width, rachis extending fully two-fifths the length and anteriorly rather more than one-third as wide as entire pygidium, moderately raised, with flattened sides and obtusely marked apex, posterior slope from latter generally more gentle than lateral slopes; posterior portions of dorsal furrows distinctly diverging; anterior two pairs of pleurae ending in very short free points, their outer margins curved, those of anterior pair forming rather even curves from fulcra to free points; third pair

¹ In my work of 1925 (p. 421) in the list of Upper Leptaena Limestone Trilobites occurring outside of Dalarne, this species is recorded from the West Baltic Leptaena Limestone. The reference is meant for *Platylichas cicatricosus* (LOVÉN).

without free points. Surface relatively coarsely tuberculate, with rather high, medium-sized, or rather small, and, relatively few, very small tubercles, closely placed.

Remarks. — The holotype of this species, a fragmentary glabella from Borensult (ANGELIN 1854, Pl. 36, figs. 2, 2 b), I have not been able to find or recognize. As neotype I have chosen the cranidium (R.M. Ar. 6078) from the same locality figured below on plate 9 (figs. 13 a—b). The pygidium (R.M. Ar. 6082) illustrated in fig. 15 (Pl. 9) is the original of LOVÉN'S (1846, Pl. 1, fig. 7 b) *Lichas laciniatus* β.

Horizons and Localities. — Dalmanites Shales. — Östergötland: Borensult (neotype. R.M. Ar. 6078; below Pl. 9, figs. 13 a—b). Västergötland: Mösseberg at Bestorp, Ålleberg. — Boda (= Upper Leptaena) Limestone. — Dalarne: Lissberg, Boda, Osmundsberg, Östbjörka, Kallholn (Vestanå?).

Lichas verrucosus (EICHWALD 1842).

Pl. 3, figs. 1—6.

1842. *Metopias verrucosus*, EICHWALD, p. 63, Pl. 3, figs. 23 a—b.
 1854 & 1878. *Lichas convexus*, ANGELIN, p. 70, Pl. 36, fig. 5.
 1858. *Lichas Hübneri*, HOFFMAN, p. 23 (pars), Pl. 1, fig. 2 (copy after EICHWALD).
 1885. » *verrucosa*, SCHMIDT, p. 62, Pl. 2, figs. 1—5 (figs. 6—11).
 1901. *Metopolichas verrucosus*, GÜRICH, Pl. 26, fig. 17 (copy after SCHMIDT).
 1902. *Lichas verrucosus*, REED, p. 73, text-fig. 4 (copy after SCHMIDT).
 1907. » » SCHMIDT, p. 32, Pl. 1, fig. 20 (figs. 21—22).
 1937. » (*Lichas*) *verrucosus*, ÖPIK, p. 49, text-fig. 13.

Diagnosis. — Cranidium with relatively strong furrows. Glabella wider than long, rather broadly rounded in front, moderately to strongly convex longitudinally, curving steeply downwards anteriorly; fronto-median lobe strongly convex and moderately expanded anteriorly, with pointed antero-lateral extremities, posteriorly with slight independent convexity, everywhere raised above lateral lobes, narrowing to a little behind middle of glabella, here narrower than bi-composite lobes, then widening to occipital furrow; bi-composite lobes elongated sub-elliptical with pointed extremities; basal lateral lobes large. Occipital lobes sub-ovate, produced at sides considerably beyond base of glabella, reaching nearly as far outwards as main portion of occipital ring. Surface finely tuberculate, tubercles small, of varying size, rather low, closely placed.

Description. — (Cephalon sub-triangular, its length about three-eighths the width at base, across posterior portions of the short, broad, and outwardly directed genal spines).

Glabella moderately to strongly convex from back to front, curving steeply downwards anteriorly, gently convex from side to side posteriorly, rounded in front, wider than long, widest a little in front of middle, narrowing gradually posteriorly, its basal width about five-sevenths its greatest width. Fronto-median lobe of glabella strongly convex in both directions anteriorly, posteriorly with slight independent convexity, everywhere raised above lateral lobes, mod-

erately expanded in front with pointed antero-lateral extremities, narrowing posteriorly to a little behind middle of glabella, where its width is about one-third the frontal width and less than one-third that of entire glabella, then widening again to occipital furrow to about half its frontal width, posteriorly coalescing with basal lateral lobes, its lateral boundaries being indicated, however, by its slight independent convexity. Bi-composite lobes sub-elliptical, widest a little in front of middle, with pointed extremities, the longer axes directed obliquely outwards and forwards and a little less than twice as long as the shorter ones; postero-laterally confluent with basal lateral lobes. Basal lateral lobes comparatively large, but much smaller than bi-composite lobes, irregularly quadrilateral, flattened or very slightly convex in both directions, coalescing internally with median lobe and antero-laterally with bi-composite lobes. Prolonged anterior lateral glabellar furrows sharply impressed, of moderate width on surface of test, broader on casts, curving from their anterior points of origin inwards, upwards, and backwards to a little behind middle of glabella, then slightly diverging to points about equally distant from occipital and dorsal furrows, where they are continuous with basal lateral glabellar furrows, making a sharp turn outwards and forwards around posterior extremities of bi-composite lobes; these well-defined, inner portions of basal lateral furrows short, extending about half-way or less than half-way to dorsal furrows, outer portions obsolete.

Dorsal furrows about as strong as prolonged anterior lateral glabellar furrows, running from anterior border furrow at first backwards and slightly outwards, describing rather slight outwardly convex curves to the points where the palpebral furrows branch off, then backwards and inwards in concave curves to occipital furrow, where they turn rather sharply outwards and continue in outwards and forwards convex curves to posterior margin of cranidium. Anterior border of cranidium narrow, rounded in middle, growing more flattened and somewhat wider at sides, marked off by narrow, rather deeply impressed furrow. Occipital furrow nearly straight, behind median lobe of glabella, dividing at sides; anterior side-branches directed very slightly forwards; posterior branches running in backwardly convex curves obliquely outwards and backwards; middle portion and anterior side-branches about as strong as dorsal and glabellar furrows; posterior branches rather deeper and narrower. Main portion of occipital ring broad (in middle), rather strongly arched transversely, gently rounded longitudinally. Occipital lobes sub-ovate, with pointed lateral extremities, their longer axes rather more than twice the shorter ones, directed slightly backwards, produced at sides outside base of glabella and reaching nearly as far outwards as main portion of occipital ring; their surfaces slightly raised, sloping downwards postero-laterally.

Fixed cheeks in front of eye lobes narrow, sloping steeply downwards anteriorly with rounded surfaces; posterior portions much wider and produced laterally, moderately to rather strongly convex in the regions inside the eye lobes, behind these sloping rather steeply downwards postero-laterally with gently convex surfaces to posterior border furrows. Palpebral lobes sub-

crescentic, of moderate size (rather narrow), with their anterior extremities a little behind middle of glabella. Posterior borders of fixed cheeks narrow at dorsal furrows, widening laterally, rounded, marked off by distinct, narrow furrows. Anterior branches of facial sutures curving from eye lobes forwards and inwards, posterior branches obliquely outwards and backwards.

Free cheeks sub-triangular, with narrow inner portions sloping steeply downwards from eye lobes. Postero-lateral portions forming short, broad, tapering, obtusely pointed, flattened genal spines, which are directed only slightly backwards; their antero-lateral margins straight and directed obliquely outwards and backwards for the greater part of their length, but curving more backwards posteriorly; postero-lateral margins directed outwards and slightly backwards, slightly concave. Posterior border furrows distinctly marked, curving backwards laterally, dying out rather close to posterior margins and not very far from ends of spines.

Labrum gently convex transversely, about three-fourths as long as wide, widest just behind posterior furrow, narrowing rapidly both anteriorly and posteriorly, narrowly rounded in front; antero-lateral margins nearly straight, lateral angles obtusely pointed, postero-lateral margins slightly convex outwards and backwards, posterior edge with deep, comparatively narrow, rounded excavation, postero-lateral extremities narrowly rounded. Anterior edge narrow, almost vertically inclined, with concave surface, growing flattened and gradually somewhat wider postero-laterally, and finally merging into the anterior wings, which are triangular, flattened, steeply inclined, and situated relatively far back. Central body moderately convex, extending about three-fifths the length of labrum, somewhat wider than long, widest at base, slightly decreasing in width anteriorly, rather narrowly rounded in front; marked posteriorly by a pair of strong middle furrows, beginning in lateral furrows a little behind middle of central body and running obliquely inwards and backwards rather more than two-thirds the way to median line, dividing a little before reaching this level, anterior divisions of about the same strength as main portions of furrows but bending more inwards, posterior divisions narrower and directed more backwards; pair of small, rounded, prominent maculae situated one on each side between inner extremities of divisions of middle furrows. Lateral furrows strongly impressed, of moderate width, extending a little beyond posterior furrow, describing slight outwardly convex curves outside postero-lateral lobes of central body, bent in at posterior furrow, then again describing slight convex curves. Posterior furrow about as deep as, but somewhat narrower than, lateral furrows, straight. Anterior furrow rather shallower and anteriorly narrower than the others, in front merging into concave anterior edge, marking off at each side a narrow slightly raised border, which grows narrower and finally disappears anteriorly. Lateral borders wide, rapidly decreasing in width anteriorly, rather strongly convex outside central body, behind this becoming less convex and sloping gently laterally. Anterior portion of posterior border separated from lateral borders by the prolongations of the lateral furrows, slightly swollen. Postero-lateral lobes of border relatively long,

their surfaces sloping from extremities anteriorly and laterally, gently convex transversely.

[Thorax not recognized.]

Pygidium (probably belonging to this species) somewhat pentagonal in general outline, wider than long, the sagittal length being about five-eighths the greatest width, found across anterior pleuræ some distance in front of their extremities. Rachis relatively strongly convex, its width anteriorly rather less than one-third greatest width of pygidium, tapering posteriorly and undefined, or very indistinctly defined, from post-rachial piece; marked anteriorly by one complete ring furrow and a second one, which is interrupted in the middle. Dorsal furrows rather narrow, sharply impressed, continued posteriorly and bounding the post-rachial piece, but dying out at a considerable distance from margin, converging posteriorly for the greater part of their length, becoming nearly parallel near extremities, which latter bend slightly outwards. Post-rachial piece strongly convex anteriorly (not defined from rachis) sloping downwards posteriorly and becoming flattened between extremities of dorsal furrows; its width across narrowest portion less than one-third the anterior width of rachis.

Pleural portions of pygidium flattened. All three pairs of pleuræ marked by rather narrow, sharply impressed pleural furrows and separated by about equally strong interpleural furrows, and with rather short, broad-based, backwardly directed, pointed free ends. Anterior pair of pleuræ somewhat longer (the length measured from innermost point of anterior margin to extremity) than second pair and considerably longer than basal pair; extending fully three-fifths the length of pygidium; increasing in width to about middle, then tapering to extremities; their outer margins with relatively short straight anterior portions, strongly curved middle portions, and very slightly curved posterior portions, the latter directed nearly straight backwards. Anterior pair of interpleural furrows, for the greater part of their length, and proximal margins of free ends of anterior pleuræ nearly straight and directed at about 40° to median line of pygidium; the innermost portions of the furrows are directed somewhat more strongly outwards. Second pair of interpleural furrows and proximal margins of free ends of second pair of pleuræ directed at about 30° to median line; the furrows slightly sigmoidally curved. Second pair of pleuræ reaching somewhat more than half-way between the lines joining extremities of anterior and those of basal pair respectively; proximally slightly wider than anterior pair, but nowhere reaching the greatest width of the latter; the distal margins of their free ends gently curved with the general direction slightly inwards. Anterior pair of pleural furrows beginning in dorsal furrows close to anterior margin of pleuræ; second pair (at least in the specimen examined) beginning in anterior interpleural furrows some distance from dorsal furrows; both those pairs rather long, but not reaching out on the free portions of the pleuræ, and distally, where they become very weak, approaching proximal margins of pleuræ. Basal pair of pleuræ sub-triangular with lateral angles truncate and the antero-laberal and postero-lateral margins

of nearly equal length, the former slightly sigmoidally curved, the latter nearly straight; the greatest width about equal to greatest width of anterior pair of pleuræ; free ends bluntly pointed, with gently curved proximal margins, distance between extremities nearly equal to half anterior width of rachis; their pleural furrows beginning in dorsal furrows at considerable distance from anterior margin of pleuræ, quite short, at first running obliquely outwards and backwards, then curving backwards and slightly inwards, becoming weak and soon dying out. Doublure of pygidium wide.

Surface of cranidium and pygidium closely covered with small, rounded or obtusely pointed, but rather low tubercles of various sizes. Surface of labrum: on median portions and internal portions of lateral borders with rounded closely-placed pits, on marginal portions of lateral borders with coarse, anastomosing ridges sub-parallel to margins.

Dimensions. — In the cranidium (R.M. Ar. 2242, Pl. 3, figs. 1 a—c) figured by ANGELIN as *Lichas convexus* the sagittal length is about 23 mm. and the width between the palpebral lobes 24 mm.; a distorted cranidium (R.M. Ar. 2245) from the same locality, Ljung in Östergötland, seems to have about the same dimensions, and in a large more strongly convex cranidium from Öland (S.G.U. Pl. 3, figs. 2 a—c) the sagittal length is approximately 36 mm. and the width between the palpebral lobes 38.5 mm. In a large labrum (R.M. Ar. 2243, Pl. 3, fig. 3) the length is 26 mm. and the greatest width 33 mm. In a smaller labrum (R.M. Ar. 2245, Pl. 3, fig. 4) belonging to the distorted cranidium from Ljung the sagittal length seems to have been about 16 mm.; the entire length, between 19 and 20 mm. and the greatest width, about 25 mm. In the pygidium described the greatest width is about 39 mm.; the sagittal length, 23 mm. and the anterior width of the rachis, 12 mm.

Remarks. — EICHWALD (1860, p. 1386) and SCHMIDT (1885, p. 62, 1907, p. 33) have already pointed out that ANGELIN'S *L. convexus* is identical with *L. verrucosus* (EICHW.) and, to judge from the descriptions and figures available of cranidia from the East Baltic Area, ANGELIN'S specimen agrees very closely in characters with those belonging to the typical form of this species, SCHMIDT'S (1907, p. 33) »forma» or var. *typica(us)*, to which it was also referred by SCHMIDT. ANGELIN'S specimen (R.M. Ar. 2242) is from Ljung in Östergötland and occurs in a red orthoceras limestone which, according to LINNARSSON and TULLBERG (1882, p. 24) is what they termed *Expansus Limestone*, and which latter according to MOBERG (1890, p. 18) corresponds to the Upper *Asaphus Limestone* of Öland.¹ In the State Museum of Natural History there

¹ In other parts of Sweden the *Asaphus Limestone* is grey, »the Lower Grey Orthoceras Limestone», and no upper division corresponding to the Upper *Asaphus Limestone* of Öland has been recognized. In several districts, Öland included, the overlying *Gigas* and *Platymus Limestones* are red, »the Upper Red Orthoceras Limestone». In most places in Östergötland where the »*Expansus*» *Limestone* occurs it is greyish-green, as for instance at Vestaná at Husbyfjöl. LINNARSSON and TULLBERG (1882, p. 24) have, however, stated that the fauna in the red limestone found at Ljung and at a few other localities in Östergötland agrees with that occurring

is also a distorted cranidium (Ar. 2245) with the labrum nearly in place from the same locality and horizon. In addition to the specimens from Ljung there are now available some others found in ordinary grey Asaphus Limestone, viz. in the State Museum of Natural History two labra, one (Ar. 2243) from Humlenäs in Småland and a smaller, fragmentary one (Ar. 2228) from Öland, and in the Museum of the Geological Survey a cranidium and an incomplete labrum from Öland. A fragmentary pygidium and a nearly entire impression of the same specimen from Öland in the Uppsala Museum most probably belong to this species and possibly also two fragments of pygidia, also from Öland, which are in the Museum of the Geological Survey.

The cranidium from Öland (Pl. 3, figs. 2 a—c) is much larger than ANGELIN's specimen (Pl. 3, figs. 1 a—c) and larger than any of those figured by SCHMIDT, and it is more strongly convex. It seems, however, to judge from SCHMIDT's figures, as if the larger cranidia of this species were more convex than the smaller ones (cf. SCHMIDT, 1885, Pl. 2, figs. 1 b and 5 b). The independent convexity of the fronto-median and bi-composite lateral glabellar lobes is also somewhat more pronounced in this large cranidium than in ANGELIN's specimen, and the basal lateral glabellar furrows are distinctly impressed for a somewhat greater length (though not longer than indicated in SCHMIDT's — 1885, Pl. 2 — fig. 1 a). The difference in the latter respect is probably chiefly due to the fact that in the large cranidium the test is not preserved on this portion, where it is present in ANGELIN's specimen. The furrows are not continued by any weaker furrows or grooves to the dorsal furrows, and the postero-lateral boundaries of the bi-composite lobe are not defined, so that the cranidium in question cannot be referred to SCHMIDT's forma or var. *circumscripta(us)* and in other characters it agrees well with ANGELIN's specimen.

The variety just mentioned (SCHMIDT, 1907, p. 32, Pl. 1, fig. 21, 1885, Pl. 2, fig. 6), which SCHMIDT considers to be the older¹, differs according to him in having the bi-composite lobes better defined, and it seems as if he was of the opinion that the basal part of the median lobe of the glabella was also as a rule more or less distinctly defined from the basal lateral lobes. Concerning the differences between the two forms, he says in his paper of 1907 (p. 32) that in the older one »die mittleren Seitenfurchen» (the basal lateral glabellar furrows) »voll entwickelt sind und dadurch auch die Seitenloben eine vollständig abgeschlossene Form erhalten» and further, when

in the greenish limestone occurring at other localities, and that it probably ought to be regarded as representing a sub-division of this. SCHMIDT (1881, p. 22), who earlier had visited both localities, was of the opinion that the red limestone at Ljung was younger than the Asaphus Limestone at Husbyfjöl.

¹ In the East Baltic Area the variety occurs according to him (1907, p. 33) only in the Eastern parts and in strata older than those (B_{3b}) in which the type-form has been found in Esthonia. The lowest horizon from which he records the species (s. lat.) (1907, p. 93) is B_{2b}, but from this horizon (or BII₂) he has figured specimens of both types (1907, Pl. I, figs. 20, 21) from Wolchow in Russia. It seems, however, as if at least the type form occurred there in younger strata also (cf. SCHMIDT, 1907, pp. 34, 93).

speaking of the prolonged anterior lateral glabellar furrows, he says: »die ihrerseits bisweilen in stärkerer oder schwächerer Ausbildung bis zur Nackenfurche zu verfolgen sind», and adds that it seems as if this feature was chiefly found in the older form. As already mentioned, he referred the specimen figured in his work of 1885 on Pl. 2, fig. 6 to the variety and, to judge from the figure and the statements given in that work concerning this specimen, it does not seem as if the portions in question were developed as real furrows. SCHMIDT (p. 63) states that a connection between the prolonged anterior lateral glabellar furrows and the occipital furrow is discernible, but in the figure it seems as if the boundaries of the basal part of the median lobe were indicated only by the rather slight independent convexity of this portion or possibly by very slight grooves. To the lateral part of the basal lateral glabellar furrow in this specimen SCHMIDT (p. 63) refers as a »schwache Andeutung einer Fortsetzung (als mittlere Seitenfurche) zu den Dorsalfurchen» and further on he says: »Ebenso sind auch die» »vorderen Seitenloben» (the bi-composite lobes) »nicht deutlich hinten geschlossen; sie markieren sich hier nur durch ihre bisweilen stärkere Wölbung (F. 6) gegenüber der hinter ihnen liegenden flachen Parthie». It seems thus as if the differences between the two forms were rather slight, and it appears doubtful to me whether the »forma circumscripta» represents a distinct variety, but possibly further finds will prove that these differences really are constant and that there are others as well¹.

The above description is drawn up from the Swedish specimens, only the parts of the description, between brackets, concerning the shape of the cranium and the free cheeks are based on SCHMIDT's (1907, p. 32, Pl. I, fig. 20) description and on one of his figures.

As mentioned above there is a pygidium from Öland in the Uppsala Museum, which most probably belongs to this species. It shows the same kind of ornament as the cranidia, and as far as can be judged from SCHMIDT's (1885, p. 64, Pl. 2, fig. 4) description and figure it seems to agree in characters with the fragmentary pygidium referred by him to this species².

KUMMEROW (1927, p. 33, Pl. II, fig. 1) has referred to this species a damaged glabella and a fragmentary pygidium found in boulders of grey Orthoceras Limestone in North Germany. To judge from the description and figure given, it does not seem as if the pygidium belonged here, but probably to *Lichas celorhin* ANG. (cf. p. 32). The glabella is neither figured nor described.

Affinities. — The affinities of this species appear to be with *Lichas celorhin* ANG. The points of difference are, however, so easily recognizable that a detailed comparison seems unnecessary. Some of the differences have, moreover, been pointed out by SCHMIDT (1907, p. 32).

¹ In the list of references on p. 17 I have put between brackets the numbers of the figures which represent specimens referred by SCHMIDT to the variety and such as do not show the characters of the type-form (labra etc.) from localities where the variety is said to occur.

² According to SCHMIDT's description of this specimen the posterior portion seems to agree in characters with the Swedish one, but the figure does not clearly show the characters described.

Horizons and Localities. — Asaphus Limestone. — Östergötland: Ljung. — Småland: Humlenäs (boulder). — Öland: Vedbarm in the parish of Högby (Loose stone), Hagen, Norra Torp, Byerum, (pygidium), ?Ölands Norra Udde (the northern point of land in Öland; fragments of pygidia).

Etage B_{2a}, Etage B_{3a}, Etage B_{3b}. — East Baltic Area (In Esthonia only the type form and only in B_{3b}: Holotype, EICHWALD, 1842, Pl. 3, fig. 23).

Lichas celorhin ANGELIN 1854.

Pl. 1, figs. 1—5 b. Pl. 2, figs. 1—7.

- ?1843. *Metopias verrucosa*, MAXIMILIAN, HERZ. v. LEUCHTENBERG, p. 10, Pl. 1, fig. 9.
 1854 & 78. *Lichas celorhin*, ANGELIN, p. 69, Pl. 35, figs. 1 a—c.
 ?1860—61. » *macrocephala*, EICHWALD, p. 1380 (excl. pygid.), Pl. 54, fig. 15.
 1882. *Lichas celorhin*, BRÖGGER, p. 128 (pars.), Pl. 5, figs. 11—12 (non fig. 13).
 1885. » » SCHMIDT, p. 56 (pars), Pl. 1, figs. 4—6 (non figs. 7—9).
 1885. » *pachyrhina*, SCHMIDT, p. 59, 61 (pygid.), Pl. 2, fig. 11.
 1907. » *celorhin*, SCHMIDT, p. 29 (pars.). Text-fig. 4 (non Pl. 2, figs. 5 a—c).
 1920. *Metopolichas pachyrinus*, FOERSTE, Pl. 4, fig. 3 (copy after SCHMIDT).
 ?1927. *Lichas (Metopolichas) verrucosus*, KUMMEROW, p. 33 (pygid.), Pl. 2, fig. 1.

Diagnosis. — Cranidium with most of its furrows about equally strong, wide and rather deep, preglabellar furrow always very wide. Glabella wider than long, with sub-conical, overhanging anterior portion, along back sloping rather steeply upwards from base, gently convex from side to side posteriorly, antero-lateral slopes very steep; fronto-median lobe sub-pentagonal, longer than wide, with sub-conical anterior portion projecting far beyond strongly arched anterior margin, narrowing posteriorly to a little in front of posterior extremities of bi-composite lobes, then parallel-sided to these, width here three-eighths to three-sevenths that of entire glabella; bi-composite lobes elongate, with pointed extremities and sub-parallel-sided median portions, strongly convex longitudinally, overhanging anterior extremities, more or less convex transversely; basal lateral lobes medium-sized. Occipital lobes rather large, sub-triangular, reaching only slightly farther outward than base of glabella, and nearly as far as main portion of occipital ring. Pygidium with rather narrow, relatively deep furrows, somewhat pentagonal in outline; rachis extending less than one-third the length and occupying less than one-third the width of entire pygidium, depressed convex; dorsal furrows converging rather sharply to about middle of pygidium, then parallel or slightly diverging for some distance, curving rather strongly outwards near extremities; all three pairs of pleurae with relatively short, broad-based, backwardly directed free ends. Surface coarsely or rather coarsely tuberculate, tubercles of very varying sizes, pointed, closely set.

Description. — Cephalon apparently sub-triangular narrowly rounded in front and with the free cheeks (only fragments known) prolonged into broad, rather short, tapering, bluntly pointed, flattened spines; its furrows generally wide or relatively wide and rather deep, most of them of about equal strength.

Glabella somewhat pentagonal in outline, greatest width, which is a little behind middle, from five-sixths to three-fourths sagittal length, tapering rather

gently posteriorly with postero-lateral sides slightly concave outwards — its basal width about four-fifths the greatest width — tapering more rapidly anteriorly to narrowly rounded front end, antero-lateral sides slightly bent in at anterior lateral glabellar furrows; its anterior portion sub-conical in outline, projecting far beyond anterior margin; distance from mid-point of anterior margin to opposite point on dorsal surface equals from five-sevenths to about the whole of the greatest width of glabella, distance to mid-point of occipital furrow greater than this width; gently convex from side to side posteriorly, antero-lateral slopes very steep, longitudinally sloping rather steeply upwards from occipital furrow, along median line nearly straight to opposite posterior extremities of bi-composite lobes, then generally at first slightly convex for some distance, and then strongly convex to anterior margin, in some specimens, however, nearly straight to about middle of glabella or even farther forward, and in those specimens the curvature along the median line on ventral surface is slight near the anterior margin, and the anterior end is more narrowly rounded than in the others. Fronto-median lobe of glabella sub-pentagonal, about two-thirds as wide as long; anterior portion sub-conical and generally rather strongly compressed from the sides, projecting far beyond strongly rounded anterior margin, which meets lateral margins at slightly obtuse angles; posteriorly confluent with basal lateral lobes; between posterior extremities of prolonged anterior lateral glabellar furrows occupying three-eighths to three-seventh the entire width of glabella, which at this level is nearly equal to greatest width of fronto-median lobe.

Bi-composite lateral glabellar lobes with narrowly pointed anterior extremities, more obtusely pointed posterior extremities, and sub-parallel-sided median portions; width (not projected) across middle about three-eighths distance between extremities; with the longer axes directed obliquely outwards; strongly convex longitudinally and overhanging anterior extremities, generally gently convex transversely, sometimes with nearly flattened surfaces; postero-laterally confluent with basal lateral lobes, their boundaries, however, generally recognizable by their slight independent convexity. Basal lateral glabellar lobes of moderate size, without or with very slight independent convexity, internally confluent with median lobe, antero-laterally with bi-composite lobes.

Prolonged anterior lateral glabellar furrows curving from their anterior points of origin at first forwards and upwards, then backwards and upwards, and finally downwards, at first for a short distance slightly diverging, then converging rather strongly to a little behind a line joining middles of palpebral lobes, then running for a short distance sub-parallel until reaching a point on each side situated rather nearer occipital than dorsal furrow, at which points they bend outwards and are continuous with basal lateral glabellar furrows. Middle lateral glabellar furrows generally represented by slight — sometimes scarcely discernible — indentations of anterior furrows into inner sides of bi-composite lobes at about middle of lobes. Basal lateral glabellar furrows directed obliquely outwards and forwards, short, distinct proximally, growing weaker distally, and generally dying out about half-way to dorsal

furrows, sometimes even before reaching thus far. Dorsal furrows running from their anterior points of origin upwards, backwards, and slightly outwards in curves gently convex outwardly to the points where the palpebral furrows branch off, then in concave curves — converging posteriorly to base of glabella, then slightly diverging — to antero-lateral extremities of main portion of occipital ring, then nearly straight back to posterior margin of cranidium.

Occipital furrow transverse in middle, dividing at sides; anterior side-branches more than half as long as undivided portion, nearly straight and directed slightly forwards, posterior side-branches longer, curving backwards and outwards. Occipital ring relatively wide; its main portion rather strongly arched transversely, flattened, or — at sides — gently rounded longitudinally with the surface sloping downwards posteriorly, though less steeply than occipital lobes and posterior parts of glabella; occipital lobes rather large, sub-triangular, generally with gently convex surfaces, sloping downwards rather steeply posteriorly, more gently laterally. Anterior border of cranidium narrow, with rounded edge in middle, broad and flattened at sides, marked off from glabella by very broad furrow — very broad even in specimens having the other furrows of the cranidium relatively narrow — defined from fixed cheeks by narrow, shallow, outwardly directed grooves; its anterior margin rather gently arched forwards.

Fixed cheeks sloping steeply downwards both anteriorly and posteriorly from above eye lobes; anterior portions rather short, narrow, band-like; posterior portions much larger, sub-triangular, sloping rather gently downwards laterally, transversely gently convex, longitudinally rather strongly convex inside palpebral furrows, more gently on postero-lateral parts. Palpebral lobes (badly preserved) very prominent, broad, situated at a distance from posterior border furrows about equal to their own length. Palpebral furrows narrower than other furrows on cranidium, sigmoidally curved, being arched outwards inside palpebral lobes, and behind them curving round apparently to merge into lower eyelid furrows on free cheeks. Posterior borders of fixed cheeks (imperfectly preserved) internally of moderate width, growing wider at sides, flattened; posterior border furrows running from dorsal furrows outwards and slightly forwards, curving more strongly forwards laterally. Anterior branches of facial sutures gently convex outwards and rather strongly converging anteriorly, meeting anterior margin of cranidium at very obtuse angles; posterior branches running from eye lobes obliquely outwards, backwards, and downwards. Free cheeks (imperfectly known) with rather short, broad tapering, obtusely pointed, flattened genal spines.

[Rostral shield (not recognized) apparently narrow, band-like.]

Labrum large, its entire length about four-thirds the sagittal length and about two-thirds the greatest width, which is behind level of posterior furrow, tapering anteriorly, the width across anterior wings about five-sevenths the greatest width, broadly rounded in front, posteriorly with the borders produced into broad, rounded, flattened postero-lateral lobes, between which is a broad, rather deep, rounded excavation; lateral margins arched slightly inwards an-

teriorly, strongly outwards posteriorly. Anterior edge steeply inclined, slightly concave in middle, becoming flattened laterally and produced at sides into a pair of sub-triangular anterior wings. Central body reaching anterior margin of labrum, gently convex, nearly three-fourths as long as wide, broadly rounded in front, truncate behind, sides sub-parallel; marked posteriorly by pair of strong middle furrows beginning in lateral furrows a little behind middle of body and running obliquely backwards and inwards rather more than half-way to median line of body, dividing internally, the branches on either side passing one in front and one behind a small, sub-ovate macula. Posterior and lateral furrows strong, nearly straight; the latter continued a considerable distance beyond posterior furrow. Anterior furrows narrower and shallower than the others, growing weaker internally and dying out at anterior edge less than half-way between their lateral extremities and anterior extremity of labrum, marking off at each side a narrow, slightly raised border, which grows narrower and finally disappears internally. Lateral borders wide, tapering anteriorly, moderately raised, and convex in both directions at sides of body, behind this gently convex transversely (the surface becoming more flattened on the postero-lateral lobes) and slightly concave longitudinally. Posterior border rather wide and forming a swollen lobe behind posterior furrow and in front of postero-lateral lobes.

[Thorax not recognized.]

Pygidium flattened, somewhat pentagonal in general outline, wider than long, the sagittal length being about three-fourths the greatest width found across anterior pair of pleuræ a little in front of their extremities. Rachis depressed convex, extending one-fourth to two-sevenths the length of pygidium, its width anteriorly about three-elevenths greatest width of pygidium, gently tapering posteriorly, rounded and rather indistinctly defined behind, especially laterally; crossed anteriorly by two ring furrows, of which the anterior is more deeply impressed than the second. Dorsal furrows rather narrow, sharply impressed, continued posteriorly and bounding the long post-rachial piece, but dying out at a considerable distance from posterior margin; converging rather gently posteriorly to about middle of pygidium, then running nearly parallel or slightly diverging for some distance (their course may vary a little in different specimens), but always curving rather strongly outwards near the extremities. Post-rachial piece very slightly raised above pleural portions anteriorly, sloping downwards and becoming more flattened posteriorly.

Pleural portions of pygidium generally with flattened, almost horizontally extended, posteriorly tapering areas in front next the dorsal furrows, and with the surfaces outside and behind these areas sloping at first gently downwards and then, the marginal portions, gently upwards (in some specimens the greater part of the pleural lobes appears flattened, this difference possibly being due to pressure). All three pairs of pleuræ marked by rather narrow, sharply impressed pleural furrows and separated by about equally strong interpleural furrows, and with relatively short, broad-based, backwardly directed, pointed free ends. Bands of pleuræ internally slightly raised and rounded, becoming

flattened distally. Anterior pair of pleuræ somewhat shorter than following ones, reaching to a little in front of middle of pygidium, increasing in width to rather approximate fulcra, then tapering to free points, their lateral margins very slightly curved and directed obliquely outwards and backwards for more than half their length, then curving more strongly backwards towards the extremities of pleuræ and sometimes, even, a little inwards. Anterior pair of pleural furrows beginning in dorsal furrows nearly at anterior margin of pleuræ, directed at about 60° to 65° to median line of pygidium, following furrows up to and including second interpleural furrows, directed successively more and more backwards, the last-mentioned — which begin in dorsal furrows a little in front of apex of rachis — at 20° to 25° to median line; the pleural furrows bending more strongly backwards and weakening at about middle of pleuræ and then soon dying out, the interpleural furrows curving more outwards externally. Second pair of pleuræ reaching about half-way between the lines joining extremities of anterior pair and those of basal pair respectively; their pleural furrows beginning in dorsal furrows at marked distances from anterior margins of pleuræ, but closer to these than to posterior margins. Basal pair of pleuræ incompletely defined internally; their pleural furrows beginning in dorsal furrows always rather far behind inner extremities of second interpleural furrows but at somewhat varying distances — marked differences in this respect are found not only in different specimens, but also between the two sides of one and the same specimen — directed slightly more outwards than second interpleural furrows to about half-way to margin, then curving backwards and slightly inwards, weakening and soon dying out. Doublure of pygidium moderately wide, narrowing anteriorly.

Surface of cranidium and pygidium closely covered by sub-conical, pointed tubercles of very various sizes. In some specimens the tubercles attain much greater sizes than in others. As a general rule the tuberculation seems to be coarser in the larger specimens than in the smaller ones, but also specimens of sub-equal sizes may show great differences in this respect and even some of the biggest cranidia observed are not as coarsely tuberculated as others which are of medium size. Edge of border of cranidium and ventral surfaces of cranidial and pygidial doublures with ridges of the usual kind sub-parallel to margins. Median portion of labrum covered by tubercles of the same kind as those on cranidium and pygidium; lateral portions with rather coarse anastomosing ridges sub-parallel to margins.

Dimensions. — The dimensions of some specimens (a = R.M. Ar. 2224 a, b = S.G.U. specimen, Pl. 1, figs. 2 a—b, c = R.M. Ar. 2237, lectotype, d = R.M. Ar. 2224, e = R.M. Ar. 2220, f = R.M. Ar. 2253, g = R.M. Ar. 2231, h = Ar. 2235) are as follows:

	a	b	c	d	e
Crania:					
distance from posterior margin to apex	37 mm.	25 mm.			
distance from posterior to anterior margin	29 »	19 »			
approximate length (projected)	35 »	23.5 »			
width between palpebral lobes	30 »	ca 20 »		ca 46 mm	
approximate length of glabella	31 »	21 »		50 »	
distance from posterior to anterior margin of glabella	25.5 »	17 »	36 mm.	44 »	
greatest width of glabella	25 »	17 »		39 »	
width of glabella at base	19.5 »	14 »	27 »	» 30 »	
greatest width of fronto-median lobe	21 »	14.5 »		33 »	38.5 mm
least width of fronto-median lobe		6 »	11 »	14 »	14.5 »
distance between extremities of bi-composite lobes	15 »	11 »	21 »	25 »	29 »
width (not projected) across middle of bi-composite lobes	6 »	4.5 »	8.5 »	10 »	10.5 »

Labrum (S.G.U., Pl. 2, fig. 6):

sagittal length to middle of posterior excavation	21.5 mm.
sagittal length to a line combining postero-lateral extremities	28 »
greatest width	41 »
length of central body	15 »
width of central body across anterior lobe	22 »

	f	g	h
Pygidium:			
sagittal length	47 mm.	40 mm.	
greatest width	62.5 »	ca 58 »	
anterior width of rachis	17 »		ca 23 mm.
length of rachis	13 »		» 18 »

Remarks. — This species is frequently found in the Asaphus Limestone and is represented in the Swedish collections by a great number of cranidia, several pygidia, two labra, and two fragments of free cheeks. It is further represented, in the State Museum of Natural History, by three large cranidia from Dalarne and one from Öland preserved in ordinary (upper) red, or in red and partly grey Orthoceras Limestone, which is probably Gigas Limestone. Only detached portions have been found and the rostral shield and the thorax are not known. That ANGELIN (1854, p. 69, Pl. 35) was right in referring the portions figured by him (cranidium, labrum, and pygidium) to one and the same species seems to be beyond doubt. It is true that SCHMIDT in 1885 (pp. 58, 59, 61) ascribed the pygidium to *L. pachyrhinus* DALM., but later on he recognized and corrected this error (SCHMIDT, 1907, p. 29). As it has now been possible to ascertain, the pygidium of the latter species differs in several

characters from the one in question (cf. below, pp. 42, 43, and Pl. 4, figs. 2 a, 3). The labrum figured by ANGELIN (R.M. Ar. 2236) seems to have been found in association with the other parts, and though the other labrum known does not seem to have been found together with other specimens, it also is from the Asaphus Limestone and there is no other species known from that limestone to which these labra could belong; moreover they agree in the character of the tuberculation with the cranium and the pygidium. The fragments of free cheeks mentioned above agree also in this respect, and they have been found at Humlenäs in Småland, where the species occurs in considerable abundance (in boulders of Asaphus Limestone).

In ANGELIN's figures of this species missing portions are, as usual with him, restored and the figure of the pygidium is apparently based on two different specimens, one (R.M. Ar. 2235) figured below (Pl. 2, fig. 7) and another smaller one (R.M. Ar. 2238) showing the impression of the middle portion and the ventral side of the posterior and postero-lateral part of the doublure. Of ANGELIN's cotypes I have chosen the cranium (R.M. Ar. 2237; figured below Pl. 2, figs. 1 a—c) as the lectotype.

As stated in the description, the cranidia vary considerably in some characters; two extreme types are recognizable among the Swedish specimens. In the one — represented by the specimens (R.M. Ar. 2249 a and R.M. Ar. 2223¹) illustrated below on Pl. 1 in figs. 3 a—c and figs. 4 a—b — the fronto-median lobe of the glabella, when viewed in lateral aspect, has the dorsal outline nearly straight to near the apex, which is comparatively narrowly rounded, and the antero-ventral outline only rather gently convex; the anterior portion of the lobe is thus sub-conical in outline in lateral as well as in dorsal and in frontal aspect, its lateral slopes are only gently convex and it extends somewhat farther in front and above the bi-composite lobes than in the other extreme type. In the latter — which is represented by the cranium (R.M. Ar. 6104) illustrated in figs. 5 a—c on Pl. 1, and which agrees better in characters with the lectotype — the fronto-median lobe is, except just posteriorly, strongly convex longitudinally, in lateral aspect more broadly rounded in front, and the lateral slopes of its anterior portion are relatively strongly convex. In the cranidia chosen as representatives of the former type (especially in Ar. 2223) the furrows — except the pre-glabellar furrow — are rather narrower and the tuberculation is finer than in that representing the other extreme type, but there are also specimens which agree best in the shape of the fronto-median lobe of the glabella with those of the type first mentioned, but have broad furrows and are coarsely tuberculate, whereas others which have a more convex fronto-median lobe may have narrower furrows and smaller tubercles. This does not in itself seem to be of any real importance from a systematic point of view, since the relative width of the furrows and the average size of the tubercles apparently vary very considerably in several of the species

¹ This is the specimen mentioned by BRÖGGER (1882, p. 129, foot-note) as showing characters, which according to him make it intermediate between the true *L. celorhin* and the true *L. pachyrhinus* DALM. (On the old accompanying label is the number 155).

belonging to the family Lichidæ, and if we had only to do with specimens which in the shape of the fronto-median lobe resembled one or the other of the two types described above, it would appear reasonable to refer them to separate species. A great number of specimens show, however, in this respect intermediate characters, and it does not seem possible to refer them, at least for the present, even to distinct varieties.

The pygidia do not seem to vary as much in characters as the cranidia. Some specimens may of course be a little more coarsely tuberculate than others, and some of the furrows vary a little in their course; the prolongations of the dorsal furrows run a little differently in different specimens, and the basal pair of pleural furrows may begin in the dorsal furrows at somewhat different levels. Variations in these respects are, however, often found in the pygidia of several other species of the family Lichidæ; e.g. the basal pleural furrows may originate at markedly different levels on the two sides in one and the same specimen both in this species (cf. Pl. 2, fig. 4) and in others.

The two fragmentary glabellæ from the Orthoceras Limestone (3 cγ) at Eker in Norway figured by BRÖGGER (1882, Pl. 5, figs. 11—12) as illustrating the degree of variation in the shape of the fronto-median lobe seem respectively to agree closely with the Swedish extreme types.

SCHMIDT (1885, pp. 56 ff.) also pointed out that in this species the characters of the cranium varied very much. He was evidently very doubtful whether all the types figured by him (Pl. 1, figs. 4—9 c) really were referable to one and the same species and, although he was not able at the time to separate them specifically, he suggested that further finds might perhaps make this possible. To judge from the figures, only three (figs. 4—6) of the cranidia illustrated by him appear to belong to our species. These seem to resemble some of the Swedish specimens fairly closely, but not perfectly. The largest one, for instance, of which three figures (4—4 c) in different aspects are given, seems to agree rather closely in most of its characters with those of the Swedish type in which the fronto-median glabellar lobe is most evenly convex longitudinally, but to be more broadly rounded and less protuberant in front. The other two, which are only figured in lateral aspect, appear to agree better with the other extreme Swedish type.

Of the other specimens in question SCHMIDT referred two (figs. 7 a—b, 8) to the variety *coniceps*. The name *Metopias coniceps* was originally proposed by MAXIMILIAN Herzog von LEUCHTENBERG (1843, p. 11, Pl. 1, figs. 10—11) as a specific name designating two specimens showing part of the fronto-median lobe of the glabella and parts of the anterior border and border furrow. He described the form as follows: »Der Stirntheil des Kopfschildes bildet einen von oben nach unten etwas plattgedrückten Kegel, und ist mit vielen ganz kleinen Wärzchen, wie mit kleinen Stacheln, überdeckt». It appears as if this form represented a species distinct from ours¹. The fronto-median lobe

¹ Since the name *coniceps* was proposed earlier than ANGELIN's name *celorhin* it is not correct to use it as a variety name. If the two forms should be referred to one and the same species, the name of this must be *coniceps*.

of the glabella seems to differ considerably in its shape from that of all our specimens. To judge from the figures, especially from the figure 11, which represents a specimen viewed in lateral aspect, it has a pointed apex. This is in accordance with the description given by SCHMIDT (1885, p. 57) who pointed out also that in an extreme type the conical point formed an upwardly directed proboscis («Rüssel») as shown in his figure 8 and indicated also in one of MAXIMILIAN v. LEUCHTENBERG's figures (fig. 10). In SCHMIDT's specimen in question the bi-composite lobes seem also to be more convex transversely than in our specimens of *L. celorhin*. The other specimen (figs. 7 a—b) referred to the var. *coniceps* by SCHMIDT seems to differ considerably from the one just mentioned and from those originally figured under this specific name. The fronto-median lobe of the glabella appears to be rounded, not pointed, in front, and there seem to be other differences. On the other hand the form does not appear to agree in characters with any of our specimens of *L. celorhin*, although somewhat better than the »typical» form of *L. coniceps* seems to do. From the figures alone it does not appear possible to decide the specific position of this specimen.

Still another type of cranidium was placed in our species in SCHMIDT's work of 1885 (Pl. 1, figs. 9 a—c). This, which SCHMIDT calls the broad form, seems to differ still more from our specimens; it differs markedly also from all the other types figured by SCHMIDT, and it appears as if this too must be placed in a separate species. The glabella is only gently convex in both directions, and its fronto-median lobe is broadly rounded anteriorly and not produced far in front of the bi-composite lobes. On the whole the glabella seems to agree in its general shape (although not in all of its characters) much better with, for instance, that of *L. Hübneri* EICHW. (cf. SCHMIDT, 1885, Pl. 1, figs. 13 a—b) than with any of the Swedish types of our species.

Finely, as regards the small specimen, a cephalon with part of the thorax attached, described and figured by SCHMIDT in 1907 [p. (29) 30, Pl. 2, figs. 5 a—c] as belonging to *L. celorhin*, its cranidium appears to agree perfectly in characters with some Swedish specimens which will be described and figured below (p. 34, Pl. 5, figs. 1—2 c) as representing a new species, *L. Ericsi*.

The fragmentary pygidium from a North German boulder described and figured by KUMMEROW (1927, p. 33, Pl. 2, fig. 1) as belonging to *L. verrucosus* EICHW. seems to belong to *L. celorhin*; cranidia of this species have also been recorded (SCHMIDT, 1885, p. 59; KUMMEROW, 1927, p. 33) as having been found in such boulders.

In Norway this species occurs in the Orthoceras Limestone (3 c γ) and is represented by several specimens from there in the Oslo Museum. BRÖGGER in 1882 (p. 129) stated that fragments of the glabella had also been found in the Expansus Shales (3 c β). Those fragments are not in the museum. It appears probable to me that they do not belong to this species at all but to *L. platyrhinus* SCHMIDT, which species has been found in the Expansus Shales at Huk (Bodö) and is represented by a fragmentary pygidium from there in the museum and by some fragments in a private collection in Oslo.

BRÖGGER (op. cit., p. 129) believed that the pygidium described and figured by ANGELIN (1854, p. 73, Pl. 38, fig. 2) as *Lichas norvegicus* represented a variety of *L. celorhin*. As I have previously (1937) pointed out ANGELIN's *Lichas norvegicus* is a Silurian species and has nothing whatever to do with *L. celorhin*. It does not even belong to *Lichas* (sens. str.). It had been believed that the specimen, which is in the Oslo Museum, was from Huk at Bygdö (=Ladegårdsö), where only strata of lower Ordovician age are represented, ANGELIN with a mark of interrogation referred it to his Regio C, and BRÖGGER (op. cit.) stated that it originated from the Expansus Shales. Evidently a mistake has been made as to the locality. The specimen is of Lower Silurian age, as is indicated by the character of the piece of rock in which it occurs and proved by the fact that several pygidia (now in the Oslo Museum) showing identical characters and indubitably belonging to the same species have more recently been found in Norway in strata of this age (Etage 6).

Affinities. — As just pointed out above, some of the forms that SCHMIDT (1885, 1907) hesitatingly referred to *L. celorhin* appear to represent distinct species, which, however, seem to be rather closely allied to the former (cf. also below, pp. 37, 38). It has further been pointed out above (p. 23) that *L. verrucosus* EICHW. seems to be rather nearly related.

BRÖGGER (1882, p. 129) compared our species with *L. pachyrhinus* DALM. (below, p. 38, Pl. 4, figs. 1—3) and pointed out that some of the cranidia of the former resembled that of the latter species rather closely. He alluded to the type of cranidium in which the frontal lobe of the glabella is sub-conical in outline in all aspects and which has relatively narrow furrows and is finely tuberculate (cf. above p. 30 and below Pl. 1, figs. 3 a—c, 4 a—b) and he even mentioned one specimen in our State Museum of Natural History (Ar. 2223, Pl. 1, figs. 4 a—b) as representing a form intermediate in characters between *L. pachyrhinus* and the typical *L. celorhin*. Even from the cranidia of this type that of *L. pachyrhinus* differs decidedly; the tuberculation of the test is still finer, the tubercles less varying in size and on the whole placed more closely together; the furrows are narrower and shallower, appearing only as lines impressed on the surface, the lobes of the glabella and the free cheeks not having any independent convexity, and the outline of the glabella being only very slightly — instead of more or less distinctly — bent at the boundaries between the frontal and the bi-composite glabellar lobes; even the preglabellar (anterior border) furrow is very narrow — in *L. celorhin* it is always broad; further the fronto-median glabellar lobe is relatively broader at the base. The pygidia of the two species differ also in several characters. That of *L. pachyrhinus* appears to be relatively shorter and broader. It is more finely tuberculate; its furrows are narrower and shallower; the rachis is more convex; the prolongation of the dorsal furrows and, at least, the posterior furrows on the pleural lobes have another direction; and the free ends of the pleurae are much shorter.

Horizons and Localities. — Asaphus Limestone. — Småland: Humlenäs [a great number of specimens and among them all ANGELIN's originals; lectotype, R.M. Ar. 2237 (Pl. 2, figs. 1 a—c)]. — Öland: Sandvik, Persnäs, Enerum, Hagen-Tokenäs, Hagudden (loose stone?), Hagen, Hälludden, Norra Torp, Ölands Norra Udde (the northern point of land in Öland), Källingsmore Köping, Horn (loose stone). — Dalarna: Östbjörka, Utby (Lindgården). — Östergötland: Skarpåsen. — Jämtland: Brunflo.

Dark-red and grey Orthoceras Limestone (Gigas Limestone?). — Öland: Lerkaka. — Dalarna: Alsarbyn, Digerberget.

Red Orthoceras Limestone. (Gigas Limestone?) — Dalarna: Born. (R.M. Ar. 2224 a; Pl. 1, figs. 1 a—c).

Orthoceras Limestone (Etage 3 c γ). — Norway: Eker etc.

Etage B₃; — East Baltic Area. (?Etage C_{1a}¹ — ?East Baltic Area).
North German boulders.

Lichas Erics n. sp.

Pl. 5, figs. 1—2 c, fig. 3?

1907. *Lichas celorhin*, SCHMIDT, p. (31) 30—32 (pars), Pl. 2, figs. 5 a—c.

Diagnosis. — Cranidium with rather narrow, but deeply impressed furrows, preglabellar furrow slightly wider in middle, not at sides, than the others. Glabella nearly as wide as long, narrowly rounded and curved downwards in front, along back slightly convex or nearly straight and sloping rather gently upwards from base, gently convex from side to side posteriorly, antero-lateral slopes very steep; fronto-median lobe sub-pyriform, projecting far beyond bi-composite lobes and slightly overhanging strongly arched anterior margin, without marked antero-lateral extensions, narrowing posteriorly to a little in front of posterior extremities of bi-composite lobes, here narrower than these lobes, then widening slightly to occipital furrow, strongly convex anteriorly, posteriorly gently convex; bi-composite lobes elongated sub-ovate, with marked independent convexity, posteriorly about as high as median lobe, anterior two-thirds steeply curved downwards but not overhanging; basal lobes of moderate size. Occipital lobes of moderate size, sub-ovate, reaching only slightly farther outwards than base of glabella and nearly as far as main portion of occipital ring. Surface coarsely tuberculate, with relatively high, pointed large and smaller tubercles, closely set.

Description. — [Cephalon sub-triangular to sub-ovate in outline, width at level of posterior margin of cranidium more than twice sagittal length,

¹ SCHMIDT (1885, p. 58; 1907, pp. 32, 92) recorded this species also from both a lower (B₂ b) and a higher (C_{1a}) horizon, as well as from B₃. All the specimens from the lower horizon (B₂ b) figured by him (1885, Pl. 1, figs. 8, 9; 1907, Pl. 2, figs. 5 a—c) appear, however, as has been pointed out above (p. 31), to belong to other species. As regards the specimens from the higher horizon (C_{1a}), SCHMIDT himself was evidently in doubt whether they really belonged to this species. »Von den grossen Formen aus der Stufe C₁ haben wir nur Glabellen, so dass es schwer fällt zu bestimmen ob hier vielleicht spezifische Unterscheide vorkommen». SCHMIDT, 1907, p. 32).

with genal angles produced into rather long, backwardly curving, tapering, pointed, flattened spines pressed close to sides of thorax]. Cranidium about as long as it is wide between middle of palpebral lobes, with most of the furrows about equally strong, rather narrow but deeply impressed.

Glabella sub-pentagonal, width across middle nearly equal to length, tapering rather gently posteriorly with postero-lateral sides slightly concave outwards — basal width to maximum width as 11 to 14 — tapering rapidly anteriorly, narrowly rounded in front. Fronto-median lobe of glabella sub-pyriform in outline projecting far beyond bi-composite lobes, with anterior margin very strongly arched forwards, widest in front, but without distinct antero-lateral extensions, greatest width about two-thirds sagittal length, narrowing posteriorly to a little in front of posterior extremities of bi-composite lobes, where its width is less than half the anterior width and less than one-third that of entire glabella, then widening slightly to occipital furrow, its hindmost portion with very slight independent convexity, and only defined by weak depressions from basal lateral lobes, in front of latter well defined at sides and with more distinct independent convexity, its foremost portion strongly convex transversely; along median line nearly straight or slightly convex and sloping rather gently upwards for the greater part of its length, steeply curved downwards in front and slightly overhanging anterior margin. Bi-composite lateral glabellar lobes elongated sub-ovate, narrowing anteriorly, with the longer axes directed obliquely forwards and outwards, with marked independent convexity, posteriorly about as high as median lobe, anterior two-thirds steeply curved downwards, but not overhanging, distance between anterior and posterior extremities nearly twice the width across middle. Basal lateral glabellar lobes of moderate size, quadrilateral in outline, length about equal to width at base, slightly widening anteriorly, with slight independent convexity, somewhat lower than basal part of median lobe and considerably lower than basal parts of bi-composite lobes, marked off internally from median lobe by shallow depressions and anteriorly from bi-composite lobes — except near their inner sides where they are better defined — by somewhat more pronounced, narrow depressions, or — in casts — by rather weak furrows. Prolonged anterior lateral glabellar furrows rather narrow, deeply impressed, describing outwardly concave curves from their anterior points of origin to their junctions with basal lateral furrows, beyond these continued posteriorly to occipital furrow by slight ill-defined depressions. Middle lateral glabellar furrows obsolete. Basal lateral glabellar furrows continuous with anterior ones, being joined by a rather sharp curve, directed obliquely forwards, with short, well-marked inner portions, continued to dorsal furrows by rather distinct, narrow depressions, or — in casts — by weak furrows.

Dorsal furrows about as strong as prolonged anterior lateral glabellar furrows, sometimes growing weaker posteriorly (especially in a testiferous specimen), describing outwardly convex curves outside bi-composite lobes — bending inwards at the points where the palpebral furrows branch off — and concave curves to antero-lateral extremities of main portion of occipital ring,

then running nearly straight back to posterior margin of cephalon. Occipital furrow transverse in middle behind median glabellar lobe, and about as strong as prolonged anterior glabellar lateral furrows, dividing at sides; side-branches narrower than median portion, gently curved. Occipital ring relatively wide (longitudinally); its main portion arched transversely, but not very strongly, slightly rounded longitudinally, with the surface sloping gently downwards posteriorly — more gently than posterior portion of glabella — its posterior margin nearly transverse in middle, curving gently forwards at sides; occipital lobes of moderate size, relatively strongly convex, sub-ovate with narrowly pointed lateral extremities and the longer axes directed obliquely outwards and downwards and slightly backwards. Anterior border of cranium rather narrow, flattened, with rounded edge, increasing in width laterally; indistinctly defined from fixed cheeks, well defined from glabella by a furrow, which in middle is somewhat broader than anterior lateral glabellar furrows, at sides rather narrower and shallower than those; its anterior margin rather gently arched forwards for the greater part of its length, but bending nearly straight outwards near the facial sutures to meet them at slightly acute angles.

Fixed cheeks sloping steeply downwards both anteriorly and posteriorly from above eye lobes, the posterior slope the steepest and convex, the anterior slope slightly concave; their anterior portions narrow, very slightly increasing in width anteriorly; their posterior portions much larger, sub-triangular, sloping rather steeply downwards laterally behind eye lobes — very gently to palpebral furrows — with gently convex surfaces. Palpebral lobes (incompletely preserved) distant by about their own length from posterior border furrows. Palpebral furrows rather narrow and not very deep, sigmoidally curved, being sharply arched outwards to middle of lobes and behind them curving round apparently to merge into lower eyelid furrows on free cheeks. Posterior borders of fixed cheeks internally rather narrow, gently raised, and with the surfaces sloping rather gently backwards, laterally growing wider, flatter, and horizontally extended, marked off by deep, rather narrow furrows, which are directed obliquely forwards. Anterior branches of facial sutures slightly convex outwards and converging anteriorly to anterior border, then bending nearly straight forwards or slightly outwards to meet anterior margin of cranium at slightly acute angles; posterior branches curving from eye lobes outwards, downwards, and backwards. [Free cheeks sub-triangular, with antero-lateral margins curved inwards opposite anterior extremities of eye lobes and the inner anterior portions produced into short points; flattened, and sloping gently downwards towards the sides — the flattened portions apparently representing the borders — except next the eye lobes, where the surface is rather abruptly elevated to the lower eyelid furrows; with moderately wide posterior borders marked off by distinct furrows, which seem to reach to the base of the rather long, backwardly curving, flattened, tapering, pointed genal spines]. [Rostral shield apparently narrow, band-like]. [Labrum not recognized].

[Thorax — anterior portion known from SCHMIDT's specimen — with rather gently convex rachis, across middle on middlemost segments apparently

occupying rather less than one-third the width of entire thorax. Articulating extensions of rachial rings posteriorly with row of small tubercles. Pleuræ apparently with inner portions flattened and outer portions curved gently downwards and bent very slightly backwards, marked for the greater part of their length by fine pleural furrows and ending in short points, which seem to be sub-falcate and directed obliquely backwards].

Pygidial pleural portions (only a fragment which appears to belong to this species recognized) with a flattening in front next the dorsal furrows, then gently curved downwards, more gently on marginal part, (above doublure) than inside doublure; their anterior margins curved rather gently backwards beyond weak fulcra; consisting of three pairs of pleuræ, separated by rather strong interpleural furrows and marked by about equally strong pleural furrows, the latter not reaching ends of pleuræ. Bands of pleuræ with gently raised surfaces. Anterior pleural and anterior interpleural furrows directed only slightly backwards for the greater parts of their length, curving somewhat more backwards distally; second pleural furrows straight, directed more strongly backwards with second interpleural furrows sub-parallel to them; third pleural furrows straight, beginning in dorsal furrows only a short distance behind second interpleural furrows and diverging from them at about 30°.

Dorsal surface of cranium (and free cheeks) very closely covered by relatively high, sub-conical, pointed, large (for such small specimens) and smaller tubercles. Surface of pygidium apparently with similar ornament (on the fragment examined the tubercles are all broken) (thorax with similar, though somewhat finer, tuberculation).

Dimensions. — The dimension of a cranium (the holotype, S.G.U.) are: distance from posterior margin to anterior extremity of glabella 17 mm.; width between palpebral lobes 17 mm.; glabella — distance from posterior margin to anterior extremity 14 mm, greatest width 14 mm., basal width 11 mm.; fronto-median glabellar lobe — greatest width 9.5 mm., least width not quite 4 mm.; bi-composite lobes — distance between extremities 8 mm., width (not projected) across middle just over 4 mm.

Remarks. — Two small crania (one, Ar. 2234, in the State Museum of Natural History, the other, the holotype, in the Museum of the Geological Survey) from the Asaphus Limestone at Hälludden, Öland, represent evidently a new species rather closely related to *L. celorhin* ANG., but differing from it in several characters. As far as can be judged from the description and figures, the cranium of the specimen from the East Baltic Area figured by SCHMIDT in 1907 on plate 2 and ascribed by him (pp. 30—32, Pl. 2, figs. 5 a—c) to *L. celorhin* agrees perfectly in characters with our specimens and must evidently be removed from the species just mentioned and referred to this new one. In SCHMIDT's specimen the free cheeks and a portion of the thorax are preserved and the above description is, so far as it concerns these portions (the parts between brackets), based on his description and figures, otherwise on the Swedish material.

In the Asaphus Limestone at Hälludden there has also been found a fragment of a pygidium, which appears to belong to this species. It agrees in point of size and, as far as can be judged, in the ornament of the test with the cranidia and differs from the pygidia of the other Lichas known from this (or from other) formations.

Affinities. — As just mentioned above, this species seems to be rather closely related to *L. celorhin* ANG., but differs distinctly from it in several characters. The glabella is relatively shorter and broader. The fronto-median glabellar lobe is less strongly raised and only slightly overhanging in front and its anterior margin is not quite as narrowly rounded. The bi-composite lobes are much more strongly convex — posteriorly reaching about the same level as the median lobe — and have a different shape, especially in dorsal aspect, they are wider both in relation to their own length and to the width of the fronto-median lobe and extend distally farther beyond the antero-lateral extremities of this lobe. The basal lateral lobes are somewhat better defined. The occipital lobes are more convex, and sub-ovate rather than sub-triangular. The foremost portions of the facial sutures have another direction and meet the anterior margin of the cranium, of which the lateral parts are bent outwards, at slightly acute instead of at very obtuse angles. It may be worth mentioning that the smaller cranidia of *L. celorhin* examined by me show no greater resemblance than the larger ones to the cranium of the form in question.

In the fragment of the pygidium that appears to belong to this new species the pleural portion is somewhat more convex than in the pygidium of *L. celorhin*, its pleural bands rather more raised, and its furrows, more especially the posterior ones, have a different course.

SCHMIDT (1907, pp. 30—31) pointed out that the cephalon of this form resembled that of *Hoplol. conicotuberculatus* (NIESZK.) in some characters. The points of agreement do not, however, appear to indicate any close relationship — SCHMIDT did not suggest that the two species ought to be referred to the same group — and the differences in other characters are so distinct that a close comparison seems unnecessary.

Horizons and Localities. — Asaphus Limestone. — Öland: Hälludden (holotype S.G.U., Pl. 5, fig. 2 a—c).

Etage B₂b. — East Baltic Area: Wolchow.

Lichas pachyrhinus (DALMAN, 1828).

Pl. 4, figs. 1—3 a, text-fig. 1.

1828. *Ampyx?* *pachyrhinus*, DALMAN p. 136.

1837. " " HISINGER, p. 18.

1846. *Metopias* (*Ampyx?*) *pachyrhinus*, LOVÉN, p. 54, Pl. 1, figs. 6 a—d.

1854 & 78. *Lichas pachyrhinus*, ANGELIN, p. 73, Pl. 38, figs. 1, 1 a, 1 c (copies after LOVÉN).

1885. *Lichas pachyrhina*, SCHMIDT, p. 59, Pl. 1, figs. 10 a—c (non figs. 11 + 12).

Diagnosis. — Cranium with narrow, sharply, but not deeply, impressed furrows, preglabellar furrow somewhat stronger than the others. Glabella

rather longer than wide, with sub-conical, overhanging anterior portion, along back nearly straight and sloping rather steeply upwards from base to near apex, moderately convex from side to side posteriorly, antero-lateral slopes very steep; its lobes without independent convexity; fronto-median lobe sub-pentagonal, longer than wide, with sub-conical anterior portion projecting far beyond strongly arched anterior margin, width between posterior extremities of bi-composite lobes somewhat more than half that of entire glabella; bi-composite lobes elongate, with pointed extremities and nearly parallel-sided median portions, strongly convex longitudinally, overhanging anteriorly, their surfaces flattened transversely; basal lobes relatively large. Occipital lobes rather large, sub-triangular, reaching only slightly farther outwards than base of glabella and nearly as far as main portion of occipital ring. Pygidium (imperfectly known) with narrow, sharply, but not deeply, impressed furrows wider than long; rachis extending slightly more than one-third the length but occupying less than one-third the width of entire pygidium, moderately convex; dorsal furrows converging for a short distance behind rachis, then curving a little outwards, posteriorly bending more backwards again but not converging; all three pairs of pleurae ending in very short, rather blunt, backwardly directed free points. Surface finely tuberculate, with rather low and small tubercles of a few different sizes, closely placed.

Description. — Cephalon sub-triangular, narrowly rounded in front with narrow, sharply but not deeply impressed furrows. (Genal spines not preserved).

Glabella sub-pentagonal, with antero-lateral and postero-lateral sides slightly concave outwards, sagittal length rather greater than width across widest part, which is at about three-eighths the distance from posterior margin to apex, tapering rather rapidly anteriorly to narrowly rounded front end, tapering more slowly posteriorly with the hindmost portion nearly parallel-sided, the basal width about four-fifths the greatest width; its anterior portion sub-conical, projecting far beyond anterior margin of glabella, distance from mid-point of anterior margin to opposite point on dorsal surface about six-sevenths the greatest width of glabella, distance to mid-point of occipital furrow about equalling this width; moderately convex from side to side posteriorly, antero-lateral slopes very steep, along median line on dorsal surface nearly straight and sloping rather steeply upwards to a little behind apex where the slope either grows more gentle and curved, or it grows steeper, the surface forming a small hump-like elevation; ventral surface strongly convex in both directions. Fronto-median lobe of glabella sub-pentagonal, between two-thirds and three-fourths as wide as long, anterior portion sub-conical and slightly compressed from the sides, projecting far beyond bi-composite lobes and anterior margin, which meets lateral margins at slightly obtuse angles; posteriorly confluent with basal lateral lobes; width across narrowest portion — near posterior extremities of anterior lateral furrows — about five-ninths the width at anterior margin and somewhat more than half that of entire glabella. Bi-composite lateral glabellar lobes with pointed extremities and nearly parallel-

sided median portions, distance between extremities more than twice the width (not projected), the longer axes directed obliquely outwards, strongly convex longitudinally and overhanging anterior extremities, their surfaces flattened transversely and making very obtuse angles both with the sides of the fronto-median lobe and, rather more distinctly, with the fixed cheeks, postero-laterally confluent with basal lateral lobes. Basal lateral glabellar lobes relatively large, without independent convexity, internally confluent with median lobe, antero-laterally with bi-composite lobes.

Prolonged anterior lateral glabellar furrows curving from their anterior points of origin at first forwards and upwards, then backwards and upwards, and finally downwards, first for a short distance running sub-parallel, then converging rather gradually posteriorly to points somewhat nearer dorsal than occipital furrow, where they are continuous with basal lateral furrows, making a rather sudden turn outwards and forwards around posterior extremities of bi-composite lobes; these inner distinctly impressed portions of basal lateral furrows quite short, sometimes being continued some distance obliquely forwards by very weak grooves. Middle, and distal portions of basal, lateral glabellar furrows completely obsolete. Dorsal furrows running from their anterior points of origin obliquely upwards, outwards, and backwards in curves very slightly convex outwards to the points where the palpebral furrows branch off, then in concave curves, for a while sub-parallel to prolonged anterior lateral glabellar furrows, to extremities of posterior side-branches of occipital furrow, then making a rather sudden bend and running for a very short distance obliquely outwards, and finally turning backwards and continuing in outwardly concave curves to posterior margin of cranidium.

Occipital furrow transverse in middle, dividing at sides; anterior side-branches each somewhat more than half as long as undivided median portion, nearly straight and directed slightly forwards; posterior side-branches longer, curving backwards and outwards and near their distal extremities slightly forwards. Occipital ring relatively wide, its posterior margin slightly arched forwards in middle; main portion rather strongly arched transversely, flattened longitudinally and sloping backwards, more steeply so at sides than in middle, where along the median line the slope appears to be more gentle than on the glabella. Occipital lobes rather large, sub-triangular, flattened, and sloping downwards postero-laterally. Anterior border of cranidium narrow and gently rounded in middle, growing wider and flattened at sides, its anterior margin gently arched forwards; confluent with anterior portions of fixed cheeks or marked off from them by very fine grooves directed obliquely outwards; marked off from glabella by a furrow somewhat stronger than the other furrows on the cephalon.

Cheeks sub-triangular both in dorsal and in frontal aspect, their antero-lateral margins curved inwards opposite anterior extremities of eye lobes. Fixed cheeks sloping steeply downwards both anteriorly and posteriorly from above eye-lobes; anterior portions rather short, narrow, band-like; posterior portions much larger, sub-triangular; sloping gently downwards laterally without

independent convexity. Palpebral lobes narrowly sub-crescentic, situated behind middle of glabella at nearly twice their own length from posterior margin of cranidium, marked off internally by distinct furrows, which curve round posterior extremities of lobes and are continued on free cheeks by furrows marking off narrow (low), rounded lower eyelids. (Visual surface of eyes not preserved). Posterior borders of fixed cheeks relatively wide, increasing in width laterally, internally with flattened surfaces sloping backwards, externally more horizontally extended, marked off by distinct furrows. Free cheeks (imperfectly preserved) sub-triangular, flattened except next to the eye lobes where the surface is rather abruptly elevated to lower eyelid furrows. Anterior branches of facial sutures nearly straight, rather strongly converging anteriorly to meet anterior margin of cranidium at obtuse angles; posterior branches directed obliquely outwards, backwards, and downwards. Rostral shield (not known) apparently narrow, band-like.

Labrum somewhat pentagonal in outline, short and wide, length from anterior extremity to a line joining postero-lateral extremities about five-sevenths the greatest width, which is across middle; anterior margin rather gently arched forwards, antero-lateral margins outwards concave, postero-lateral margins outwards convex, posterior margin with broad, rather deep rounded excavation in middle, postero-lateral extremities rather narrowly rounded. Anterior edge (imperfectly preserved) steeply inclined, apparently gently concave in middle, becoming flattened at sides and merging into pair of rather small, sub-triangular anterior wings, which are situated far forward. Central body reaching anterior margin of labrum, moderately convex, its length about three-fourths the width in front, slightly tapering posteriorly, anterior margin gently arched forwards, posterior margin still more gently arched backwards; marked posteriorly by pair of rather strong, oblique middle furrows, dividing internally, the branches much weaker than main trunk, on either side passing one in front and one behind a small sub-ovate macula. Lateral furrows continued behind posterior furrow about half-way to base of postero-lateral lobes, forming curves gently concave outwards outside central body, rather narrow and deeply impressed outside its anterior lobe, then suddenly growing shallower and broader, but behind central body becoming somewhat deeper and narrow again and bending obliquely inwards. Posterior furrow rather narrow and deep, gently arched backwards. Anterior furrows meeting lateral furrows at slightly obtuse angles, narrow, not very deep, dying out less than half-way from their distal points of origin to anterior extremity of labrum, marking off at each side a narrow, gently raised border, which becomes narrower and finally disappears internally. Lateral borders rather broad posteriorly to base of body, rapidly narrowing anteriorly, rather strongly convex outside body, becoming flatter posteriorly. Posterior border rather wide, forming behind posterior furrow a swollen lobe tapering rather gently posteriorly. Postero-lateral portions of border flattened.

Thorax of eleven segments, about two-thirds as long as wide, slightly narrowing posteriorly. Rachis narrow, in the middle occupying about two-

sevenths the entire width of thorax, widest anteriorly. Rachial rings with articulating half-rings finely tuberculate posteriorly, apparently never completely covered. Dorsal furrows narrow, sharply but not deeply impressed. Pleural portions flattened internally and, apparently, distally slightly bent downwards (the specimen examined is pressed and somewhat distorted). Pleurae all of about equal width, with weak fulcra, which on the anterior pleurae are remote, posteriorly successively becoming more and more approximated, on posterior margin of last pair situated about half-way out; their distal portions gently curved backwards and ending in short, falcate points; pleural furrows narrow, beginning in dorsal furrows nearer anterior than posterior margins of pleurae, soon becoming median, not reaching ends of pleurae, but, at least on the posterior ones, some distance beyond fulcra.

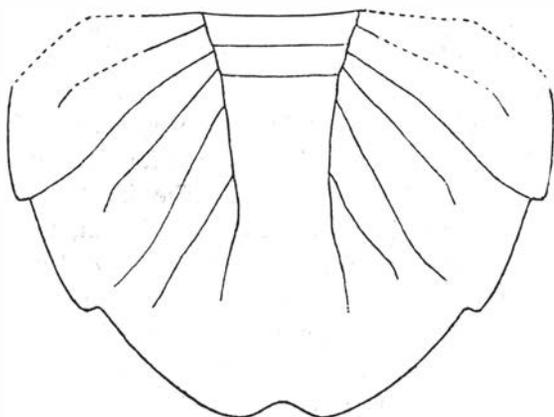
Pygidium (imperfectly known) sub-semioval in outline with the anterolateral angles truncate, its sagittal length about five-sevenths the greatest width; its furrows resembling those on cephalon and thorax, narrow and generally sharply but not deeply impressed. Rachis moderately convex, narrow, extending slightly more than one-third the length of pygidium, its anterior width not quite one-third greatest width of pygidium, gently narrowing posteriorly, rounded and rather indistinctly defined behind: crossed anteriorly by two ring furrows. Dorsal furrows continued behind rachis to above anterior margin of doublure, bounding the post-rachial piece, rather slightly converging at sides of rachis, bent in at its extremity and behind it converging somewhat more strongly for a short distance, then curving a little outwards, but posteriorly bending more backwards again although not converging.

Pleural portions of pygidium flattened and horizontally extended internally, the distal portions apparently very slightly bent downwards or slightly concave. All three pairs of pleurae ending in very short, blunt, backwardly directed free points. First two pairs of pleural furrows beginning in dorsal furrows nearer anterior than posterior margins of pleurae, soon becoming submedian, directed obliquely backwards for the greater part of their length, the anterior ones not very strongly so, the second ones more strongly; both pair weakening and bending more backwards near their extremities, dying out at a considerable distance from extremities of pleurae. Anterior interpleural furrows sub-parallel to anterior pleural furrows, or directed somewhat more backwards, for the longer part of their course, but bending more outwards distally, becoming very weak near the margin. Second interpleural furrows directed more strongly backwards than second pleural furrows, but these also, bending more outwards distally and apparently dying out some distance from margin. Basal pair of pleural furrows beginning in dorsal furrows rather far behind anterior margins of pleurae, for the longer part of their course directed somewhat more strongly outwards than second interpleural furrows but near their extremities bending more backwards, dying out at considerable distance from margin. Doublure of pygidium of moderate width.

Dorsal surface of cephalon, thorax, pygidium, and median portion of ventral surface of labrum closely covered by small, rather low, sub-conical

tubercles of a few different sizes, which on some portions are very oblique, often so strongly as to appear flattened; doublures and anterior and anterolateral edges of cephalon with rather coarse, sub-parallel ridges of the usual kind; lateral portions of labrum with coarse, anastomosing ridges sub-parallel to margins and between them very small tubercles.

Dimensions. — In the holotype (cranidium with labrum, R.M. Ar. 2246) the dimensions are as follows: cranidium — distance from posterior margin to apex about 35 mm. (projected length apparently somewhat greater), width between palpebral lobes approximately 35 mm.; glabella — greatest width about 30 mm., basal width 24.5 mm.; fronto-median lobe — greatest width approximately 24 mm., least width 14 mm.; bi-composite lobes — distance between anterior and posterior extremities 17 mm., width across middle 7.5 mm.; labrum — length from anterior extremity to a line joining postero-latera



Text-fig. 1. *Lichas pachyrhinus* (DALMAN). Pygidium restored in outline from specimen showing fragmentary natural cast and hollow inside of test. $\times 1$. Asaphus Limestone. Dalarne. U.M. (cf. Pl. 4, figs. 3 a—b).

extremities 20 mm., length to mid-point of posterior margin 17 mm., greatest width 28 mm. The dimensions of a nearly complete individual (S.G.U. Pl. 4, fig. 2) are: cranidium — distance from posterior margin to apex about 17 mm., to anterior margin 16 mm., width between palpebral lobes 18 mm.; glabella — greatest width 15.5 mm., basal width 12 mm., distance from mid-point of anterior margin to opposite point on dorsal side 12.5 mm.; fronto-median lobe — greatest width 11.5 mm., least width just over 6 mm.; bi-composite lobes — distance between anterior and posterior extremities 9 mm., width (not projected) across middle 3.5 mm.; thorax — length approximately 28 mm., width across middle approximately 42 mm., width of rachis on second thoracic segment 12 mm., on posterior thoracic segment about 10 mm.; pygidium — greatest width at least 35 mm. In a large fragmentary pygidium (U.M. Pl. 4, fig. 3 a—b; text-fig. 1) the greatest width has been about 74 mm., the sagittal length about 52 mm.; the anterior width of the rachis is 21 mm. and its length 19 mm.

Remarks. — In the holotype, cranium with labrum (R.M. Ar. 2246), the dorsal part is well preserved, though not quite complete, but on the under (anterior) side the cranium is badly damaged, the rostral shield is lacking and the labrum, which is rather well preserved, slightly displaced. In addition to this there are now available in Swedish collections four other specimens. One (U.M.) is a fragmentary cranium of nearly the same dimensions as the holotype, in which the anterior portion of the fronto-median lobe is broken off. Two of the specimens represent much smaller individuals. The one (R.M. Ar. 2200) is only a fragmentary glabella. The other (S.G.U.; Pl. 4, fig. 2) consists of a well-preserved cranium, one slightly displaced and incomplete free cheek (lacking the genal spine), and the incompletely preserved and distorted thorax and pygidium. The above description of the thorax is based on this specimen, as in part is the description of the pygidium. Of the latter the posterior portion is lacking as well as the ends of the anterior and second pleurae on the left side. The rachis is much damaged; its posterior part is compressed and distorted. [The figure (Pl. 4, fig. 2 c) does not give a correct idea of its true character]. The distal part of the right anterior pleura is also damaged; the outermost part is, however, preserved, though distorted, and it is possible to discern that this pleura, like the second one, ended in a very small backwardly directed free point. The fourth specimen (U.M.; Pl. 4, fig. 3 a—b) consists of portions of a large pygidium, which in point of size seems to agree with the holotype. One piece shows the natural cast of the left pleural portion (except its foremost and hindmost parts) and the greater portion of the post-rachial piece, and also part of the upper surface of the doublure, which latter gives the shape of the basal free ends. Another piece shows the hollow inner surface of the test of the rachis, the post-rachial piece, and of parts of the pleural portions. As far as the corresponding portions are preserved and show the characters this pygidium seems to agree rather well with that belonging to the nearly entire individual. In the latter the furrows on the pleural portions appear to have been directed somewhat less strongly backwards but it is possible that this is due to the distorted condition of the specimen.

In the glabella of the nearly entire individual and in the other small glabella the anterior, upper, end of the fronto-median lobe forms a low hump-like elevation, which is not the case in the holotype, and they differ also in having the anterior, free portion of this lobe more strongly compressed from the sides. They seem to agree perfectly in characters with the specimen from the East Baltic Area figured by SCHMIDT (1885, Pl. 1, figs. 14 a—e), which also is rather small. Whether the differences may be due to age cannot be decided with certainty without having more material, but it does not appear probable. As just pointed out above, the pygidium belonging to one of these specimens appears to differ somewhat in the direction of the furrows on the pleural lobes from the other pygidium, which agrees in size with the holotype. Since, however, this difference (if existing) seems to be of very slight importance, and in consideration of the great variability in the shape of the

fronto-median glabellar lobe found in the related species *L. celorhin* ANG. (cf. above p. 30), there do not for the present appear to be sufficient grounds for referring these smaller specimens to a separate species or a distinct variety. It seems, however, quite possible that it will ultimately prove necessary to do so, if further finds should show that the differences now observed really are constant distinctive features and perhaps that there are others as well.

The East Baltic form described and figured by SCHMIDT (1885, p. 60, Pl. 1, figs. 12 a—b) as a variety, *longerostrata*, of this species, ought, it seems to me, to be regarded as representing a separate species. It is not known from Sweden.

It has already been mentioned above (p. 29) that SCHMIDT in his work of 1885 ascribed the pygidium of *L. celorhin* to this species, but that he himself later on (1907, pp. 29, 33) recognized and corrected this error.

Affinities. — The cranidium of this species resembles in several characters that of *L. celorhin* ANG.; in others it agrees better with that of *L. platyrhinus* SCHMIDT, but it shows also characters which distinguishes it from both, and the pygidium does not indicate an especially close relationship with either of those species (cf. above p. 33, below, p. 51).

Horizons and Localities. — Asaphus Limestone. — Östergötland: Husbyfjöl Skarpåsen (Holotype, R.M. Ar. 2246), Husbyfjöl Vestanå (nearly entire individual, S.G.U., glabella, R.M. Ar. 220), Kongs Norrby (cr. U.M.). — Dalarne: Neighbourhood of Rättvik?¹ (pyg. U.M.).

Etage B₃. — Esthonia.

Lichas platyrhinus FR. SCHMIDT 1907.

Pl. 5, figs. 4—9.

1907. *Lichas platyrhinus*, SCHMIDT, p. 34, Pl. 2, figs. 1—4, text-fig. 3.

Diagnosis. — Cranidium with narrow, sharply but not deeply impressed furrows, produced in front into a long marginal extension; the latter indistinctly defined from glabella, flattened on top, widening anteriorly, rounded in front. Glabella proper wider than long, with anterior portion sub-triangular, very gently convex in both directions posteriorly, antero-lateral slopes steep, its foremost portion with slight longitudinal convexity of its own; fronto-median lobe rather suddenly expanded in front of bi-composite lobes, narrowing posteriorly to a little in front of middle, here narrower than bi-composite lobes, slightly widening posteriorly; bi-composite lobes sub-ovate with pointed ex-

¹ The specimen belongs to an old collection and on the old label Rättvik is given as the locality-name. In the village of Rättvik itself neither Asaphus Limestone nor any other part of the Orthoceras Limestone has been found as far as I know, and it does not seem probable that this limestone has ever been accessible there. Perhaps the name Rättvik does not refer to the village but to the parish of Rättvik, which covers a large area. It seems more probable, however, that the neighbourhood of the village is meant, and quite likely the specimen is from Alsarbyn or Utbyn, east of Rättvik village, where Asaphus Limestone of the same appearance as the rock which contains the specimen is accessible and has been quarried and where, especially at Lindgården at Utbyn, loose fragments of it occur in abundance.

tremities, with slight independent convexity, curved steeply downwards in front; basal lobes relatively large. Occipital lobes large, sub-ovate, extending considerably farther outwards than base of glabella, but not quite as far as main portion of occipital ring. Pygidium with narrow, not deeply impressed furrows, sub-trapezoidal, wider than long, narrowing posteriorly, antero-lateral angles sub-truncate or very broadly rounded, fulcra approximate; rachis extending somewhat less than half length of pygidium, anteriorly occupying nearly one-third its width, gently convex; posterior portions of dorsal furrows slightly diverging; anterior two pairs of pleurae ending in rather short, broad-based, backwardly directed, falcate free points; basal pair with short, broad, rounded free ends separated by broad, shallow emargination; third pleural furrows, like preceding pairs, beginning proximally at anterior margins of pleurae. Surface finely tuberculate, low, small tubercles of a few different sizes, closely placed, sometimes coalesced into low ridges or producing a partly pitted surface.

Description. — Cephalon gently convex transversely, sub-triangular, produced in front into a long marginal extension; its furrows narrow, sharply but not deeply impressed.

Glabella proper well defined at sides and posteriorly, very indistinctly defined in front, especially antero-laterally, from marginal extension: length about equal to width across middle, tapering rapidly anteriorly, somewhat more slowly posteriorly to a little in front of occipital furrow, then increasing very slightly in width to base, very gently convex in both directions posteriorly, but with the surface sloping steeply downwards antero-laterally; its foremost portion (anterior portion of frontal lobe) internally with slight convexity of its own in longitudinal direction. Fronto-median lobe clavate, expanded rather suddenly in front and overhanging bi-composite lobes; neck of lobe posteriorly coalescing with basal lateral lobes, narrowest a little in front of middle (the length counted all the way to the occipital furrow), where its width is less than one-third that between antero-lateral extremities of lobe, slightly widening posteriorly. Bi-composite lobes postero-laterally coalescing with basal lateral lobes but, at least in some specimens, indistinctly defined from these by their slight independent convexity; relatively large, sub-ovate in outline with pointed extremities, greatest (not projected) width about three-fifths the distance between anterior and posterior extremities, longer axes directed obliquely outwards and forwards. Basal lateral lobes comparatively large, but much smaller than bi-composite ones, without independent convexity.

Prolonged anterior lateral glabellar furrows curving from their points of origin in dorsal furrows at first upwards and inwards and slightly forwards a little more than half-way to median line of glabella, then making a rather sudden, but not sharp, bend and continuing obliquely backwards, converging posteriorly at first rather strongly, then slightly, and finally curving slightly outwards to a point on each side somewhat nearer dorsal than occipital furrow, where they are continuous with the very short basal lateral furrows, making a sharp turn outwards and forwards around posterior extremities of bi-com-

posite lobes. Middle lateral and distal portions of basal lateral glabellar furrows obsolete.

Anterior marginal extension more than two-thirds as long as glabella proper, rather longer than broad, either narrowest next the glabella proper — where the width is about two-thirds that of glabella at base — and gradually widening to semi-circularly rounded anterior margin, or slightly contracted a short distance in front of glabella proper and then expanding to rounded anterior margin; rather strongly convex from side to side posteriorly but with a flattening on top and lower than glabella proper, anteriorly the whole surface growing more flattened. Anterior border furrows only represented by weak side-branches extending from base of anterior marginal extension to anterior branches of facial sutures opposite junctions of dorsal and anterior lateral glabellar furrows; marking off on each side a narrow border continued on the free cheeks by a somewhat broader flattened area, which grows narrower postero-laterally and soon dies out and which is not marked off by any furrow.

Occipital furrow transverse in middle and somewhat stronger than dorsal and prolonged anterior lateral glabellar furrows, dividing at sides, the side-branches about as strong as the furrows just mentioned; anterior branches nearly straight and directed slightly forwards; posterior branches describing backwardly convex curves. Occipital ring broad, slightly narrower at lateral extremities than in middle, gently arched transversely, its main portion slightly rounded longitudinally and with the surface internally sloping gently downwards anteriorly, extending at sides beyond base of glabella, the distance between its lateral extremities being about eleven-eighths the width of this, its posterior margin nearly transverse; occipital lobes not reaching quite as far outwards as main portion of occipital ring but beyond base of glabella, large with slightly raised surfaces, sub-ovate with pointed extremities and the longer axes directed outwards and slightly backwards.

Cheeks sub-triangular with posterior margins directed obliquely outwards and backwards and with comparatively short, broad, tapering, flattened genal spines directed only relatively slightly backwards. Anterior portions of fixed cheeks very short and narrow, slightly rounded transversely, and sloping steeply downwards anteriorly. Posterior portions of fixed cheeks rather wide, widest opposite base of glabella, highest a little in front of this at dorsal furrows and sloping downwards, with about the same degree of steepness as adjacent portions of glabella, both anteriorly, laterally, and postero-laterally (to posterior border furrows). Free cheeks with lateral margins forming curves gently convex outwards to opposite anterior extremities of eye lobes, where they are slightly bent in, then becoming nearly straight, their surfaces sloping gently downwards towards the sides posteriorly, the slope growing stronger anteriorly. Eye lobes rather narrow, sub-crescentic, situated at a distance from posterior margin of cephalon slightly greater than their own length and with their anterior extremities nearly opposite middle of glabella proper. Palpebral lobes narrow, marked off by distinct furrows. Eyes (not preserved) supported by

narrow lower eyelids marked off by narrow furrows. Posterior borders of cheeks flattened, or very slightly rounded, internally somewhat narrower than adjacent portions of occipital ring (their posterior margins being a little in front of posterior margins of latter), rapidly increasing in width to facial sutures, where they are rather broader than occipital ring across middle, then becoming nearly parallel-sided. Posterior border furrows well marked internally, growing weaker distally and rather soon dying out, the portions on the free cheeks having about the same length as those on the fixed cheeks; combined with lower eyelid furrows by narrow, impressed grooves, starting close to facial sutures and only rather slightly diverging from them anteriorly. Anterior branches of facial sutures curving from eye lobes forwards, downwards, and slightly inwards; posterior branches directed obliquely backwards and outwards.

Rostral shield very large, extending underneath the entire anterior marginal extension of cranidium and at sides reaching to nearly opposite lateral extremities of frontal lobe of glabella, its posterior margin being very strongly arched forwards.

Labrum large, sub-pentagonal in general outline, widest at about level of posterior furrow, width here somewhat greater than sagittal length; narrowly rounded in front; posterior margin with rather narrow, shallow, rounded excavation in middle; postero-lateral extremities rather broadly rounded. Anterior edge very narrow, steeply inclined, slightly concave in middle, becoming flattened or slightly convex postero-laterally. Anterior wings of moderate size, sub-triangular, steeply inclined, placed very far back, at about middle of labrum, the anterior portion of the central body being extended far forwards. Central body reaching anterior margin of labrum, gently convex, sub-pentagonal, about seven-ninths as wide as long, widest a little behind middle; marked posteriorly by pair of slightly oblique, strong middle furrows, reaching about half-way to median line of labrum, each with a narrow, much weaker posterior side-branch reaching about as far inwards as main trunk and passing behind a small, ovate macula. Lateral furrows continued behind posterior furrow about half-way to posterior margin, of moderate width, rather deeply impressed and posteriorly converging slightly to middle furrows, then growing shallow and running nearly straight backwards to a little beyond posterior furrow, and then suddenly growing deep again and bending obliquely inwards. Posterior furrow about as strong as anterior portions of lateral furrows, nearly straight in middle, curving slightly forwards at sides. Anterior furrows meeting lateral furrows at very obtuse angles, narrow and shallow, dying out about half-way from their distal points of origin to anterior extremity of labrum, marking off at each side a narrow, slightly raised border, which grows narrower and finally disappears anteriorly. Lateral borders of moderate width, tapering anteriorly, gently convex in both directions anteriorly, growing more flattened posteriorly, or, in longitudinal direction, slightly concave; their lateral margins nearly straight, or slightly concave, outside the central body, behind the latter slightly convex and sub-parallel to posterior portions of lateral furrows.

Posterior border of moderate width, gently raised behind posterior furrow and in front of flattened postero-lateral portions of border.

[Thorax of 11 segments, wider than long. Rachis moderately convex, rather wide, tapering posteriorly, with rings gently rounded longitudinally. Dorsal furrows narrow, sharply but not very deeply impressed. Pleuræ directed nearly straight outwards — or the anterior ones slightly backwards — to rather approximate, weak fulcra, then curving gently downwards and the anterior ones bending rather slightly, the following ones successively, more and more strongly backwards, ending in backwardly directed, falcate points. Pleural furrows sharply but not deeply impressed in the flattened surfaces, beginning in dorsal furrows at anterior margins of pleuræ, but soon becoming sub-median, extending about half-way, or rather more than half-way, to extremities of pleuræ].

Pygidium sub-trapezoidal, sagittal length about three-fifths greatest width, narrowing posteriorly, antero-lateral angles sub-truncate or very broadly rounded, posterior margin between extremities of basal pair of pleuræ arched rather gently forwards. Rachis gently convex, extending somewhat less than half the length of pygidium and having a width at anterior margin nearly equal to one-third entire width of pygidium, tapering moderately posteriorly, rounded behind and indistinctly marked off from post-rachial piece though considerably raised above it; marked anteriorly by two narrow ring furrows, of which the first one is the stronger and gently arched forwards in middle, the second one weaker, especially in middle, and nearly transverse. Dorsal furrows narrow, distinctly, but not deeply, impressed, converging rather gently posteriorly from anterior margin to a little behind middle of rachis, running sub-parallel outside its posterior portion to a little in front of its extremity, then suddenly bending inwards and then continuing behind rachis, slightly diverging rather more than half-way to posterior margin. Post-rachial piece sloping gently downwards posteriorly, slightly raised anteriorly, becoming flattened posteriorly.

Pleural portions of pygidium sloping gently downwards laterally and posteriorly, on anterior pair of pleuræ the slope being more gentle inside approximate fulcra than beyond them, on following pairs having about the same degree of steepness throughout; consisting of three pairs of pleuræ marked by fine pleural furrows and separated by about equally fine interpleural furrows. Anterior two pairs of pleuræ sub-equal, elongate, sub-parallel-sided, directed obliquely backwards and ending in rather short, broad-based, backwardly directed, falcate free points. Basal pair of pleuræ not defined on inner sides posteriorly, about as long as preceding pairs, increasing in width posteriorly and growing wider than these, with short, broad, rounded free ends. Pleural furrows beginning in dorsal furrows — or, as regards the second pair, sometimes a little outside these — at anterior margins of pleuræ, soon becoming sub-median, extending one-half to two-thirds the length of pleuræ; basal pair somewhat shorter than preceding ones, Bands of pleuræ very slightly raised, marginal portions more flattened.

Dorsal surface of cephalon, thorax, and pygidium very closely covered by small, low tubercles of a few different sizes; the tubercles form as a rule oblique cones, often they are so oblique as to appear flat or somewhat scale-like, sometimes they have coalesced so that nodose ridges are formed, or the smaller tubercles may be effaced and the interspaces between the remaining ones appear pitted. Ridges of the usual kind occur on the doublures; those on the doublures of the free cheeks are continued on the posterior part of the rostral shield, where they postero-laterally, adjacent to the free cheeks, run close together, anteriorly successively more and more apart, and between them and in front of the foremost one the surface is covered by small tubercles and other ridges, which are broken up into small pieces of different sizes and which have a more irregular course, but on the whole more transverse. Similar ridges occur on the marginal portions of the labrum and between the ridges are small pits; on the other portions of the labrum the surface is pitted, or there is a network of fine ridges, and small tubercles may also occur.

Dimensions. — The dimensions of a cranidium (R.M. Ar. 2204) are: sagittal length of entire cranidium to base of anterior extension (of which the greater part is lacking) 23 mm., width between palpebral lobes 24.5 mm.; glabella — length to base of anterior extension 19 mm., greatest width 21.5 mm., basal width 15 mm.; fronto-median glabellar lobe — greatest width 18.5 mm., least width 6 mm.; bi-composite lobes — distance between anterior and posterior extremities 11.5 mm., width (not projected) across middle 7 mm. In a labrum, belonging to a somewhat larger individual (R.M. Ar. 2202) — in which the basal width of the glabella is 17 mm., — the sagittal length is 22.5 mm. and the greatest width 24 mm.; in an incomplete pygidium (R.M. Ar. 2247) the sagittal length seems to have been nearly 31 mm. and the greatest width about 50 mm.

Remarks. — Of this species, originally described and figured by SCHMIDT (1907, p. 34, Pl. 2, figs. 1—4, text-fig. 5) from the East Baltic Area (B_{3a}), a good number of specimens — representing the different parts of the shield — have also been found in the Asaphus Limestone at different Swedish localities. The Swedish specimens agree closely in characters with the East Baltic ones as described and figured by SCHMIDT. The above description of the cephalon, labrum, and pygidium is based on the Swedish material, the statements as to the variations found in the shape of the anterior extension of the cranidium is, however, partly, and the description of the thorax chiefly, based on SCHMIDT'S figures and description; the thorax is not complete in any of the Swedish specimens, there are only fragmentary and badly preserved portions.

In Norway the species has been found in the Expansus Shales at Huk (Bodö) and is represented from there by a fragmentary pygidium in the Oslo Museum and by some fragments in a private collection in Oslo.

Affinities. — As pointed out by SCHMIDT (1907, pp. 34, 37), the cranidium of this species resembles in several characters that of *L. pachyrhinus* DALM. (cf. above p. 45, below, Pl. 4, figs. 1—3). There are, however, also very considerable differences and it hardly seems as if the relationship was especially

close. It is easily distinguishable from that species by the different character of the anterior portion of the cephalon; the narrower neck of the fronto-medial glabellar lobe; the distinct, though slight, independent convexity and the different shape of the bi-composite lateral glabellar lobes; the course of the dorsal furrows, which converge more strongly posteriorly to the occipital lobes and then bend much more strongly outwards; the elongate labrum; the broader and less convex thoracic and pygidial rachis; the more approximate fulcra on the thoracic segments and on the anterior margin of the pygidial pleural lobes; the more backward direction of the interpleural and pleural furrows on the pygidium; the different points of origin of the two posterior pleural furrows, which are at the anterior margins of the respective pleuræ — instead of, as regards the second pair, a little behind, or, as regards the third pair, at a considerable distance behind the anterior margins; by the somewhat longer free ends of the anterior and second pairs of pygidial pleuræ; and by the more remote and broader free ends of the basal pair.

SCHMIDT (1907, p. 37) compared the pygidium with that of *L. norvegicus* ANG. [ANGELIN, 1854, p. 73, Pl. 38, fig. 2; BRÖGGER, 1882, p. (128) 129, Pl. 5, fig. 13] but, as has since been stated (cf. p. 33), the latter is of much younger geological age (Lower Silurian) and apparently does not belong to *Lichas* s. str.

Horizons and Localities. — Asaphus Limestone. — Östergötland: Husbyfjöl Vestanå, Kongs Norrby. — Öland: Borgholm, Sandvik, Hälludden, Eriksöre. — Jämtland: Pilgrimstad.

Etage B_{3a} — East Baltic Area (Lectotype, entire individual, SCHMIDT, 1907, Pl. 2, figs. 2—2 a).

Expansus Shales (3 c β). — Norway: Huk at Bygdö.

Genus *Conolichas* DAMES, 1877, em.

Genotype: *Conolichas aequiloba* (STEINHARDT 1874).

Synonyms: *Lichas* STEINHARDT 1874 pars., auctt. pars. — *Lichas* (*Conolichas*) DAMES 1877. — *Lichas* (*Conolichas*+*Homolichas*) SCHMIDT 1885; GÜRICH 1901, REED 1902, 1923, auctt. — *Conolichas*+*Homolichas* auctt. — *Conolichas*+*Homolichas*+*Cypholichas* PHLEGER 1936.

Diagnosis. — Cranidium with complete dorsal furrows; prolonged anterior lateral glabellar furrows reaching occipital furrow, sometimes growing weak near the latter; basal lateral glabellar furrows completely obsolete or represented by fine, scarcely impressed lines crossing posterior portions of tri-composite lobes; occipital lobes well defined. Pygidium with dorsal furrows not reaching posterior margin; rachis with two ring furrows, undefined behind and continued by moderately wide post-rachial piece; pleural portions composed of three pairs of furrowed pleuræ ending in free points, basal pair of free points, however, sometimes nearly obsolete; basal pair of pleuræ posteriorly confluent with post-rachial piece.

Remarks. — My reasons for uniting *Conolichas* DAMES and *Homolichas* SCHMIDT in one genus are given above (p. 13).

Conolichas deflexus (ANGELIN 1854¹).

Pl. 6, figs. 1—8.

- 1854 & 78. *Lichas deflexus*, ANGELIN p. 71, Pl. 37, fig. 3 a (? figs. 3, 3 b—c).
 1854 & 78. » *depressus*, ANGELIN, Pl. 36, fig. 4 a (non fig. 4).
 1857. *Lichas deflexa*, NIESZKOWSKI, p. 569 (55),
 1857. » *platyura*, NIESZKOWSKI, p. 578 (64), Pl. 1, fig. 9.
 1874. » *velata*, STEINHARDT, p. 30, Pl. 3, fig. 9.
 1877. *Hoplolichas proboscidea*, DAMES, p. 800 (pars), Pl. 13, fig. 4.
 1885. *Lichas deflexa*, SCHMIDT, p. 101, Pl. 4, figs. 24—35.
 1888. » » WIGAND, p. 66, Pl. 8, figs. 4 a—c.
 1890. » » POMPECKI, p. 49, Pl. 3, figs. 30—30 a (copies after SCHMIDT).
 1902. » *deflexus*, REED, p. 78, text-fig. 14 (copy after SCHMIDT).

Diagnosis. — Glabella somewhat longer than wide, longitudinally very strongly convex; transversely rather strongly to strongly convex anteriorly with fronto-median lobe strongly arched and side lobes sloping steeply with flattened surfaces, becoming less convex posteriorly with flattened neck of fronto-median lobe depressed below lateral lobes; fronto-median lobe with or without very small antero-lateral extensions and anterior margin strongly and evenly arched, rapidly narrowing posteriorly to about middle, then very slowly to about level of middle of palpebral lobes, width here about one-sixth frontal width and less than one-seventh entire width of glabella, widening posteriorly to about half frontal width, extending farther back than lateral lobes. Occipital lobes convex, rounded sub-triangular, extending somewhat farther outward than base of glabella and considerably more forward than main portion of occipital ring. Pygidium broadly sub-semioval, somewhat truncate behind; rachis relatively gently convex; dorsal furrows converging behind rachis, bending outwards near extremities and connected with third pleural furrows by distinctly impressed, curved grooves: pleural portions sloping steeply downwards laterally, more gently posteriorly; anterior two pairs of pleurae with rather short, obtusely pointed, recurved free ends, their pleural furrows long, extending out on free ends; basal pair with shorter pleural furrows and short free points situated slightly less than width of rachis apart. Surface coarsely tuberculate.

Description. — Glabella very strongly convex longitudinally, overhanging margin in front, rather strongly to strongly convex from side to side anteriorly, becoming less strongly convex in this direction posteriorly and with the neck of the fronto-median lobe depressed below the lateral lobes; somewhat longer (projected length) than wide, widest well in front of middle, narrowing slowly posteriorly with nearly straight sides, narrowing rapidly anteriorly, also with nearly straight sides, to rounded front end. Fronto-median lobe expanded in front but without antero-lateral extensions, or with very small ones, with anterior margin strongly arched forwards; rapidly narrowing posteriorly to about its middle, then very slowly for some distance to nearly opposite middle of palpebral lobes, where its width is about one-sixth the frontal width and rather less than one-seventh entire width of glabella, posteriorly widening

¹ ANGELIN (not SJÖGREN) must be considered the author of this species, cf. below, p. 56.

again to about half the frontal width; strongly convex longitudinally, generally with a marked bend at about the middle of the lobe (measured along the curvature) and a flattening or depression of the surface immediately behind this; neck of lobe flattened transversely and, except just in front, lower than side-lobes; anterior portion of lobe more or less strongly convex transversely with somewhat flattened lateral slopes, the surface sloping upwards from anterior margin and sides, often forming a kind of small hump in front of the flattened neck, at the bend. Tri-composite lobes not reaching quite as far back as fronto-median lobe, greatest width (not projected) a little more than half the distance between extremities, sub-ovate in dorsal aspect, narrowing more anteriorly than posteriorly and with the outer sides nearly straight for most of their length; anterior ends rather sharply pointed, posterior ends rounded or obtusely pointed; strongly convex longitudinally, with long anterior and rather short posterior slopes, rather strongly convex from side to side posteriorly, and higher than median lobe, more flattened anteriorly with the surfaces sloping rather steeply downwards to dorsal furrows.

Prolonged anterior glabellar furrows, dorsal, and preglabellar furrows sharply impressed and rather narrow on testiferous specimens, moderately wide on casts. Basal pair of lateral glabellar furrows obsolete. Prolonged anterior glabellar furrows strongly and relatively evenly curved vertically, rather strongly curved inwards, generally with a flattening (not complete) of the curvature for some distance behind middle of glabella. Dorsal furrows from their anterior points of origin at first diverging for a rather short distance, then converging rather slightly to occipital lobes, then bending a little outwards and outside these lobes forming gentle outwardly convex curves.

Occipital furrow in its mid-region rather wider than dorsal furrows and transverse, dividing at sides; side-branches narrower than median portion; anterior side branches curving at first for a short distance forwards and upwards and only slightly outwards, truncating postero-lateral extremities of median glabellar lobe, then outwards and downwards. Main portion of occipital ring of moderate, nearly uniform width in middle, growing narrow behind occipital lobes; moderately arched transversely with comparatively straight lateral slopes. Occipital lobes rounded sub-triangular with the inner angles generally obliquely truncate, extending somewhat farther outward than base of glabella and considerably more forward than main portion of occipital ring, but not quite as far outward as latter; their surfaces convex, sloping steeply downwards posteriorly. Anterior border of cranidium very narrow in middle, becoming rather suddenly relatively wide at sides, flattened, with the surface sloping steeply, but not vertically, downwards anteriorly; gently arched forwards in middle; the median part of its anterior margin, below middle half of glabella, is either arched gently upwards, or is nearly straight in the middle, when seen in frontal aspect, and directed downwards at sides; the lateral parts of the margin are straight, or nearly so, and directed obliquely upwards, forming obtuse angles with the median part.

Fixed cheeks sloping steeply downwards both anteriorly and posteriorly

from above palpebral lobes. Anterior portions narrow, widening anteriorly, sloping downwards towards the sides as well as anteriorly, but less steeply, with transversely gently rounded surfaces. Posterior portions of moderate width, sub-triangular, with gentle convex lateral slopes. Palpebral lobes narrowly sub-crescentic. Palpebral furrows sharply impressed except anteriorly, where they generally grow weaker, not angulated or only very obtusely angulated opposite middle of palpebral lobes. Posterior borders of fixed cheeks very narrow near the occipital furrow, widening laterally, flattened, marked off by well-impressed furrows. Anterior branches of facial sutures running almost directly forwards from palpebral lobes to nearly opposite anterior extremities of anterior glabellar furrows, then making a sharp bend and curving obliquely inwards to anterior border of cranidium, and then running nearly straight forwards and downwards again; posterior branches curving from palpebral lobes outwards, downwards, and backwards to posterior borders, then obliquely outwards across these.

[Free cheeks, rostral shield, labrum, and thorax not known from Swedish localities].

Pygidium sub-semioval in outline, with rounded antero-lateral angles; sagittal length about three-fifths the greatest width. Rachis extending less than half the length of pygidium, about as wide as long, slightly narrowing posteriorly, broadly rounded and indistinctly defined behind, moderately convex with, it appears (the specimens examined are not well preserved), rather protruding apex; anteriorly with two well defined, gently rounded rachial rings. Post-rachial piece gently convex adjacent to rachis, becoming flatter posteriorly, sloping moderately steeply downwards from rachis to posterior extremities of dorsal furrows; posteriorly, where it is confluent with basal pair of pleuræ, the slopes become more gentle. Dorsal furrows narrow, sharply impressed, continued beyond rachis, but not across marginal border; converging slightly outside rachis, more strongly beyond it but bending outwards posteriorly and connected with basal pair of pleural furrows by strongly curved, distinctly impressed grooves.

Pleural portions of pygidium with a flattened, sub-triangular, posteriorly tapering area in front next the dorsal furrows, beyond this sloping steeply downwards laterally and less steeply posteriorly, the marginal portion posteriorly — on the basal pair of pleuræ, the post-rachial piece, and sometimes to a lesser degree on the second pair of pleuræ — with gentler slope and thus forming a sort of moderately broad marginal border. Anterior two pairs of pleuræ, completely defined; marginal (border) portions of basal pair of pleuræ confluent with post-rachial piece. Interpleural and pleural furrows of about equal strength, narrow, sharply impressed. Pleural bands with gently raised and rounded surfaces. Anterior two pairs of pleuræ relatively long and narrow, of sub-equal length; with tapering, obtusely pointed free ends, only slightly projecting on margin, the anterior ones being directed slightly, the second ones more strongly, inwards, and the emarginations between them and the respectively following pleuræ being very narrow. Anterior two pairs of pleural

furrows curved, nearly reaching extremities of pleuræ; both pairs beginning in dorsal furrows near anterior margins or respective pleuræ; the anterior ones soon becoming sub-median and on the free ends approaching posterior (inner) margins; second ones for the greater part of their length running considerably nearer anterior than posterior margins of pleuræ, but near the free ends making a rather sudden bend and approaching posterior (inner) margins. Anterior pair of interpleural furrows running in gently convex curves obliquely outwards and backwards to some distance from free ends, then bending a little more strongly outwards. Second interpleural furrows running from dorsal furrows nearly straight, at angles of about 25° to sagittal line, to near border, then bending more outwards; except near the dorsal furrows only slightly diverging from anterior interpleural furrows. Basal pair of pleuræ shorter and relatively broader than anterior pairs; ending in short, sub-triangular free points situated somewhat less than width of rachis apart and extending but slightly farther back than extremities of second pair; posterolateral margins with slight sigmoid curve, which near the free points is very slightly convex inwards and forwards and laterally somewhat more strongly convex outwards and backwards. Basal pair of pleural furrows beginning in dorsal furrows relatively near anterior margins of pleuræ (though at a greater distance than anterior pairs), nearly opposite end of rachis, sub-parallel with second interpleural furrows for the greater part of their length but bending more inwards posteriorly to merge into the grooves connecting them with dorsal furrows. Distal bands of basal pleuræ narrow; proximal bands broader, sub-ovate with pointed anterior extremities. Doublure of pygidium relatively broad, sloping downwards posteriorly, the inner portion steeply, the marginal portion, which corresponds to the marginal border of the dorsal test, less steeply, anteriorly this more gently sloping portion grows successively narrower and narrower and the strongly sloping portion increases in width and finally the former disappears.

Surface of cranium and pygidium with low, or relatively low, sub-conical tubercles of different sizes, with small granules between and on the tubercles. Where the surface slopes downwards — e. g., on the anterior part of the fronto-median glabellar lobe — the tubercles are oblique and consequently lower than on other parts¹. On the anterior border of the cranium and on the posterior borders of the fixed cheeks there are no tubercles, or only some scattered small ones, but the test is closely and finely granulated, as on other parts (except in the furrows). On the main portion of the occipital ring are some scattered, small tubercles and three fairly large ones, of which

¹ When the surface is badly preserved, which is very often the case, or the granules are very crowded on the tubercles, the original shape of the latter is very difficult, sometimes impossible, to recognize, especially as regards the low oblique tubercles on the steeper slopes. They may then have the flattened-convex appearance which SCHMIDT has described (SCHMIDT 1885, p. 102: »fiach gerundete Tuberkulirung»). On the natural casts the tubercles are higher and narrower than on the surface of the test, and the shape easier to recognize since furthermore there are no granules.

the largest is on the median line a little in front of the posterior edge, the other two on the edge, one on each side and rather close to the median tubercle. On the other parts of the cranium the tubercles are closely crowded, especially posteriorly; a pair of conspicuous, high tubercles appears generally to occur on the neck of the fronto-median lobe some distance in front of its narrowest part, and some distance behind this are often two other about equally large tubercles; these latter, however, are not always on a line; just on the very narrowest part of the neck there seems to be either one single, fairly large tubercle, or three smaller ones, the one in the middle being the largest. On the pygidium the tubercles are more scattered than on the cranium; the largest are placed along the median lines of the posterior bands of the pleuræ; fairly large ones occur also on other portions, especially on the marginal parts.

Dimensions. — The dimensions of three cranidia (a = R.M. Ar. 2214; b = S.G.U. Pl. 6, figs. 3 a—c; c = S.G.U., Pl. 6, figs. 1 a—c) are: sagittal distance between anterior and posterior margins a) 26 mm., c) 13 mm.; width between palpebral lobes a) 33 mm.; glabella — sagittal distance between anterior and posterior margin a) 24 mm., b) 14 mm., c) 11.5 mm.; fronto-median lobe — greatest (frontal) width a) 18 mm., b) 10.2 mm., c) 8.5 mm., least width a) 3 mm., b) 1.7 mm. (about), c) 1.5 mm.; tri-composite lobes — distance between anterior and posterior ends a) 18 mm., b) 10.5 mm., c) 9 mm., greatest width (not projected), a) 10 mm., b) 5.6 mm., c) 5 mm.

The dimensions of a small pygidium (R.M. Ar. 5097) are: sagittal length 6.5 mm., greatest width 11 mm.; rachis — length 3 mm., frontal width 3 mm. In another, imperfectly preserved pygidium (R.M. Ar. 2210) the sagittal length appears to have been about 14 mm.

Remarks. — As the author of this species, SJÖGREN has always been quoted, for the first time by ANGELIN (1854, p. 71). The material on which it was founded had been collected in Öland by SJÖGREN, but there is no evidence that he had anything to do with the diagnosing and figuring of the species in ANGELIN'S work, or, even, with proposing a name for it. In fact SJÖGREN listed the form in his paper of 1851 (p. 44) as *Lichas angustus* BEYR. and the same name is given on an old label probably written by him. It is clear that it is ANGELIN who must be considered the author.

The material collected by SJÖGREN, which is now in the State Museum of Natural History, consists of several fragmentary cranidia (Ar. 6002—6006), and the figures given by ANGELIN (1854, Pl. 37, figs. 3—3 c) seem to be based on at least three different specimens. The lectotype (Ar. 6002 a, b internal cast and impression) is illustrated below (Pl. 6, figs. 4 a, 4 b). On this ANGELIN'S figure 3 a is evidently based, but not only on this, which only represents part of the cranium; it is clear that he must also have used at least one additional specimen. Probably it was a fairly large cranium (Ar. 6004), belonging to the material in question, in which the anterior portion is rather well preserved, but the posterior part very badly worn by weathering. It is possible, however, that he might have had another specimen, which is

not now to be found or recognized. Anyhow this figure of ANGELIN's seems to be based only on specimens really belonging to this species, and it shows the chief characters of the cranidium fairly well. The other figures given by him as representing this species seem on the other hand partly to have been drawn from a small rather badly preserved cranidium (Ar. 6006; below. Pl. 6, fig. 9) which apparently does not belong here, but to a new species which will be described below (p. 58) as *Conol. Sjögreni* (represented in the State Museum of Natural History also by another specimen, the holotype, Ar. 2212, Pl. 6, figs. 10 a—d).

That the type of pygidium originally described and figured by STEINHARDT (1874, p. 30, Pl. 3, fig. 9) as *Lichas velata* and later ascribed to *Hoplol. proboscideus* DAM. by DAMES (1877, p. 800, Pl. 13, fig. 4) belongs to *Conol. deflexus* was pointed out by SCHMIDT in 1885 (p. 101 ff.) and can be regarded as established beyond reasonable doubt, the two portions of the body having frequently been found associated, in the East Baltic area at several localities, where, according to SCHMIDT, other trilobites have hardly been found in the same beds.

The pygidium (R.M. Ar. 6017) ascribed by ANGELIN (1854, p. 70, Pl. 36, fig. 4 a) to *Conol. depressus* (ANG.)¹ belongs to *Conol. deflexus*. Both the natural cast (figured below, Pl. 6, fig. 8) figured by ANGELIN, and the impression are in our State Museum of Natural History. They are neither of them completely preserved and a little pressed, but as far as it is preserved the pygidium agrees closely in characters with other pygidia of this species and occurs as the other Swedish specimens in *Macrourus* limestone from Öland.

In Sweden *Conol. deflexus* is only known from the *Macrourus* limestone in Öland, which limestone occurs there in boulders, and in which a great number of mostly rather badly preserved cranidia and several pygidia have been collected and are now in the State Museum of Natural History and in the Museum of the Geological Survey. Outside Sweden the species occurs relatively frequently in the Kegel Formation (Etage D₂) in the East Baltic area, and it has also been found in boulders at different places in North Germany.

From Sweden only the cranidium and the pygidium are as yet known. In the East Baltic area a fragmentary free cheek and some labra have been found (presumably in the same beds as the cranidia and pygidia), which, probably correctly, have been ascribed to this species by SCHMIDT (1885, p. 102, Pl. 4, figs. 32, 33).

Affinities. — The species from the *Macrourus* limestone of Öland, which will be described below as *Conol. Sjögreni* n. sp., is evidently closely related to *Conol. deflexus*, but shows some distinct differences (cf. below).

As already pointed out by POMPECKI another species that seems to be closely related is *Conol. branconis* (POMP.) (POMPECKI, 1890, p. 48, Pl. 2, figs. 26—26 a), founded on a cranidium found in East Prussia in a boulder, which POMPECKI considered to belong to the East Baltic Kuckers Formation (C₂).

¹ Regarding this species see below, p. 65, under *Conol. Peri* n. sp.

This form seems thus to be considerably older than our species and, as shown by POMPECKI's descriptions and figures and pointed out by him, it differs from it in several characters and it appears that the form really represents a distinct species, though SCHMIDT (1907, p. 42) seems to have doubted this.

SCHMIDT (1885, p. 103) considered the affinites of *Conol. deflexus* to be with *Conol. Schmidtii* DAM. although he provisionally referred the two species to different groups (*Homolichas* and *Conolichas* respectively). The pygidia agree well in their general characters, as do also the cranidia to a certain extent. There are, however, several marked differences and the two species do not appear to be very nearly related, but the affinites seem to be too close to allow the placing of them in separate genera or sub-genera. The cranidium of our species recalls also in several features that of the type of *Conolichas*, *Conol. aequilobus* (STEINH.) (SCHMIDT, 1885, p. 89, Pl. 5, figs. 4—10) and the pygidium, although markedly dissimilar in appearance, is built on the same general plan as in the latter species.

The other species placed in the group *Homolichas* by SCHMIDT (1885) and considered by him as more typical members of the group than our species, seem to be closely related to each other, but none of them appears to be very nearly allied to this species. The characters in which they differ from it and from the species originally placed in *Conolichas* do not, however, appear to be of generic or sub-generic importance, and as pointed out above (p. 13) it seems most correct to refer both *Conol. deflexus* and those other species previously placed in *Homolichas* to *Conolichas*.

Horizons and Localities. — Macrourus Limestone. — Öland, in boulders: Eriksöre (Lectotype R.M. Ar. 6002 a—b), Gräsgård, Hulterstad.

Kegel Formation (D₂). — East Baltic Area.

North Germany, in boulders.

Conolichas Sjögreni n. sp.

Pl. 6, figs. 9—10 d.

Diagnosis. — Glabella slightly longer than wide, strongly convex longitudinally, anteriorly only gently convex from side to side and the lobes without independent convexity, posteriorly as a whole not convex from side to side but with lateral lobes independently convex and raised above neck of fronto-median lobe; fronto-median lobe with small antero-lateral extensions and anterior margin somewhat strongly arched with strongest bend at sides, rapidly narrowing posteriorly, with, in dorsal aspect, nearly straight sides from behind antero-lateral extensions to about level of middle of palpebral lobes, width here (seemingly) about one-tenth frontal width, less than one-tenth entire width of glabella, widening posteriorly to about half frontal width, extending farther back than lateral lobes. Occipital lobes convex, broadly sub-ovate, extending somewhat farther outward than base of glabella and considerably more forward than main portion of occipital ring. Surface coarsely tuberculate.

Description. — Glabella strongly convex longitudinally, anteriorly and in middle gently convex from side to side, posteriorly as a whole not convex in this direction, but with the side-lobes independently convex and raised above neck of fronto-median lobe; slightly longer (projected length) than wide, widest well in front of middle, narrowing rather slowly posteriorly, with nearly straight sides, narrowing rapidly anteriorly, also with nearly straight sides to rounded front end. Fronto-median lobe expanded in front, with small antero-lateral extensions and with anterior margin arched moderately strongly forwards; rapidly narrowing posteriorly to about on a line with middle of palpebral lobes, where its width appears to be about one-tenth the frontal width and less than one-tenth the width of entire glabella, then widening again posteriorly to about half the frontal width; strongly and rather evenly convex longitudinally; gently convex from side to side anteriorly; flattened posteriorly with middle of neck depressed below side-lobes. Tri-composite lobes not reaching quite as far back as fronto-median lobe, distance between extremities a little more than twice the greatest width, which is more than half way back, narrowing very slowly anteriorly for part of their length; their anterior extremities rather obtusely pointed; the posterior extremities rounded to obtusely pointed; their inner margins nearly straight in dorsal aspect for the greater part of their length but curving strongly outwards near extremities; their distal margins also nearly straight for part of their length, curving gently inwards anteriorly; strongly convex longitudinally, with long anterior and short posterior slopes; anteriorly without independent transverse convexity, posteriorly moderately convex transversely and raised above median lobe.

Prolonged anterior glabellar furrows, dorsal, and pre-glabellar furrows sharply impressed and rather narrow on testiferous specimens, moderately wide on casts, curving from their anterior points of origin at first strongly inwards, but very soon bending more backwards but still converging strongly posteriorly to about on a line with middle of palpebral lobes, nearly straight in dorsal aspect during this part of their course, then curving rather strongly outwards. Basal lateral glabellar furrows obsolete. Dorsal furrows at first, from their anterior points of origin, diverging for some distance, then converging relatively strongly (at about 35°) to occipital lobes, then bending a little outwards and outside these lobes forming curves gently convex outwards.

Occipital furrow, occipital ring, anterior border of cranium, and fixed cheeks showing, so far as preserved, the same characters as corresponding portions of *Conol. deflexus*, except that the occipital lobes appear to be more rounded, the main portion of the occipital ring to be somewhat less strongly arched, the portions of the fixed cheeks lying inside the palpebral lobes to be more flattened transversely, and the posterior portions of the fixed cheeks to slope more gently towards the sides.

Ornament of test of cranium as in *Conol. deflexus*.

Dimensions. — The dimensions of the holotype (R.M. Ar. 2212) are: cranium — sagittal distance between anterior and posterior margin 16.5 mm., width between palpebral lobes 18.5 mm.; glabella — sagittal distance between

anterior and posterior margin 15 mm., greatest width 13.5 mm.; fronto-median lobe — greatest width 11 mm., least width just over 1 mm.; tri-composite lobes — distance between anterior and posterior ends 11 mm., greatest width 5.2 mm. In the other cranidium the sagittal distance between the anterior and the posterior margin is only 8 mm. and the greatest width of the glabella about 6.5 mm.

Remarks and affinities. — This new species is founded on two cranidia from the Macrourus limestone of Öland in the State Museum of Natural History (Ar. 2212 holotype, and Ar. 6006)¹. Although they agree in several characters with the cranidia of *Conol. deflexus* from the same strata, they differ so markedly in some features that it appears necessary to regard them as representatives of a distinct species, which, however, evidently is closely allied to *Conol. deflexus*. The glabella is much more gently rounded transversely. The fronto-median glabellar lobe is more broadly rounded in front; its antero-lateral extensions are more distinct (though small), and behind these it tapers more gradually, in dorsal aspect with nearly straight sides, all the way to its narrowest portion, the prolonged anterior furrows running at first from their anterior points of origin more strongly inwards, then relatively suddenly bending more backwards and over the middle part of their course becoming nearly straight in dorsal aspect and, except just posteriorly, much more gently curved vertically than in *Conol. deflexus*. As a consequence of the different course of these furrows the tri-composite lateral glabellar lobes are also rather differently shaped.

Horizon and Localities. — Macrourus limestone. — Öland (in boulders): Eriksöre (holotype, R.M. Ar. 2212, Pl. figs. 10 a—d), Gräsgård (R.M. Ar. 6006).

Conolichas Eichwaldi (NIESZKOWSKI) 1857.

Pl. 9, figs. 9—10.

1842. *Metopias* (no specific name). EICHWALD, p. 64, Pl. 3, fig. 4.
 1857. *Lichas Eichwaldi*, NIESZKOWSKI, p. 570, Pl. 1, figs. 16—17.
 1858. » *verrucosus*, HOFFMAN, p. 23 (pars), Pl. 1, fig. 1.
 1874. » *Eichwaldi*, STEINHARDT, p. 28, Pl. 3, figs. 1 a—c.
 1885. » » SCHMIDT, p. 104, Pl. 4, figs. 10—17.
 1890. » » POMPECKI, p. 50, Pl. 2, fig. 27, Pl. 6, fig. 16.
 1901. *Homolichas Eichwaldi*, GÜRICH, Pl. 20, fig. 15 (copy after SCHMIDT).
 1908. *Lichas* » WIMAN, p. 134, Pl. 8, figs. 35—36.

Diagnosis. — Glabella about one and one-fifth times as long as wide, rather gently convex longitudinally, gently convex transversely, its lobes without, or with very slight, independent convexity; fronto-median lobe with moderately long antero-lateral extensions and anterior margin strongly and evenly arched, narrowing posteriorly, rapidly at first then more and more slowly, to a little in front of level of middle of palpebral lobes, width here less than one-third greatest width and less than one-third, generally just over

¹ One of these (Ar. 6006) was collected by SJÖGREN and it seems as if some of the figures given by ANGELIN (1854, Pl. 37) as representing *Conol. deflexus* were partly based on this (cf. above p. 57).

one-fourth, width of entire glabella, widening posteriorly to about, or slightly less than, half frontal width, extending farther back than side-lobes, its postero-lateral extremities generally truncate. Occipital lobes gently convex, rounded quadrilateral, extending farther forward than main portion of occipital ring and slightly farther outward than base of glabella, sloping rather steeply downwards posteriorly, gently towards the sides. Pygidium sub-semioval; rachis moderately convex; posterior parts of dorsal furrows diverging relatively strongly, not connected with third pleural furrows by distinct grooves; pleural portions sloping gently downwards laterally and posteriorly; anterior two pairs of pleurae with very short, inwardly directed free points not projecting on margin, their pleural furrows very long, nearly reaching margin at fissure-like emarginations between different pleurae; basal pair with relatively long pleural furrows, their points very small and obtuse, placed somewhat more than half width of rachis apart, hardly discernible in dorsal aspect, posterior margin between points being only gently arched upwards and nearly straight in dorsal aspect. Surface rather finely tuberculate.

Description. — Cephalon somewhat triangular in outline, a little more than half as long as wide across occipital ring; the margin rounded in front, becoming sinuate on either side in the anterior portion of the free cheeks and then broadly convex to the extremities of the genal spines.

Glabella about four-fifths as wide as long, with the greatest width a little in front of middle, tapering very gradually posteriorly, rather narrowly rounded in front, gently convex from side to side posteriorly, rather gently convex longitudinally; its lobes without, or with slight, independent convexity. Fronto-median lobe with the anterior margin strongly arched forwards and with antero-lateral extensions overhanging tri-composite lobes for the greater part of their width; narrowing posteriorly at first very rapidly, then gradually to nearly opposite middle of palpebral lobes, where it occupies less than one-third the width of glabella (generally just over one-fourth, sometimes less), then increasing in width again to base, or nearly to base, its postero-lateral extremities generally being a little truncate; its posterior width generally about, or slightly less than, half its anterior width and about one and two-thirds the width across the narrowest portion. Tri-composite lobes about twice or slightly more than twice as long as wide, narrowing anteriorly and posteriorly, proximal outlines rounded, distal outlines nearly straight, anterior extremities pointed; not extending quite as far back as median lobe. Prolonged anterior glabellar furrows narrow, rather deeply impressed throughout. Basal lateral glabellar furrows obsolete; in some specimens their course seems, however, to be indicated either by very slight impressions across the tri-composite lobes beginning in the dorsal furrows a little posterior to the narrowest part of the median lobe and directed obliquely outwards and forwards, or by a slight change in the convexity of the surfaces of the side-lobes, their posterior portions, which seem to represent the basal lateral glabellar lobes, being somewhat more flattened than the antero-median portions. Dorsal furrows about as strong as prolonged anterior furrows.

Occipital furrow deep and rather wide (especially wide on casts) behind median lobe of glabella, dividing at sides; anterior side divisions generally with very short, rather wide internal parts which run from the extremities of the undivided portion of the furrow obliquely forwards and outwards, truncating the postero-lateral extremities of the median lobe and the inner ends of the occipital lobes; the chief portions of these divisions narrow and directed nearly straight outwards and lying a little in front of the undivided portion of the furrow; posterior divisions deeper and arched slightly backwards. Main portion of occipital ring of moderate and uniform width proximally, growing narrower at sides, behind occipital lobes; rather strongly arched transversely, slightly rounded longitudinally; with conical median tubercle placed rather near posterior margin, not very conspicuous, but larger than the other tubercles on the occipital ring. Occipital lobes rounded sub-triangular, extending farther forward than main portion of occipital ring, but not quite as far outward as this, and only slightly farther outward than base of glabella, with gently rounded surfaces sloping rather steeply downwards posteriorly, gently laterally. Anterior border of cranidium narrow and rounded in middle, growing wider and flattening out at sides and continued by the flat side-borders on the free cheeks, marked off from glabella by narrow distinctly impressed furrow, and from anterior portions of fixed cheeks by weak grooves running from anterior extremities of prolonged anterior glabellar furrows and continued on free cheeks.

Inner portions of cheeks convex, but not quite as high as glabella, sloping very steeply downwards posteriorly from eye-lobes and somewhat less steeply anteriorly and laterally; in front and at sides not marked off from borders by any distinctly impressed furrows; on fixed cheeks rising directly from the narrow but distinctly impressed posterior border-furrows; the latter continuing for short distance out on free cheeks, but there separated from rounded, raised portions by small, sub-triangular, flattened areas (which may also be defined at sides by weak furrows or grooves representing the posterior parts of the lateral border-furrows). Palpebral lobes rather prominent, sub-crescentic to rounded-bandlike, flattened, marked off by distinct furrows, which are rather deep anteriorly and posteriorly, shallow in middle. Lower eyelids narrow, band-like, marked off by distinctly impressed furrows. Lateral borders of cheeks sloping obliquely downwards laterally, not quite flat, very narrow in front where the margins are sinuous, increasing rapidly in width to become wide posteriorly. Posterior borders rather narrow adjacent to occipital furrow, relatively rapidly widening laterally. Genal angles prolonged into rather narrow and short, tapering, pointed, slightly curved, and diverging spines. Posterior margins of cheeks directed relatively strongly backwards from occipital furrow to posterior extremities of facial sutures, beyond these more straight outwards and then bending rather suddenly — although not abruptly — backwards at bases of genal spines; lateral margins of cheeks forming continuous curves to extremities of spines. Anterior branches of facial sutures rather slightly convergent anteriorly and running in very gentle outwards convex curves to

anterior border, and then continuing across this in the same general direction but forming nearly straight lines; posterior branches running from eye-lobes obliquely outwards, backwards, and downwards to posterior borders, then continuing in about the same outward and backward direction to near posterior margin, and then bending nearly straight backwards.

[Rostral shield narrow band-like, gently arched transversely, gently rounded longitudinally].

Labrum somewhat pentagonal in outline, with anterior margin broadly rounded, posterior margin deeply and broadly excavated in middle, greatest width nearly twice sagittal length. Central body gently convex, somewhat more than two-thirds as long as wide, anterior margin broadly rounded, lateral and posterior margins nearly straight, the former sub-parallel; marked posteriorly at sides by pair of short, oblique, rather broad and shallow middle furrows. Posterior furrow moderately deep and rather wide (at least in casts); lateral furrows rather narrower, continued some distance behind posterior furrow by shallow, ill-defined grooves which diverge posteriorly. Anterior furrow only represented by short side-branches, marking off narrow antero-lateral borders, which increase in width distally and merge into anterior pair of wings. The latter narrow and rather short, sub-triangular, relatively slightly bent upwards. Lateral borders narrow anteriorly, rapidly widening to opposite posterior furrow, then narrowing again posteriorly but more gradually, moderately convex anteriorly, becoming more flattened posteriorly; their antero-lateral margins nearly straight, postero-lateral margins gently convex. Posterior border of moderate width, rounded longitudinally, gently arched transversely. Postero-lateral extensions of border rounded, with flattened surfaces gently bent downwards.

Surface of cephalon covered by sub-conical tubercles, varying in size from very small to fairly large, the largest being the median tubercle on the occipital ring. Surface of labrum with small, low tubercles and granules; the tubercles best developed and closely set on central body; on borders ridges of usual kind and between these minute tubercles and granules.

Dimensions. — The dimensions of a cranidium and a labrum from the North Baltic Area (U.M. Pl. 9, figs. 9, 10) are as follows: cranidium — length about 13.5 mm.; glabella — length 11.5 mm., greatest width 9.5 mm., basal width approximately 7.5 mm.; fronto-median lobe — greatest width 8 mm., least width 2.5 mm.; tri-composite lobes — distance between anterior and posterior extremities 6.5 mm., greatest width just under 3 mm.; labrum — sagittal length about 5.5 mm., greatest width nearly 10 mm.

Remarks. — This species is not known to occur in Sweden itself, but a cranidium and a labrum (already recorded and figured by WIMAN 1908, Pl. 8, figs. 35—36) have been found in a boulder of Östersjö Limestone from the North Baltic Area. The above description is based both on these specimens and on some specimens (cranidia, free cheeks, and labrum) in our State Museum of Natural History from the Wesenberg Formation (E) of Esthonia,

the description of the rostral shield on SCHMIDT'S (1885, p. 106, Pl. 4, fig. 12 b) description and figure.

There are also in the State Museum of Natural History some pygidia from Esthonia. It may be worth mentioning that, to judge from these, the basal pair of pleural points is somewhat more distinct than appears from the figures of the pygidium given by SCHMIDT (1885, Pl. 4, fig. 17) and ПОМРЕКИ (1890, Pl. 2, fig. 27). There are no real free points, but the posterior margin is more sharply angulated at the sides of the forwardly and upwardly convex mid-most part than appears when, as in those figures, the pygidium is viewed in dorsal aspect, since the posterior edge is more or less strongly curved downwards.

Affinities. — The chief points of difference between this species and the others which were referred by SCHMIDT to the group *Homolichas* have already been pointed out in his work of 1885. Of those species *Conol. angustus* (BEYR.) appears to be the most closely allied. SCHMIDT (1885, p. 107) considered it probable that this younger form — which occurs in the Lyckholm (F₁) and Borkholm (F₂) Formations — was a descendant of *Conol. Eichwaldi* (E) and stated that there were several transition forms. The pygidium (from a North German boulder) which ROEMER (1861, p. 76, Pl. 8, fig. 8 b), probably correctly, referred to *Conol. angustus* is not complete, but, as previously pointed out by me (1925, p. 256; see also below, p. 73), it appears probable that the pygidia from the Lyckholm (F₁) and Borkholm (F₂) Formations of Esthonia ascribed by SCHMIDT (1907, p. 26, Pl. 2, fig. 14, text-fig. 3) to *Amphilichas lineatus* (ANG.) also belong to *Conol. angustus*, and they show the portions that are wanting in ROEMER'S specimen. These pygidia (and as far as it is preserved ROEMER'S specimen of the pygidium) agree apparently very closely with that of *Conol. Eichwaldi* in most characters. The chief differences seem to be that the interpleural furrows curve less strongly outwards distally, the free points of the anterior pairs of pleuræ are directed more backwards and project more on the margin, and there is a pair of small, but distinctly projecting, basal points.

The pygidia from the Wesenberg Formation (E) ascribed by SCHMIDT (1885, pp. 54–55, Pl. 6, figs. 16, 17) to *Amphil. Holmi* (SCHMIDT) seem also to represent a form rather closely allied to *Conol. Eichwaldi*, but they differ distinctly from the pygidium of that species in some characters as seen from SCHMIDT'S descriptions and figures. Only the two specimens figured were known to SCHMIDT, but in our State Museum of Natural History there are four pygidia from the same formation and locality (Wesenberg) which appear to belong to the same form¹. It is evident that this type of pygidium is not referable to *Amphil. Holmi* or to any species of *Amphilichas* (cf. WARBURG

¹ The two figures given by SCHMIDT differ somewhat in their characters and our specimens agree in the shape of most portions on the whole best with his figure 17 (which represents the ventral side with the doublure), but in some features — e.g. the shape of the hindmost portion and the situation of the basal pair of free points — they resemble the figure 16 more closely.

1925, p. 256) and the cranidium belonging to it has not been recognized. It is not quite inconceivable, however, that some of the great number of cranidia which have been regarded as belonging to *Conol. Eichwaldi* belong to this form instead.

Horizons and Localities. — Östersjö Limestone. — Uppland: Torrön in the parish of Börstil (in a boulder).

Wesenberg Formation (E). — Esthonia (Lectotype, NIESZKOWSKI, 1857, Pl. 1, fig. 16).

North Germany in boulders.

Conolichas Peri n. sp.

Pl. 7, figs. 8—10.

?1854 & 1878. *Lichas depressus*, ANGELIN, p. 70, Pl. 36, fig. 4 (non fig. 4 a).

1885. *Lichas depressa*, SCHMIDT, p. 95, Pl. 4, figs. 2—5, ?figs. 1 a—d.

1902. *Lichas (Homolichas) depressus*, REED, p. 78, figs. 12 a—b. (copies after SCHMIDT).

1920. *Homolichas depressus*, FOERSTE, Pl. 4, figs. 10 a—b. (copies after SCHMIDT).

?1930. *Lichas (Homolichas) depressa*, WEBER, p. 86, text-figs. 3 a—c.

Diagnosis. — Glabella slightly longer than wide, very gently convex in both directions posteriorly, steeply curved downwards anteriorly; fronto-median lobe with moderately long antero-lateral extensions and anterior margin strongly and evenly arched, narrowing posteriorly, very rapidly at first, then more slowly, to a little in front of level of palpebral lobes, width here rather less than one-fourth frontal width and about one-fourth width of entire glabella, widening posteriorly to a little more than half frontal width, hardly extending farther back than proximal parts of side-lobes, its postero-lateral extremities acutely pointed. Occipital lobes moderately convex, rounded sub-triangular, extending considerably farther outward than base of glabella, sloping rather steeply downwards laterally as well as posteriorly. Pygidium sub-semioval, somewhat truncate behind; rachis strongly convex; dorsal furrows converging behind rachis, becoming sub-parallel posteriorly, not connected with third pleural furrows by distinct grooves; pleural portions sloping very steeply downwards laterally, more gently posteriorly; pleural furrows relatively short; anterior two pairs of pleuræ with rather short, acutely pointed free ends having distal, but not proximal, margins curving inwards; basal pair with short free points situated about half width of rachis apart. Surface finely tuberculate.

Description. — Glabella a little longer than wide, greatest width just behind anterior extremities of tri-composite lobes, tapering rather gradually posteriorly for some distance, then becoming nearly parallel-sided; basal width about four-fifths greatest width; very slightly tapering anteriorly to rather narrowly rounded front end; very gently convex in both directions posteriorly, steeply curved downwards in front. Fronto-median lobe with anterior margin strongly arched forwards and with antero-lateral extensions overhanging tri-composite lobes for the greater part of their width; narrowing posteriorly, at first very rapidly, then more slowly, to a little in front of level of middle

of palpebral lobes, where its width is rather less than one-fourth the frontal width and about one-fourth the width of entire glabella, then increasing in width again to base, at first slowly, then more rapidly, to a little more than half frontal width; its postero-lateral extremities acutely pointed. Tri-composite lobes proximally extending nearly as far back as median lobe, their width about equal to half distance between extremities, median portions nearly parallel-sided, end-portions tapering; their anterior thirds steeply curved downwards and overhanging pointed extremities. Prolonged anterior lateral glabellar furrows narrow, sharply impressed throughout, or becoming rather shallow and less distinctly defined near the occipital furrow. Basal pair may be represented by fine, scarcely impressed lines — connected across median lobe of glabella — running from prolonged anterior furrows, from a little behind the points where these turn more strongly outwards, obliquely forwards and outwards to dorsal furrows, meeting latter at, or near, the points where the palpebral furrows branch off. Dorsal furrows about as strong as anterior glabellar furrows.

Median portion of occipital furrow somewhat narrower than dorsal furrows for greater part of length, widening laterally, nearly straight; anterior side-divisions relatively wide, nearly straight, and directed slightly forwards; posterior side-divisions narrow, gently curved backwards. Main portion of occipital ring (incompletely preserved in the Swedish specimen) relatively wide and of uniform width in centre, narrowing behind occipital lobes, strongly arched transversely, flattened longitudinally; with conical median tubercle placed rather near posterior margin, not large but larger than the other tubercles and fairly conspicuous. Occipital lobes rounded sub-triangular, moderately convex, sloping rather steeply downwards postero-laterally, reaching slightly farther forward than main portion, not extending as far outward as latter though considerably (about half their width) beyond base of glabella. Anterior border of cranium very narrow proximally, widening distally, marked off from glabella by narrow, sharp furrow and from anterior portions of fixed cheeks by more or less distinct grooves.

Fixed cheeks only slightly lower than glabella, inside palpebral lobes gently convex, anteriorly and posteriorly sloping steeply downwards; anterior portions narrow, of moderate length; posterior portions of moderate size; Palpebral lobes (not preserved in Swedish specimen) rather prominent, sub-crescentic to rounded band-like, marked off by distinct furrows, which are shallow in middle but rather deep anteriorly and posteriorly. Posterior borders of fixed cheeks narrow near the dorsal furrows, becoming relatively wide distally, marked off by narrow, shallow furrows. Anterior branches of facial sutures rather slightly converging anteriorly, running in curves very gently convex outwards to anterior border and then continuing across it in about the same general direction but in nearly straight lines; posterior branches curving from palpebral lobes outwards, downwards, and backwards. Free cheek (not known from Swedish locality) with outer margin sinuous anteriorly, then broadly convex to extremity of genal spine; its inner portion steeply raised

(slope steeper anteriorly than posteriorly), convex in both directions. Posterior border and border-furrow continued a short distance out on free cheek and here separated from raised portion by small, sub-triangular, flattened area, which is defined at side by the weak posterior part of the lateral border furrow, the two furrows meeting at very acute angle. Lateral border sloping obliquely downwards distally, not quite flat, very narrow anteriorly, where the margin is sinuous, increasing rapidly in width to become wide posteriorly. Genal angle prolonged into relatively short, broad, gradually tapering, pointed spine.

Labrum (probably belonging to this species) somewhat pentagonal, with anterior margin arched relatively strongly forwards and posterior margin broadly and deeply excavated in middle, greatest width rather more than one and three-fourths sagittal length. Central body gently convex, length somewhat more than two-thirds greatest width, slightly tapering posteriorly, relatively narrowly rounded in front, lateral and posterior margins nearly straight; marked posteriorly at sides by pair of short, oblique middle furrows. Lateral and posterior furrows of moderate depth and width, the former continued some distance behind posterior furrow by shallow, ill-defined grooves. Anterior furrow distinctly impressed at sides, anteriorly merging into narrow, concave anterior margin, which latter increases in width and becomes less concave laterally. Anterior wings small, sub-triangular, relatively slightly bent upwards. Lateral borders narrow anteriorly, rapidly widening to opposite posterior furrow, then narrowing again posteriorly, but more slowly, moderately convex anteriorly, becoming more flattened posteriorly; their antero-lateral margins nearly straight, postero-lateral margins gently curved. Posterior border of moderate width, rounded longitudinally, gently arched transversely. Postero-lateral extensions of border rounded behind, flattened, gently bent downwards.

[Thorax not known].

Pygidium sub-semioval in general outline, somewhat truncate behind, with (in dorsal aspect) only slightly rounded antero-lateral angles, nearly twice as wide as long. Rachis rather narrow, its anterior width — about equal to length — a little less than one-third greatest width of entire pygidium, slightly tapering posteriorly, undefined behind, strongly convex with rounded, undefined apex, from which the surface slopes steeply downwards posteriorly; posterior slope, however, less steep than lateral slopes; anteriorly with two rachial rings, of which the second is weakly defined behind on surface of test — well defined on cast. Post-rachial piece convex and sloping steeply from rachis to near posterior ends of dorsal furrows, between their extremities slightly depressed, beyond them without independent convexity and sloping gently posteriorly. Dorsal furrows narrow, sharply impressed, continued beyond rachis, but ending at considerable distance from posterior margin of pygidium, converging rather slightly posteriorly outside rachis, bending rather strongly inwards at level of apex, becoming sub-parallel near extremities.

Pleural portions of pygidium with a flattening on each side in front next the dorsal furrows, beyond this curving steeply, but not abruptly, downwards

laterally, and more gently posteriorly; consisting of three pairs of free-ending, furrowed pleuræ with raised and rounded pleural bands. All pleuræ of moderate width. Anterior two pairs completely defined, of sub-equal length, ending in rather short, broad-based, pointed free ends; distal margins of first pair of free ends curving slightly inwards, those of second pair more strongly so, proximal margins of both pairs nearly straight, directed slightly outwards, Basal pair of pleuræ posteriorly confluent with the post-rachial piece; the free ends short, sub-triangular, situated about half width of rachis apart, extending only slightly farther back than those of second pair; postero-lateral margins, apparently, nearly straight for the greater part of their length from free ends, bending strongly forwards distally to meet proximal margins of second pair of free ends at very acute angles. All pleural and inter-pleural furrows of about equal strength, narrow, and — excepting ends — sharply impressed, the former relatively short. First pair of interpleural furrows curving rather gently backwards, following pairs of furrows successively directed more and more strongly backwards and becoming straighter, last pair, third pleural furrows, only slightly diverging posteriorly. Anterior two pairs of pleural furrows beginning in dorsal furrows close to anterior margins of respective pleuræ, diverging from these laterally, first pair finally running somewhat closer to posterior than anterior margins, second pair throughout running closer to anterior margins. Third pair of pleural furrows beginning in dorsal furrows at considerably greater distance from anterior margins of pleuræ than preceding pairs, but not far back, at about level of apex of rachis, posteriorly becoming sub-median, neither curving inwards near extremities nor connected with ends of dorsal furrows by any distinct furrows or grooves.

Surface of cranium and pygidium closely set with low or relatively low, small, different-sized, sub-conical tubercles which, on some portions — especially on marginal parts of pygidium — are very oblique. Surface of labrum with small low tubercles and granules, on median portions mostly more or less incompletely coalesced, forming uneven, irregular ridges, between which scattered pits occur; on lateral marginal portions the usual anastomosing ridges occur, between them granules.

Dimensions. — The dimensions of the holotype (cranium, U.M.) are; glabella — sagittal distance between anterior and posterior margin just over 8 mm.; greatest width 7.5 mm.; fronto-median lobe — greatest width 7 mm. (about), least width 1.6 mm. (about); tri-composite lobes — distance between anterior and posterior end 5.2 mm. (about), greatest width 2.6 mm. (about). In a pygidium the sagittal length is approximately 7 mm., the greatest width is 13 mm., the anterior width of the rachis, just over 4 mm. In a labrum the sagittal length is nearly 8 mm. and the greatest width 14 mm.

Remarks. — The above description is based on a cranium, a pygidium, and a labrum in the Upsala Museum, found by Mr. PER THORSLUND in boulders of Lower Chasmops Limestone at Ringsö in Södermanland. The cranium I have selected as holotype of the species, which I have called *Conol. Peri*; possibly it is identical with ANGELIN'S *Lichas depressus* (cf. below, p. 70).

The specimen shows most of the characters clearly, although it is not complete. Only parts of the test are preserved, the main portion of the occipital ring is nearly entirely lacking. Further the frontal lobe of the glabella is damaged and in consequence the figures give perhaps the impression of the glabella as being too abruptly bent down anteriorly. The pygidium is in two pieces; the larger is a cast with only parts of the test preserved and lacking the posterior portion; the smaller shows the hollow inside of the test and partly the impression of the posterior part, a little more than the portion lacking in the larger piece. The labrum, which is well preserved, is relatively large and evidently belonged to a cranidium larger than the holotype. That it belongs to this species there does not seem to be any reason to doubt; it resembles much that of *Conol. Eichwaldi*, to which our species apparently is closely allied. (cf. below).

In our State Museum of Natural History there are four small cranidia (Ar. 6070—72, 6074) from the East Baltic Kuckers Formation (C₂) which evidently belong to this species; the largest is only slightly smaller than the Swedish specimen. They vary a little in the degree of convexity of the glabella. In two of them its anterior portion is curved down about as steeply as in the holotype, in the other two a little less steeply. There are besides in the same museum and from the same locality (Kuckers) as one of those cranidia a fragmentary pygidium (Ar. 6075) and a free cheek (Ar. 6073), which also seem to belong to this species.

In the above description the parts concerning the free cheek, the palpebral lobes, the main portion of the occipital ring, and the occurrence of the fine lines probably representing the basal lateral glabellar furrows are based on the East Baltic specimens, as well as the references to variation in strength of the posterior portions of the prolonged anterior lateral glabellar furrows. In the holotype, in which the test is not preserved on this portion, the furrows in question are strongly impressed throughout. In the other cranidia, all which are testiferous, the furrows — which in this respect may be differently developed on the two sides of one and the same specimen — are either about equally strongly impressed throughout, or become shallower, narrower, and more blurred posteriorly. It is only the portions situated behind the points apparently representing the inner extremities of the basal lateral glabellar furrows which vary. The change in the character of the furrows does not, however, always take place at these points, sometimes it is closer to the occipital furrow, and the change is not in all cases equally strongly pronounced. — The lines that appear to represent the basal lateral glabellar furrows are traceable in three of the cranidia.

The cranidia and fragmentary pygidia from the Kuckers formation which SCHMIDT (1885, p. 95, Pl. 4, figs. 1—5) referred to ANGELIN's species *Lichas depressus* (cf. below) seem, to judge from the description and figures, to agree in characters with the specimens in our Swedish collections and to belong evidently to the same species, possibly with the exception of one of the cranidia. From SCHMIDT's figures (1 a—c) of the latter, it appears as if the

glabella was much more broadly rounded in front, and as if the anterior parts of the prolonged anterior lateral glabellar furrows had a somewhat different course from that in the other cranida figured by him and in those examined by me, but possibly the differences are in reality slighter and of no importance.

Of the pygidium SCHMIDT had only two very fragmentary specimens, and from the figures alone of these one would not be able to identify the species. In fact SCHMIDT's fig. 4, in which most of the missing parts are restored in outline, gives a false impression. Judging from that one would suppose that the posterior outline formed a continuous curve, the marginal portion of the right side being seemingly complete all the way to the mid-point of the posterior margin. Unfortunately this feature has been considered proved (cf. above p. 13), although SCHMIDT pointed out in the text (p. 96) that his material did not show the character of the hindmost portion of the pygidium, and it appears from his statements as if he himself thought it likely, or at least quite possible, that a pair of free points was originally present. His statement on p. 96 is as follows: »Der Hinterrand ist unvollständig erhalten; man kan nicht sagen ob er deutliche Zähne hat». He also pointed out (p. 97) that the pygidium resembled that described and figured by him in the same work (p. 55, Pl. 6, figs. 16—17) and — apparently incorrectly (cf. above, p. 64) — attributed by him to *Amphilichas Holmi* FR. SCHMIDT, and in that a basal pair of free points is present.

Recently WEBER [1930, p. 86 (1132), text-figs. 4 a—c] figured as *Lichas* (*Homolichas*) aff. *depressa* ANG. an incomplete cranidium and a pygidium lacking the marginal portion. As far as can be judged from the text-figures given and as far as the parts are preserved, the form seems to agree fairly well in characters with our species, and it appears quite probable that it belongs to it.

It is possible that our new species really is identical with ANGELIN's *Lichas depressus*, as assumed by SCHMIDT, but it seems to me rather doubtful. Under that name ANGELIN (1854, Pl. 36, figs. 4—4 a, p. 70) figured a small incomplete cranidium and a pygidium, and gave the following short diagnosis of the species (evidently founded on the cranidium) and statements regarding locality and horizon: »L. minute granulatus, lobo frontis terminali postice lateralibus fere duplo angustiore. Loc. nat. In saxis dispersis regionis Da?) *Ælandiae*». He further stated that the cranidium figured was incomplete: »fragm. capit. decortic.».

The cranidium I have not been able to find, nor any other cranidia from Öland with the characters indicated by ANGELIN's diagnosis and figure. The pygidium is in our state Museum of Natural History (Ar. 6017). Evidently it does not belong to the same species as the cranidium but to *Conol. deflexus* (ANG.) (cf. above, p. 57). The specimen is from a boulder of Macrourus Limestone (the Upper Chasmops Limestone), which is in accordance with ANGELIN's statement. This limestone it not found as solid rock in Öland, but boulders of it, transported by the ice from the bottom of the Baltic, probably from

somewhere quite near the southeastern shore, occur very abundantly in the southern, especially the southeastern, parts of the island. Of the rocks found in Öland only these boulders were referred by ANGELIN to his regio Da and always with a mark of interrogation. The Lower Chasmops Limestone, which occurs as solid rock in the northeastern part of the island, he referred to regio C, although in Da he included beds of the same age, but petrographically somewhat different, occurring in other parts of Sweden (cf. LINNARSSON, 1876, pp. 78—79).

It is evident that ANGELIN's statement implies that the holotype (the cranidium) of his species — as well as the pygidium, which he attributed to it — had been found in a boulder of Macrourus Limestone, and thus originated from a younger formation than the specimens which I have referred to the new species. It is possible of course that ANGELIN made a mistake. It is likewise possible that new finds will show that the »new» species occurs in both formations. However this may be, it seems as if ANGELIN's name must be dropped, since it appears impossible to identify the species with any reasonable degree of certainty from his diagnosis and figures alone. The diagnosis does not say much and the figure, if correct, indicates differences from our species in several characters. Provided that the anterior portion of the glabella is broken off and partly »restored» in the figure to make the anterior outline symmetrical — which appears probable — and that the figure in other respects also is about as incorrect as ANGELIN's figures generally are, there is nothing which indicates that the original might not have belonged to our new species, but this surely is not enough for an identification.

SCHMIDT, according to his own statement (1885, p. 95) had for comparison a plaster cast (or casts) of the cranidium in question as well as of the pygidium which ANGELIN had attributed to the same species. There seems to be reason to doubt the correctness of this, and it appears probable that SCHMIDT only meant to state that he had the cast (or casts) of the pygidium. It is when giving his reasons for referring the pygidia from the Kuckers Formation to the same species as the cranidia, that he made this statement concerning the casts. The several casts of ANGELIN's type-specimens, which SCHMIDT used when preparing his paper of 1885, he had evidently received from our State Museum of Natural History, from professor G. LINDSTRÖM, the then keeper of the Palæozoological Department, and it appears very improbable that the cranidium in question should at that time have belonged to the collection and been recognized as a type-specimen and been lost later on. Moreover, a catalogue of the trilobites in the collection made during the time of LINDSTRÖM's keepership and evidently not earlier than 1877 but earlier than 1885, gives only one specimen of »*Lichas depressus*» apparently referring to the pygidium ascribed to that species and still in the collection. That SCHMIDT, although he had a plaster cast, did not observe the differences between this pygidium and those from the Kuckers Formation and its likeness to other pygidia of *Conol. deflexus* (ANG.) was of course partly owing to the incompleteness of the specimen, but apparently in large part to the fact that the cast did not show

properly the characters of all the portions preserved. It could not have done, so since the specimen has not until recently been entirely laid bare. ANGE-LIN's figure is not correct.

Affinities. — As pointed out by SCHMIDT (1885, p. 96), the cranidium of this species resembles that of the considerably later *Conol. Eichwaldi* (NIESZK.) (cf. above, p. 60; below, Pl. 9, figs. 9—10) rather closely. A comparison between the diagnoses of the two species (p. 60; p. 65) shows the chief points of difference, some in addition to those already mentioned by SCHMIDT. The pygidia of the two species differ more strongly than the cranidia. SCHMIDT compared that of our form to the pygidia from the Wesenberg Formation which he ascribed to *Amphilichas Holmi* (SCHMIDT) and which evidently belong to a species of *Conolichas* (cf. above p. 64). SCHMIDT's figures of those pygidia (1885, Pl. 6, figs. 16—17) indicate that the originals have not quite the same characters. Both seem, however, to differ decidedly in several features from that of our considerably earlier species, and a closer comparison seems unnecessary. The pygidium of *Conol. deflexus* (ANG.) (cf. above, p. 52 and Pl. 6, figs. 5—8) is also markedly different. The rachis is more gently convex; the pleural portions slope less steeply downwards laterally; the two anterior pairs of pleurae have longer pleural furrows and their free ends point inwards; the third pair of pleural furrows is connected with the out-bent ends of the dorsal furrows by distinctly impressed grooves; and the tuberculation is coarser.

Horizons and Localities. — Lower Chasmops Limestone. — Södermanland: Ringsö (in boulders).

Kuckers Formation (C₂). — Esthonia.

Conolichas angustus (BEYRICH, 1846)?

Pl. 7, fig. 7.

1902. *Lichas* sp. WIMAN, p. 170, Pl. 5, fig. 10.

Remarks. — The fragment of a pygidium from the Borkholm Formation of the Middle Baltic Area mentioned and figured by WIMAN (1902, p. 170, Pl. 5, fig. 10) as *Lichas* sp. seems to represent a species of *Conolichas* and it appears probable that it belongs to *Conol. angustus* (BEYR.), which species in the East Baltic Area occurs in the Borkholm (F₂) as well as in the Lyckholm (F₁) Formation. The specimen only shows the greater part of the rachis and the inner anterior portion of one of the pleural lobes; as far as it is preserved, it appears to agree well in characters with the pygidium which ROEMER (1861, p. 76, Pl. 8, fig. 8 b), probably correctly, referred to this species, and with those figured by SCHMIDT (1885, Pl. 6, fig. 10; 1907, Pl. 2, fig. 14; text-fig. 3) which also seem to belong to it (cf. below). The other species of *Conolichas* known from the East Baltic Area, e. g. *Conol. Eichwaldi* (NIESZK.), to which this specimen might otherwise with equally good reason have been attributed, are from lower horizons.

As previously pointed out by me (1925, p. 256) the pygidia which SCHMIDT in 1907 (p. 26, Pl. 2, fig. 14, text-figs. 3, 12) attributed to *Amphilichas lineatus* (ANG.)¹ do not belong to a species of *Amphilichas*, but evidently to *Conolichas*. One of the specimens, from the Wesenberg Formation (E), which SCHMIDT (1907, p. 101, text-fig. 12) with some hesitation referred to the same species as the others, seems to differ in some characters, and may represent a distinct species. The others appear to belong to *Conol. angustus*. Cranidia of that species have been found at the same localities as two of these pygidia. The incomplete pygidium referred to *Conol. angustus* by ROEMER (1861, p. 76, Pl. 8, fig. 8 b; SCHMIDT, 1885, p. 108) seems, to judge from the figure and as far as it is preserved, to agree rather closely with SCHMIDT's specimens. SCHMIDT (1885, p. 108) (also judging from ROEMER's figure) pointed out its close likeness to the pygidium of *Conol. Eichwaldi* (NIESZK.), and the pygidia in question are also very like the pygidium of *Conol. Eichwaldi*, except as regards the marginal parts, and these are not preserved in ROEMER's specimen.

The pygidia seem further to be very like the pygidium of the form represented by entire specimens from the Dufton Shales near Melmerby in England, and described by REED (1907, p. 396, Pl. 17, figs. 1—7, text-fig.) as *Lichas (Homolichas) melmerbiensis*. It appears quite likely that REED's species is identical with *Conol. angustus* (BEYR.). REED (op. cit. p. 399) says that »the general characters of the head-shield ally this form very closely to *L. angusta*,» and that »the hypostome of *L. angusta* seems to be practically identical, so far as» that of the English form »is known». His chief reason for making his form a new species seems to have been his belief — based on SCHMIDT's statement — that the pygidium of *Conol. angustus* was more like that of *Conol. Eichwaldi*.

Horizon and Locality. — Borkholm Formation (F₂). — In boulder from the Middle Baltic Area found at Öjle Myr in Gotland.

Conolichas? oelandicus (ANGELIN, 1854).

Pl. 3, fig. 11.

1854 & 78. *Lichas oelandicus*, ANGELIN, p. 71, Pl. 36, fig. 10.

Remarks. — This species was founded by ANGELIN on a pygidium (R.M. Ar. 2187) from the Asaphus Limestone of Öland, of which the more precise locality is unknown. The specimen, which shows the hollow inside of the test, is incomplete; the posterior edge is damaged and the greater part of one of the pleural lobes and the distal portion of the anterior pleura of the other are lacking.

¹ One of the specimens SCHMIDT had earlier 1885 (p. 52, Pl. 6, fig. 10) ascribed to *Amphil. laevis* (EICHW.), but he came later to the conclusion that EICHWALD's species was identical with ANGELIN's, which, however, there appear to be strong reasons to doubt (cf. below under *Amphil. lineatus*). The figure of the pygidium then given — and generally reproduced as representing the typical *Amphilichas* pygidium — is a reconstruction and, according to SCHMIDT (1907, p. 26) himself, not correct.

Since the holotype only shows some of the characters of the pygidium, and no other specimens referable to this species have been recognized, it has not been possible to determine its true generic position. The pygidium differs very decidedly from the pygidia of the other members of the family Lichidae that are known from the Swedish Asaphus Limestone, and cannot be referred to the same genus (*Lichas* s. str.) as those. It shows several characters recalling the *Hoplolichas* pygidium, but the basal pair of pleurae have well-developed, nearly median pleural furrows, so that it cannot be placed in that genus, and its affinities appear to be rather with the species of *Conolichas*.

The rachis is moderately convex with rounded apex, its length about equalling the frontal width; it tapers posteriorly, and is rounded and indistinctly defined behind; anteriorly it is marked by two ring furrows, of which the second is incomplete in the middle. The dorsal furrows are rather narrow, relatively deep, converging posteriorly, slightly bent in at the sides of the rachis, and continued behind it to the marginal border bounding the tapering post-rachial piece, which has a convex surface sloping downwards posteriorly.

The pleural lobe has a sub-triangular, posteriorly tapering, flattened area in front next the dorsal furrow, and outside and behind this area the surface slopes rather gently downwards: posteriorly, at least, the marginal part has a more gentle slope, forming a moderately wide marginal border, which is continued behind the post-rachial piece and is marked off by a weak groove. (Anteriorly the marginal parts are not preserved). The three pleurae are marked by rather narrow, moderately deep pleural furrows, of which at least the two posterior die out at the marginal border. They are about as strong as the pleural furrows. The anterior pleural furrow is directed at about 65° to the sagittal line, and the following furrows are directed successively more and more strongly backwards; the second interpleural furrow, however, (possible also the anterior one, of which the distal portion is not preserved) bends rather strongly outwards at the marginal border. The pleural furrows of the basal pair of pleurae originate in the dorsal furrows at a marked, but not very great, distance from the second interpleural furrows and diverge only slightly posteriorly; the anterior and second pleural furrows originate, as usual, close to the anterior margins of the respective pleurae.

The distal portion of the anterior pleura is, as already mentioned, not preserved. The second pleura has a tapering free end, not very long, and directed more backwards than outwards. The posterior part of the marginal border — between the basal pair of pleurae — extends some distance behind the extremities of the second interpleural furrows, and postero-laterally is separated from the basal parts of the second pleural spines by sharp emarginations. The posterior edge is damaged; a small median point seems to have been present, otherwise the posterior margin seems to have been nearly straight or with a slight sigmoid curve on each side of the median point: apparently the basal pair of pleurae did not end in separate free points.

The surface of the pygidium is rather closely covered by small to medium-sized tubercles, the larger ones occurring on the pleural portions.

Horizon and Locality. — Asaphus Limestone. — Öland (Holotype R.M. Ar. 2187).

Genus *Hoplolichas* DAMES 1877.

Genotype: *Hoplolichas dissidens* (BEYRICH, 1845) [= *Lichas tricuspidatus* BEYR., 1846].

Synonyms: *Lichas* BEYRICH 1845 pars., auctt. pars. — *Lichas* (Hoplolichas) DAMES 1877, auctt. — *Hoplolichas* + *Hoplolichoides* + *Cyranolichas* PHLEGER 1936.

Diagnosis. — Cranium with complete dorsal furrows; prolonged anterior lateral glabellar furrows reaching occipital furrow, sometimes growing weak near latter; basal lateral glabellar furrows completely obsolete or represented by faint traces across posterior parts of tri-composite lateral glabellar lobes; occipital ring with simple or bifurcated median spine; occipital lobes present, well defined. Pygidium with dorsal furrows not reaching posterior margin; rachis with two ring-furrows, undefined behind, and continued by relatively wide post-rachial piece: pleural portions composed of three pairs of pleurae; two anterior pairs completely defined, furrowed, and with free terminations; basal pair posteriorly confluent with post-rachial piece, generally without pleural furrows or sometimes with traces of short weak furrows close to ends of dorsal furrows — the proximal pleural bands probably being more or less completely squeezed out — with pair of approximate free points or single median point.

Hoplolichas dissidens (BEYRICH 1845).

Pl. 8, figs. 1—3 c.

1845. *Lichas dissidens*, BEYRICH, p. 30, Pl. fig. 18.
 1846. » *tricuspidata*, BEYRICH, p. 7, Pl. 1, figs. 7 a—b.
 1852. *Metopias verrucosus*, QUENSTEDT, p. 291, Pl. 22, fig. 34—34 a.
 1858. *Lichas tricuspidatus*, BOLL (DETHLEFF) p. 161 (fide DAMES and FR. SCHMIDT).
 1858. » *Arenswaldi*, BOLL, p. 161 (fide DAMES and FR. SCHMIDT).
 1869. » " KARSTEN, p. 66, Pl. 22, figs. 6 a—b.
 1874. » *quadricornis*, STEINHARDT, p. 33, Pl. 3, fig. 4 a—b.
 1877. *Hoplolichas tricuspidata*, DAMES, p. 795, Pl. 12, figs. 1—3 a, Pl. 13, fig. 1.
 1885. *Lichas tricuspidata*, FR. SCHMIDT, p. 69, Pl. 2, figs. 12—13. ? figs. 14—16.
 ? 1888. » (*Hoplolichas*) *tricuspidata*, WIGAND, p. 59, Pl. 8, figs. 1 a—b.
 1890. » *tricuspidata*, POMPECKI, p. 45, Pl. 2, fig. 20, 21, 22, ? 24.
 ? 1890. » *affn. tricuspidate*, POMPECKI, p. 46, Pl. 2, fig. 23.
 1902. » *tricuspidatus*, REED, p. 77, text-fig. 11 a—b (copies after SCHMIDT and DAMES).
 1908. » *tricuspidata*, WIMAN, p. 89, (only the pygidium).
 1920. *Hoplolichas tricuspidatus*, FOERSTE, Pl. 4, fig. 7 b, ? fig. 7 a (copies after SCHMIDT).
 ? 1927. *Lichas* (*Hoplolichas*) cf. *tricuspidatus*, KUMMEROW, p. 34, Pl. 2, fig. 3.

Diagnosis. — Glabella slightly longer than wide, narrowing rapidly anteriorly to obtusely pointed or narrowly rounded, protruding front end, and narrowing slowly posteriorly with the hindmost portion nearly parallel sided, its width at base about five-sixths the greatest width, its posterior margin

gently arched backwards, anterior margin arched more strongly forwards; fronto-median lobe with anterior portion short-sub-conical, overhanging anterior margin, from which the surface slopes upwards to apex, and bearing two pairs of spines, neck of lobe gently convex transversely, the surface sloping gently upwards along median line from base to a little behind apex, then gently downwards to this, its width across narrowest part somewhat less than half the greatest width of lobe and slightly more than one-third entire width of glabella; tri-composite lobes nowhere broader than narrowest part of median lobe and nowhere quite reaching its level, moderately convex transversely, rather strongly convex longitudinally, with long anterior and short posterior slopes; prolonged anterior furrows well marked all the way to occipital furrow, converging rather gradually to behind middle of glabella, then very slightly for a short distance, then diverging to occipital furrow. Occipital ring sub-triangular, with simple median spine; occipital lobes rounded sub-triangular, rather strongly convex. Pygidium, excluding basal extension and free ends of pleurae, sub-semioval, with broadly rounded antero-lateral angles, the posterior portion somewhat triangular, wider than long, posteriorly with marginal border rather indistinctly marked off; rachis convex, rounded and indistinctly marked off behind; post rachial piece posteriorly without independent convexity; pleural portions sloping fairly steeply downwards laterally; free ends of two anterior pairs of pleurae directed obliquely outwards, sub-triangular, with broad bases; first pair of free ends rather short, the second ones relatively long; posterior part of marginal border extended backwards in middle, the extension forming the base of a pair of tapering, diverging spines.

Description. — Glabella somewhat pentagonal in outline, slightly longer than wide, widest a little in front of middle, narrowing rapidly anteriorly to narrowly rounded or obtusely pointed, protruding front end, narrowing slowly posteriorly with the hindmost portion nearly parallel-sided; its width at base about five-sixths the greatest width; posterior margin gently arched backwards; anterior margin, below protruding front end, more strongly, but not very strongly, arched forwards. Fronto-median lobe about one-and-a-half times as long as wide, broadest between antero-lateral extremities, narrowing posteriorly to well behind middle, and nearly opposite anterior ends of palpebral lobes, where its width is somewhat less than half its greatest width and slightly more than one-third the width of glabella, then gradually increasing in width again to base; its anterior portion short-sub-conical, overhanging anterior margin, from which the surface slopes upwards to apex; neck of lobe gently convex transversely; the surface sloping gently upwards along median line from occipital furrow — more strongly near furrow than anteriorly — to a little behind apex, then gently downwards to it. Four spines present on anterior portion of lobe; the two anterior spines placed with their bases close together, one on each side of median line where the surface begins to slope steeply downwards, rather stout and long, tapering to points, slightly diverging, directed obliquely upwards and forwards, and slightly curved in lateral aspect, the two others placed a little behind the former and more towards the sides,

more slender and, it appears, shorter and straight (their entire length not known), more strongly diverging and directed more upwards. Tri-composite lobes slightly oblique in direction, elongate, the distance between their anterior and posterior extremities being more than twice their greatest width, narrowing anteriorly and posteriorly, pointed in front, their hindmost portions (the basal lobes?) sub-quadrilateral; their proximal margins convex inwards, distal margins with gentle sigmoidal curve; moderately convex transversely, the convexity growing more gentle on the posterior portions (the basal lateral glabellar lobes?), nowhere quite reaching level of median lobe, and nowhere (at least in the specimens examined) broader than its narrowest part; rather strongly convex longitudinally, with long anterior and short posterior slopes; at least in some specimens, with a slight notch on their inner sides a little more than half way up.

Prolonged anterior lateral glabellar furrows rather broad, but not very deep — broader and deeper on casts — growing somewhat shallower next the occipital furrow, curving from their anterior points of origin at first upwards and inwards, soon bending strongly backwards, converging posteriorly to well behind middle of fronto-median lobe, then diverging to occipital furrow. Middle lateral glabellar furrows apparently represented by the notches on the inner sides of the tri-composite lobes, mentioned above. Basal lateral glabellar furrows obsolete, but their ends may, it appears, be indicated by slight bends in the prolonged anterior or dorsal furrows respectively. Dorsal furrows on casts about as strong as the prolonged anterior glabellar furrows, — on the surface of the test they appear to be narrower than the latter — with a gentle sigmoidal curve — being first arched outwards then inwards from their anterior points of origin to postero-lateral extremities of occipital lobes, then directed nearly straight backwards or a little inwards.

Occipital furrow about as strong as dorsal furrows, dividing at sides; main portion and anterior side-divisions forming a continuous curve gently convex backwards; posterior divisions running in backwardly convex curves obliquely outwards and downwards. Occipital ring sub-triangular, very broad (longitudinally) in middle and produced posteriorly into a long (incompletely preserved), stout, straight median spine which is directed obliquely upwards and is compressed from the sides, at base only slightly, more and more strongly posteriorly; two large tubercles (or small spines) — one on each side of median spine — typically present. Main portion of occipital ring gently arched transversely in middle, the slope becoming steeper laterally, side-portions, behind occipital lobes, of moderate, nearly uniform width. Occipital lobes rounded sub-triangular, rather strongly convex, and sloping steeply downwards postero-laterally.

Anterior border of cranidium bent steeply downwards in front of glabella, somewhat less steeply at sides, narrow and gently rounded in middle, widening and flattening at sides, indistinctly defined from adjacent portions of fixed checks, well defined from glabella by broad, rather shallow furrow; its anterior margin with a moderate and rather even forward convexity in front of glabella,

beyond this bending more outwards with the outermost portions (which are not well preserved in any of the specimens examined) apparently directed straight outwards or obliquely forwards and meeting anterior branches of facial sutures at acute angles.

Fixed cheeks with both anterior and posterior portions sloping steeply downwards from above palpebral lobes; anterior portions of moderate length and width, widest at about one-third the distance from anterior border to anterior extremities of palpebral furrows, gently or moderately convex transversely: posterior portions relatively narrow, sub-triangular, the surface gently convex from side to side proximally, becoming flattened distally behind palpebral lobes. Palpebral lobes narrow, sub-crescentic, placed far back, marked off by strong furrows, of which the anterior and posterior branches meet at slightly acute angles. Posterior borders of fixed cheeks narrow, with the surface curving downwards posteriorly next the dorsal furrows, rapidly increasing in width and becoming flattened laterally, marked off by very shallow furrows. Anterior branches of facial sutures running from palpebral lobes nearly straight forwards and downwards about two-thirds the way to anterior border, then obliquely inwards to this, and then nearly straight forwards (and slightly downwards) again; posterior branches running from palpebral lobes obliquely downwards, outwards, and backwards.

(Rostral shield, labrum, and thorax not recognised).

Pygidium, not including basal extension and free ends of pleuræ, sub-semioval with posterior portion somewhat triangular, wider than long (with broadly rounded antero-lateral angles). Rachis convex, extending about two-fifths the length of pygidium, the length about equalling the anterior width, rather slowly tapering posteriorly (rounded and indistinctly defined behind), marked anteriorly by two rachial ring-furrows. Dorsal furrows of moderate strength, continued beyond rachis to »marginal border», bounding the post-rachial piece, which posteriorly is without independent convexity; converging posteriorly for the greater part of their length, but curving rather strongly outwards near extremities.

Pleural portions of pygidium with a slight flattening in front close to dorsal furrows, beyond this sloping downwards laterally and posteriorly, the lateral slope the stronger, the marginal portions, above the doublure, mostly with gentler slope and thus forming a sort of broad marginal border partly marked off by rather shallow grooves; consisting of three pairs of free ending pleuræ, second pair the broadest (marginal portions of basal pair not considered). Anterior two pairs of pleuræ marked by narrow (on casts relatively wide), rather deeply impressed pleural furrows, ending on or at inner margin of marginal border, and defined posteriorly by about equally strong interpleural furrows. Basal pair of pleuræ posteriorly confluent with median portion of border, without pleural furrows [or, apparently, with traces of such furrows adjacent to posterior extremities of dorsal furrows (cf. DAMES, 1877, Pl. 13, fig. 1, SCHMIDT, 1885, p. 73, WIGAND, 1888, p. 64)]. Anterior pleural and interpleural furrows very gently convex forwards and only slightly diverging,

the latter (in our specimen and in the figure of the holotype) directed at about 65° to median line of pygidium, but near margin bending more outwards. Second pleural and interpleural furrows successively directed more backwards, the former nearly straight, the latter straight and (in our specimen) directed at about 27° to median line of pygidium for the greater part of its length, bending rather strongly outwards at inner margin of border [or, according to some of the figures of other specimens, on the border]. Pleural bands of anterior two pairs of pleuræ raised and rounded. Surface of second pleuræ flattened on border parts anteriorly and on free ends; in continuation of posterior pleural bands, the surface is gently raised also on border parts, the raised portions ending in obtuse points on (or just inside) margin at extremities of second interpleural furrows. Free ends of second pair of pleuræ directed obliquely backwards, rather long [longer than those of anterior pair, elongated sub-triangular in outline; free ends of anterior pair directed obliquely outwards and backwards, sub-triangular and rather short, reaching to a line about half-way between end of rachis and posterior extremities of dorsal furrows]. Anterior portions of basal pair of pleuræ with raised and rounded surfaces, separated from border parts by shallow grooves which unite the out-turned extremities of the prolonged dorsal furrows with the second interpleural furrows. Posterior part of marginal border, between second interpleural furrows, with slight independent convexity, extended backwards in middle; the extension, which has about the same width as the posterior part of the rachis, forming the base of a pair of [rather short] relatively narrow, tapering, diverging spines.

Surface of cranium and pygidium with scattered, large, subconical tubercles, between which are similar but smaller tubercles of various sizes, while fine granules also occur both between and on the tubercles. One especially large tubercle is placed on the inner part of the hindmost portion (the basal lobe?) of each of the tri-composite glabellar lobes a short distance in front of the occipital furrow, close to the furrow is another generally considerably smaller tubercle, and a little in front of the large tubercle are two fairly conspicuous ones; on the middle and anterior portions of the lobes only medium-sized and small tubercles are found. On the fronto-median lobe there is a large tubercle on each side near the postero-lateral angles, other large ones occur along the back of the lobe and in front and at the sides of the anterior spines. Inside the palpebral lobes on the fixed cheeks there are also a few fairly large tubercles, one of them at the angle made by the branches of the palpebral furrow, one at the angle between this furrow and the dorsal furrow; another rather conspicuous tubercle occurs on the anterior portion of the fixed cheek about half-way between the palpebral lobe and the anterior border. On the posterior edge of the occipital ring is a fairly large and rather conspicuous tubercle on each side almost directly behind the large tubercle on the tri-composite lobe [at the base of the median occipital spine is also a large tubercle], On the pygidium there are scattered large tubercles; on the pleural bands chiefly placed along the median lines.

Dimensions. — The dimensions of two cranidia (a/ S.G.U. sp. Pl. 8, fig. 2, b/ R.M. Ar. 2193) are: sagittal length (occipital spine excluded) approximately a/ 31 mm., b/ 28 mm.; width between palpebral lobes a/ 31 mm., b/ 28 mm.; glabella — length a/ 25 mm., b/ 23 mm., greatest width a/ 22.6 mm., b/ (approximately) 21.5 mm., basal width a/ 19 mm., b/ (approximately) 18 mm.; fronto-median lobe — greatest width a/ 16 mm., b/ 15 mm. (14 without the test), least width a/ 7 mm., b/ 6.5 mm., basal width a/ 11 mm., b/ 10 mm.; tri-composite lobes — distance between anterior and posterior ends a/ 16 mm., b/ 13.5 mm., width (greatest) across middle a/ 6.5 mm., b/ 6.1 mm.; length of one of the anterior frontal glabellar spines b/ on the inside 8.5 mm., on the outside 9.5 mm. In a fragmentary pygidium (U.M.) the sagittal length is approximately 29 mm.; the width in front of the second pair of pleural spines, approximately 37 mm.; and the anterior width of the rachis 12 mm.

Remarks. — That the pygidium described and figured by BEYRICH in 1845 (p. 30, Pl. fig. 18) as *Lichas dissidens* and the cranidium described and figured by him in the following year (1846, p. 7, Pl. 1, figs. 7 a—b) as *Lichas tricuspidata* belong to the same species — as pointed out by DAMES in 1877 — seems to be established beyond reasonable doubt. DAMES and later writers have used the name *tricuspidata(us)* originally proposed by BEYRICH for the cranidium, but according to the nomenclature rules the trivial name must be *dissidens*, since BEYRICH had earlier given this name to the pygidium and adequately described and figured this (the holotype).

In Swedish collections this species is represented by one cranidium in the State Museum of Natural History (Ar. 2193), two cranidia in the Museum of the Geological Survey, and one pygidium in the Upsala Museum. The latter is a boulder specimen (from the North Baltic Area) found at Söderön in Upland.¹ The cranidia are all from Öland. One of them is said on the label to have come out of a loose block, but it seems probable that this was derived from the solid rock of the neighbourhood (Gärdslösa), it need not mean that it had been transported from distant parts. All the specimens are from the Chiron limestone. None of them is complete, but all distinctly show typical characters of the species and agree well with the figures and descriptions of specimens found in boulders in North Germany.² All the cranidia bear clear evidence of the four typical frontal spines; either the spines themselves or parts of them are preserved, or the scars are distinct. Only in one of the specimens (Pl. 8, fig. 2) is the great occipital spine preserved, and then only for a part of its length. At its base the surface is damaged both dorsally and laterally (ventrally the test is preserved) and the side-spines or large side-

¹ WIMAN in 1908 (p. 89) also recorded a cranidium from Kragsta in Upland, but this belongs to *Hoplol. proboscideus*. Its anterior portion was at that time partly hidden in the rock; it has since been prepared and is figured below, Pl. 8, fig. 6.

² In the North German boulders the species seems also frequently to be associated with *Iliaenus Chiron* HOLM (= *Ill. centaurus* DALM.) (cf. DAMES, 1877, p. 799); DAMES stated also that it was associated with *Asaphus expansus*, but to that species a multitude of specimens from different horizons have been referred and SCHMIDT pointed out as late as 1907 (p. 67) that so far not a single typical *Asaph. expansus* had been discovered (»nachgewiesen») in the North German boulders).

tubercles are not preserved; the position of the left one is, however, just discernible.

The above description is chiefly based on the Swedish material; those parts of the description (between brackets) which deal with portions not preserved in any of our specimens are based on the descriptions and the figures given by BEYRICH (1845, 1846), DAMES (1877), and SCHMIDT (1885) — on SCHMIDT'S description only as far as it deals with typical specimens from North German boulders and only on his figures of such specimens (fig. 12—13 on his Pl. 2).

DAMES (1877, pp. 796, 798, 801) stated that the large tubercle on the narrow hindmost portion of the tri-composite lateral glabellar lobe (the anterior lateral lobe, according to his terminology) was distinctly marked off from the other part of the lobe by a shallow groove, and he considered this an important feature distinguishing this species from *Hoplol. proboscideus* DAM. In the text he stated (pp. 798, 801) that the tubercle was surrounded by the groove, but in his figure 1 on Pl. 12, showing these portions, a groove is indicated only in front of it. These »grooves» in front of the large tubercles have also been mentioned by other writers or indicated in the figures given by them. SCHMIDT (1885, p. 70) referred to them as weakly indicated depressions, representing the basal lateral glabellar furrows (the median lateral glabellar furrows of his terminology).

In the specimens examined by me, the hindmost portion of the tri-composite lateral glabellar lobe, which portion seems to represent the basal lateral lobe, is, as mentioned in the description, flatter than the rest of the lobe (= the bi-composite lobe) and its surface slopes backwards posteriorly. The same presumably is the case in all other specimens. The large, conspicuous tubercle is placed on its inner anterior part; behind it on the posterior edge is another fairly large one. There are also a few tubercles on the proximal edge, and two or three (two generally fairly large ones) in front of the large one on »the posterior edge of the bi-composite lobe». These smaller tubercles are not as a rule placed quite close to the large one. Since the specimens are casts and show no granules, the smooth space around the large tubercle naturally gets more or less the appearance of a groove although it is not really impressed. In two of the specimens it is more groove-like behind and posterolaterally to the large tubercle than in front of it. In the third specimen the difference in the degree of convexity between the posterior part of the »bi-composite» lobe and the »basal lateral glabellar lobe» is relatively great, and the change more distinct than in the other two, and naturally the smooth portion in front of the large tubercle looks in this more like a groove. Quite likely the change in the degree of convexity is still more distinct in some of the foreign specimens (cf. SCHMIDT, 1885, Pl. 2, fig. 12), but it seems hardly probable that there is present a really impressed groove or furrow. In *Hoplol. proboscideus* the »bi-composite lobe» is more gently convex and in that species the »groove» in front of the tubercle seems always to be indistinct or absent (cf. below p. 93).

The cranidia and the pygidium from the East Baltic Area which SCHMIDT (1885, Pl. 2, figs. 14—16) referred to this species do not seem to agree in all characters with the typical form, as SCHMIDT himself pointed out expressing his suspicion that it might prove necessary to refer them to a distinct variety. — »es wird sich jetzt nur noch die Frage erheben, in wie weit die von mir zu dieser Art gerechneten Stücke des Ostbaltischen Gebiets mit den typischen deutschen Geschiebeexemplaren identisch sind und ob ich für unsre Form nicht am Ende eine Varietät aufstellen muss, da ich zwei der von DAMES in seiner Beschreibung angeführten Kennzeichen, die starke Vorwölbung des Mittellappens der Glabella und die vier Hörner auf dem Vordertheil derselben nach meinem Material nicht in gleichem Maasse für unsre Stücke als charakteristisch ansehen kann, wobei ich freilich berücksichtigen muss, dass der Vordertheil des Mittellappens an unsern Stücken selten vollständig erhalten ist». (SCHMIDT, 1885, p. 70). »Bei unsern estländischen Exemplaren habe ich nur einmal die beiden Mittelhörner» (the anterior pair of spines) »constatieren können» (p. 72). It seems (though this is not clearly expressed) as if he had not been able to ascertain the presence of the second pair of spines or of the characteristic large tubercles on the posterior portions of the tri-composite lateral glabellar lobes in any of his specimens, nor are these portions indicated in his figures. — Regarding the pygidia he stated (p. 73): »Der . . . hintere Theil der zweiten Pleure» »tritt an seinem Hinterrande in einem Bogen vor, der am Beginn des Randsaums am stärksten vorspringt. Dieser Vorsprung erscheint viel stärker ausgeprägt bei den Geschiebeexemplaren (F. 13) als bei unsrem estländischen (F. 16).»

These statements and the figures given by SCHMIDT suggest that the differences may be rather important. Perhaps the East Baltic form should be removed from this species and made a new species. The figures indicate some differences not mentioned by SCHMIDT in the text. The anterior outline of the fronto-median glabellar lobe seems to be more broadly rounded than in the typical form and both on the cranidium and on the pygidium there appears to be a greater number of medium-sized tubercles; the free ends of the second pair of pygidial pleurae seem to have been relatively shorter and the posterior outline of the pygidium to have been more broadly rounded. The figure of the pygidium gives the impression that the posterior portion of the doublure (the dorsal test of this portion is lacking) is nearly entire on the left side. If this really is the case, the marginal border is not prolonged in the middle into an extension forming the base of the posterior pair of free spines as in *Hoplol. dissidens* but these spines are quite differently placed, and anyhow the course of the rugæ on the doublure, as given in the figure, indicates a more broadly rounded outline, as we must assume them to run subparallel to the margin in this as in other forms (cf. the figure of the holotype, BEYRICH, 1845, Pl. fig. 18).

Various cranidia, from boulders found in Mecklenburg were referred by WIGAND (1888, p. 59 et sqq.) to this species, and concerning two of them he stated (p. 62) that the four spines or long tubercles on the fronto-median

lobe were lacking. These specimens are not figured, and it is not quite clear whether he meant that such spines or tubercles were distinctly absent, or only that they were not discernible, but might originally have been there. If the former is the case it appears possible, even probable, that these specimens belong to the same form as the East Baltic ones.

Concerning a third cranidium, of which WIGAND (1888, Pl. 8, figs. 1 a—b) gave two figures, he stated (p. 62) that there were three spines present, preserved with their test, the largest being exactly in the middle and directed forwards and upwards, the two smaller ones on the left side and placed nearly on the same horizontal line («auf ziemlich gleicher Höhe») — the figure shows them situated a little behind the median spine — and further that on the right side the bases of the two spines that would have corresponded were not discernible; but that there was present an obliterated stump of a rather large tubercle. The outermost of the »spines» on the left side, which, as seen on the figure, is much larger than the other, evidently corresponds to one of the posterior frontal spines in typical specimens, and presumably its fellow on the right side is represented by the »obliterated stump of a rather large tubercle». It is not quite inconceivable that the smaller inner »spine» represents the left anterior frontal spine in typical cranidia, but that for some reason it has been reduced, pushed a little backwards, and partly displaced by the right anterior spine — the anterior spine in the specimen, which in the figure is not placed exactly in the middle but a little towards the right. Since, however, WIGAND specially stated that this spine was placed exactly in the middle, it seems probable that the figure is not correct in this respect, and it appears most likely that the small, inner »spine» on the left side is only a well-preserved large tubercle, and that this cranidium only possessed three frontal spines, one anterior median one and a pair of posterior ones. This would be in accordance with *Hoplol. proboscideus* DAMES (cf. below p. 87, Pl. 8, figs. 6—7 b), but the median spine is of much smaller size than in that species and WIGAND's specimen differs from it also in other characters, viz. the relative width of the neck of the fronto-median lobe and the shape of the occipital ring, in both of which it agrees with typical cranidia of *Hoplol. dissidens*. Most probably it represents a distinct variety of the latter species.

WIGAND (1888, p. 63) also described some fragmentary pygidia as belonging to this species. It seems as if the specimens were too fragmentary to be referred with certainty to the typical form, but at any rate they appear to belong to a closely related form. One of them is of especial interest, since in it, according to the description, on the third pleura a furrow, apparently the pleural furrow, is distinctly to be seen originating in the dorsal furrow a little in front of its blind end and dividing the anterior portion of the pleura (in front of the marginal border) into a trapezoidal distal (anterior) part and a smaller rounded sub-triangular proximal (posterior) part, thus having the same course as the furrows in the pygidium of this species figured by DAMES (1877, Pl. 13, fig. 1). According to SCHMIDT (1885, p. 73) faint traces of this third pleural furrow are present also in the East Baltic pygidium which he

with some hesitation referred to this species (cf. above, p. 82), and likewise (SCHMIDT, 1885, p. 79, Pl. 2, fig. 24) in a pygidium of *Hoplol. Plautini* SCHMIDT described and figured by him.

Whether the fragmentary free cheek, which POMPECKI (1890, p. 45, Pl. 2, fig. 24) hesitatingly referred to this species, really belongs to it cannot of course be decided, but it appears quite likely, since it seems to agree with the cranidia and the pygidia in the tuberculation of the surface and shows other characters that might be expected, and since this species seems to occur more frequently in North German boulders than any of the others to which it might conceivably belong. It is also quite probable that the fragmentary cranidium described and figured by POMPECKI (1890, p. 46, Pl. 2, fig. 23) as *Lichas affn. tricuspidae* BEYR. [*Lichas tricuspidatus* BEYR. = *Hoplol. dissidens* (BEYR.)] belongs to this species, although it seems to be too fragmentary to enable one to decide this definitely. The features in which it is said to differ from typical cranidia do not seem important. One of them is that the prolonged anterior glabellar furrows grow suddenly very shallow for a short part of their course in front of the narrowest portion of the fronto-median lobe, instead of being of the same depth throughout. This is a feature, which, so far as I know, is not found in any normally developed or preserved Lichidae, and it is apparently an abnormality, or is only owing to the state of preservation; the figure suggests that only one of these furrows was preserved. Further, there are on the hindmost portion of the tri-composite glabellar lobe two large pointed tubercles placed behind one another and separated by a shallow depression. This is not really a difference from other cranidia of *Hoplol. dissidens*; both these tubercles seem, at least as a rule, to be present¹, but the posterior one is, generally, much smaller than the other and they are placed closer together than in POMPECKI's figure. Their relative size varies a little both in this species and in *Hoplol. proboscideus* in which species also they are present. There are no other tubercles between them, and since the surface slopes downwards posteriorly the smooth interspace naturally appears as a depression, especially when the hindmost of the two tubercles, as well as the anterior one, is of considerable size and occupies the whole or the greater part of the edge of the lobe. Finally POMPECKI mentioned the presence of a small tubercle in the posterior part of the prolonged anterior glabellar furrow as a feature indicating relationship with *Hoplol. proboscideus*. To judge from the figure, the tubercle does not seem to be right in the furrow, but to be placed low down on the lateral slope of the median glabellar lobe and protruding into the furrow. The same feature appears to be present in the lectotype of *Hoplol. proboscideus* (DAMES, 1877, p. 801, Pl. 12, figs. 4—4 a), but it is found also in some typical cranidia of *Hoplol. dissidens* (cf. below Pl. 8, fig. 3 a), while in other specimens of both species the tubercles

¹ The bases of the posterior as well as those of the anterior of these tubercles are as a matter of fact shown in the figure given by SCHMIDT (1885, Pl. 2, fig. 12) and copied by POMPECKI (1890, Pl. 2, fig. 20).

are not placed quite as low down or protruding as much in to the furrows (cf. below p. 92).

The pygidium described and figured by KUMMEROW (1927, p. 34, Pl. 2, fig. 3) as *Lichas (Hoplolichas) cf. tricuspидatus* BEYR. differs, as stated by him, in some respects from the typical pygidia of *Hoplol. dissidens (=tricuspидatus)*. It was found in a boulder and came from a lower horizon (B₂) than the type form of this species, and, as KUMMEROW himself pointed out, it seems to represent at least a distinct variety. KUMMEROW compares it to the pygidium from a North German boulder figured by SCHMIDT (1885, Pl. 2, fig. 13) and states that it differs in the characters of the second pair of pleural spines, which are directed straight backwards instead of continuing in the same direction as the inner portions of the pleuræ. He says also that these spines are considerably longer and narrower, but, to judge from the figures, the difference in this respect seems to be very slight. Moreover, in the figure of the holotype (BEYRICH, 1845, Pl. fig. 18) the spines are both longer and narrower: In KUMMEROW's specimen, as figured, they give the impression of being longer, this, however, is not due to their own actual length, but to the fact that the median portion of the pygidium is less produced posteriorly than in typical pygidia of the species, the margins of the basal pair of pleuræ, from the bases of these spines to the median extension bearing the basal pair of spines, being directed more inwards and the basal extension itself, apparently, being shorter. The differences seem hardly to be of specific importance, but quite likely the cranidium differs more, and it may prove necessary to make the form a new species.

Affinities. — The affinities of this species seem to be with *Hoplol. Plautini* SCHMIDT (SCHMIDT 1885, p. 75, Pl. 2, figs. 17—24), *Hoplol. proboscideus* DAM. and *Hoplol. longispinus* SCHMIDT. (SCHMIDT 1885, p. 75, Pl. 2, fig. 25). The characters in which it differs from the species first named have been pointed out by SCHMIDT and need not be repeated here; its relation to *Hoplol. proboscideus* will be discussed below under that species.

Of *Hoplol. longispinus* only the pygidium is known, and of this, as far as the writer is aware, only a single specimen from the East Baltic Kuckers formation (C₂). SCHMIDT who originally (1885) seems to have been more inclined to believe that it represented a new species, came later (1907, p. 39) to the conclusion that it ought to be regarded as only a variety of *Hoplol. dissidens*. To judge from his description and figure, it seems, however, to differ rather markedly from the pygidia of that species and since it, moreover, is from a higher horizon, it appears to me probable that it really represents a distinct species. A difference not pointed out by SCHMIDT, but shown in the figure (which I assume to be correct), and apparently important, is that the basal pair of pleuræ are placed much farther apart and do not form the continuation of a relatively narrow, undivided median extension of the marginal border.

Horizons and Localities. — Chiron Limestone. — Öland: Lerkaka, Kråketorp, Gärslösa (loose block). — Uppland: in boulder from Mälby (Söderön).

?Echinosphærite Limestone (C_{1a}, C_{1b}). — ?East Baltic Area: several localities.

Grey Orthoceras Limestone (?Chiron Limestone, ?Etage C₁). — In boulders at several different localities in North Germany. (Holotype, pygidium, original of BEYRICH 1845, Pl. fig. 18)

Hoplolichas proboscideus DAMES.

Pl. 8, figs. 4—7 b.

1874. *Lichas quadricornis* var., STEINHARDT, p. 34, Pl. 3, fig. 5.
 1877. *Hoplolichas proboscidea*, DAMES, p. 800, Pl. 12, figs. 4—4 a, Pl. 13, figs. 2—3 (non fig. 4).
 1888. *Lichas* (*Hoplolichas*) aff. *proboscidea*, WIGAND, p. 64, Pl. 8, fig. 2—3 b.
 1908. » *tricuspidata*, WIMAN, p. 89 (pars, cranidium only).
 1908. » *proboscidea*, WIMAN, p. 108 (pars).
 1927. » (*Hoplolichas*) *proboscideus*, KUMMEROW, p. 35, Pl. 2, fig. 4.

Diagnosis. — Glabella about six-sevenths as long as wide, rapidly narrowing anteriorly to rather narrowly rounded, protruding front end, tapering more gradually posteriorly, its width at base about three-fourths the greatest width, its posterior margin arched slightly backwards, anterior margin arched rather strongly forwards; fronto-median lobe very slightly convex in both directions posteriorly, the convexity increasing anteriorly, steeply curved downwards in front and overhanging anterior margin, on its apex a stout, long median spine, and a little behind a small spine on each side of this; its width across narrowest part about one-third the greatest width and less than one-third the width of entire glabella; tri-composite lobes across broadest portions distinctly wider than median lobe, nowhere quite reaching its level, gently convex transversely, but with the surfaces sloping rather steeply downwards laterally, rather strongly convex longitudinally, the anterior slope the longest and rather steep, posterior slope gentle; prolonged anterior furrows well marked all the way to occipital furrow, converging strongly to about middle of glabella, then gently for some distance, then diverging to occipital furrow; occipital ring with posterior margin slightly arched backwards, with simple median spine; occipital lobes rounded sub-triangular, rather strongly convex. [¹Pygidium, excluding free ends of lateral and median spines, sub-trapezoidal with truncate antero-lateral angles, much wider than long, posteriorly with marginal border indistinctly marked off; rachis rather strongly convex, rounded and indistinctly defined behind; pleural portions sloping rather steeply downwards laterally; free ends of second pair of pleurae (those of first pair not known) long, broad at base but rapidly tapering so as to become very narrow in their hinder half and sharply pointed, directed nearly straight backwards, or only slightly outwards; posterior part of marginal border prolonged into a relatively broad median spine, on each side of which the margin describes a sigmoid curve.]

¹ It is not absolutely certain that the pygidium in question belongs to this species, but it seems more than likely.

Description of Swedish specimens. — Glabella sub-pentagonal, about six-sevenths as wide as long, widest some distance in front of middle, rapidly narrowing anteriorly to rather narrowly rounded front end, tapering more gradually posteriorly; width at base about three-fourths the greatest width; posterior margin arched slightly backwards; anterior margin rather strongly arched forwards. Fronto-median lobe nearly one-and-a-half times as long as wide, widest between antero-lateral extremities, narrowing posteriorly to nearly opposite anterior ends of palpebral lobes, where its width is about one-third its greatest width and less than one-third the width of entire glabella, then gradually increasing in width again to base; very slightly convex in both directions posteriorly, the convexity increasing anteriorly, steeply curved downwards in front, with the front end protruding and overhanging front margin; on apex a stout spine — in one specimen, where it is perfectly preserved — about as long (measured along the curvature) as the portion of the lobe lying behind it, nearly circular in section at base, then becoming compressed from the sides and tapering to a point, nearly straight for about half its length and directed obliquely forwards and upwards, then curving more strongly upwards, so that the tip points nearly straight upwards; a pair of much smaller, nearly straight, elongated sub-conical, pointed spines are placed one on each side and a little behind the large median spine; they are slightly divergent and directed more upwards than the basal half of the median spine. Tri-composite lobes slightly oblique in direction, elongate, the distance between their anterior and posterior extremities being more than twice their width, across broadest portion distinctly wider than narrowest portion of median lobe, narrowing anteriorly and posteriorly, pointed in front; their proximal margins convex inwards, distal margins with gentle sigmoid curve; gently convex transversely, but with the surfaces sloping relatively steeply downwards to dorsal furrows; nowhere quite reaching level of median lobe; rather strongly convex longitudinally, the anterior slope the longest and rather steep, posterior slope gentle.

Prolonged anterior lateral glabellar furrows moderately deep (deeper on casts), rather broad, converging strongly posteriorly to about middle of glabella, then gently for some distance to opposite anterior portions of palpebral lobes, then diverging to occipital furrow. Dorsal furrows about as wide as, but somewhat shallower than prolonged anterior glabellar furrows, with gentle sigmoid curve from their anterior points of origin to beyond occipital lobes — first arched outwards, then inwards — outside main portion of occipital ring growing much narrower and bending a little inwards.

Occipital furrow about as strong as dorsal furrows, dividing at sides; main portion and anterior side-divisions forming a continuous curve, very gently convex backwards; posterior divisions rather narrower than other portions, curving backwards, outwards, and downwards. Occipital ring rather broad, with the posterior margin slightly arched backwards and bearing on its posterior edge a stout median spine (incompletely known), and at each side of this a large conical tubercle. Main portion of occipital ring very gently arched

transversely in middle, the slopes growing steeper laterally, side portions behind occipital lobes rather wide and of nearly uniform width. Occipital lobes rounded-sub-triangular, rather strongly convex, sloping steeply downwards postero-laterally.

Anterior border of cranium bent steeply downwards in front of glabella, somewhat less steeply at sides, very narrow and gently rounded in middle, widening and flattening at sides, indistinctly defined from adjacent portions of fixed cheeks, well defined from glabella by broad, rather shallow furrow; its anterior margin with a moderate and rather even forward convexity in front of greater part of glabella, at sides bending more outwards, and close to facial sutures suddenly a little forwards to meet their out-bent ends at an acute angle.

Fixed cheeks with both anterior and posterior portions sloping steeply downwards from above palpebral lobes; anterior portions of moderate length and width, widest at about middle, gently convex transversely; posterior portions sub-triangular, relatively narrow, gently convex from side to side proximally, becoming flattened distally behind palpebral lobes. Palpebral lobes narrow, sub-crescentic, placed far back, marked off by strong furrows, of which the posterior and anterior branches meet at slightly acute angles. Posterior borders of fixed cheeks of moderate width, widening laterally, with the surface next the dorsal furrow gently rounded and sloping posteriorly, becoming flattened and more horizontally extended laterally, marked off by shallow furrows. Anterior branches of facial sutures sigmoidally curved, forming outwardly convex curves from palpebral lobes to anterior border and in their general direction converging, then curving more forwards and finally obliquely outwards; posterior branches running from palpebral lobes obliquely downwards, outwards, and backwards.

(Fixed cheeks, rostral shield, labrum, and thorax not recognized.)

Pygidium (probably belonging to this species; imperfectly preserved), excluding free ends of pleuræ and median spine, sub-trapezoidal with truncate antero-lateral angles, apparently about twice as broad as long. Rachis rather strongly convex, extending about half the length of pygidium, the length about equalling the anterior width, rather strongly tapering posteriorly, rounded and indistinctly defined behind; anteriorly with two well-defined, raised, and rounded rings; its posterior undivided portion with sides gently convex outwardly. Dorsal furrows of moderate strength, continued beyond rachis to »marginal border», bounding the post-rachial piece; converging posteriorly for the greater part of their length, but curving obliquely outwards near extremities.

Pleural portions of pygidium with a flattened, subtriangular area in front next the dorsal furrows, beyond this sloping downwards laterally and posteriorly, the lateral slope rather strong, the posterior slope more gentle; the marginal portions, above the doublure, with more gentle slope than proximal portions and thus forming a sort of marginal border (continued behind post-rachial piece), which is partly marked off by shallow grooves. Anterior two pairs of pleuræ with free ends, marked — even on casts — with rather narrow, but deep

pleural furrows ending at marginal border, and defined posteriorly by about equally strong interpleural furrows. Basal pair of pleuræ posteriorly confluent with median part of marginal border, without pleural furrows, and without separate free ends. Anterior pair of pleuræ rather narrow, considerably narrower than second pair, increasing relatively rapidly in width to the fulcrum, which is rather indistinct and situated at a distance from rachis about equalling two-thirds the anterior width of this; beyond fulcrum only very slowly increasing in width to border, then growing narrower (free ends not preserved); the pleural furrows gently convex forwards, their general direction at about 70° to sagittal line. Anterior interpleural furrows somewhat more strongly convex forwards than anterior pleural furrows and diverging slightly from them, but at inner margin of border bending more outwards. Second pair of pleural and interpleural furrows directed successively more and more backwards, the former nearly straight, the latter straight and directed at 25° to 30° to sagittal line for the greater part of their length, curving strongly outwards from inner margins of border. Pleural bands of anterior two pairs of pleuræ raised and rounded, only anterior bands of second pair fairly distinctly marked off from border. Free ends of second pair of pleuræ long, having about the same length as the internal (attached) portions, with flattened surfaces, fairly wide at base, but rapidly tapering so as to become very narrow in their hinder halves and sharply pointed, directed in one specimen nearly straight backwards, in the other backwards and slightly outwards. Anterior portions of basal pair of pleuræ with raised and rounded surfaces, separated from border portions by rather narrow grooves joining extremities of prolonged dorsal furrows with second pair of interpleural furrows. Posterior portion of marginal border, between second pair of interpleural furrows, with very slight independent convexity, prolonged in the middle into a relatively broad, tapering spine, which seems to have been rather long (only the base is preserved in one of the specimens); posterior margin describing a sigmoid curve on each side of median spine, from posterior extremities of second interpleural furrows curving at first for a short distance inwards and rather strongly backwards, then more strongly inwards, and finally at base of spine more backwards.

Surface of cranium and pygidium with larger and smaller sub-conical tubercles and granules, the latter (not shown on internal casts) both on and between the tubercles. On corresponding parts the distribution of the tubercles is about the same as in *Hoplot. dissidens* (cf. above p. 79). On the stout frontal spine small to rather large tubercles occur, the largest ones on the posterior part dorsally and laterally (not on the ventral side); anteriorly they grow, on the whole gradually smaller and near the tip there are only very small tubercles and granules. The tubercles on the spine appear to be relatively higher and narrower than those on the other parts of the cranium. They are, at least generally, very oblique, pointing obliquely forwards, whereas on other parts the tubercles are straight and perpendicular to their basal planes (or nearly so), possibly with the exception of those on the occipital

spine, on which, however, only small or rather small and relatively low ones appear to occur.

Dimensions. — The dimensions of two cranidia (a, U.M., Pl. 8, fig. 7; b, R.M. Ar. 2192) are: sagittal length (frontal and occipital spines excluded) a) approximately 35 mm., width between middle of palpebral lobes a) 31 mm., b) 29 mm.; glabella — length a) 28 mm., b) 26.5 mm., greatest width, a) approximately 26 mm., b) 23 mm., basal width, a) 18.5 mm., b) 16.5 mm.; fronto-median lobe — greatest width a) approximately 20 mm., b) 18.5 mm., least width a) 7 mm., b) 6 mm., basal width a) 11 mm., b) 10 mm.; tri-composite lobes — distance between anterior and posterior ends a) 18 mm., b) 16.5 mm. (greatest) width across middle a) 8 mm., b) 7.5 mm.; frontal spine — length along curvature of dorsal surface a) 24 mm., distance from base on dorsal side to end a) 21.5 mm., diameter of base a) 7 mm. In the larger of the two fragmentary pygidia examined (R.M. Ar. 2191) the sagittal length to the base of the spine seems to have been about 30 mm.; the width between the extremities of the first pair of interpleural furrows, about 48 mm.; and the anterior width of the rachis, 14 mm.; in the smaller pygidium (R.M. Ar. 2190) the sagittal length appears to have been about 18 mm.

Remarks. — The above description is based on two cranidia in the Uppsala Museum and on one cranidium (Ar. 2192) and two pygidia (Ar. 2190, Ar. 2191) in the State Museum of Natural History. All the specimens are found in boulders. Those in the Uppsala Museum were found, one at Haraldsby Holme on Åland, the other at Kragsta in Upland. The third cranidium and the pygidia were found at Visby in Gotland. It does not seem as if the pygidia were found in the same boulder as the cranidium, but they occur in a similar kind of limestone. I do not hesitate to refer them to this species since their characters in all respects agree so well with those of the cranidium.

The cranidia seem to agree closely in characters with the one that I have selected as lectotype (DAMES, 1877, Pl. 12, figs. 4—4 a). DAMES did not mention the occurrence of the pair of small spines or large tubercles behind the large frontal spine — which apparently corresponds to the second pair of frontal spines in *Hoplol. dissidens* (cf. above p. 76). The base of the left one is, however, clearly illustrated on both his figures of the lectotype. That on the other side is also, as a matter of fact, drawn in its right place (fig. 4), but it is not shown as larger than several of the other tubercles on the cranidium. It is conceivable, of course, that in the specimen this right spine really is smaller than the other, but it appears more probable that it is entirely broken off, and if such is the case it might be difficult, or even impossible, to discern that at this place there was a spine or a specially large tubercle. In the figures of the paratypes given by DAMES (1877, Pl. 13, figs. 2—3) the presence of such spines or large tubercles is not indicated; probably they were broken off in those specimens also. To judge from the cranidia in the Swedish collections, the size of the spines varies in different specimens. In one of them (Pl. 8, fig. 7 a—b), in which both these spines are complete, they are relatively long and considerably broader at base than any of the tubercles.

In another specimen (Pl. 8, fig. 6), which is very coarsely tuberculate, the one spine preserved (of the other there is only the base) is a good deal shorter than in the specimen mentioned above and scarcely wider at base than the largest of the tubercles on the hind part of the glabella, but it is considerably higher than any of those. In the cranidium referred to this species by KUMMEROW (1927, p. 35, Pl. 2, fig. 4) the bases of the spines appear to be preserved, as shown in the figure. That the fragmentary cranidia described and figured by WIGAND (1888, p. 64, Pl. 8, figs. 2—3 b) as *Lichas (Hoplolichas) aff. proboscidea* DAMES possessed such a pair of spines, WIGAND himself has mentioned and indicated in his figures. As regards the latter specimens there seems to be no real reason to doubt that they are referable to *Hoplol. proboscideus*.

The great frontal spine seems to vary in size. According to the descriptions available, its shape is not the same in all specimens, but I am inclined to believe that the differences in this respect are not original, but that in some cases the shape has been altered by pressure after embedding. In one of the Swedish specimens (Pl. 8, fig. 6) the spine, of which a great portion is preserved, is badly distorted; other parts also show signs of pressure, but their shape is not so much altered. In this specimen the spine appears to have been both wide at base and long; though a considerable portion seems to be lacking the portion preserved is more than two-thirds as long as that part of the glabella which lies behind it. Only in the specimen from Åland (Pl. 8, figs. 7 a—b) is the spine complete, and on this the above description of the spine is based. As already mentioned, it is wide at base and rather long, with the posterior portion straight and directed obliquely upwards, and the anterior portion curving more strongly upwards. At the base the section is circular or nearly so, but anteriorly the spine becomes rather strongly compressed from the sides. This latter feature is possibly due to pressure, but more likely it is the original shape. Except that the tip points slightly to the left, the spine seems to be symmetrical, and, since it appears as if the occipital spine was compressed from the sides in this species (cf. DAMES, 1877, p. 801) as well as in *Hopl. dissidens*, it seems probable that the frontal spine corresponded in this feature. Also in a cranidium that will be described below (p. 96) as representing a variety of the species the frontal spine is compressed from the sides, except at its base. The third Swedish specimen shows only the base of the spine, and this resembles the corresponding portion in the specimen with the complete spine, except that it is relatively less stout. In the lectotype this portion of the spine (the rest is broken off) seems to have the same shape and direction and to be rather stout.

In one of WIGAND's specimens (WIGAND 1888, p. 65, Pl. 8, figs. 2 a) the spine is completely preserved, as it is also in the one figured by KUMMEROW (1927, Pl. 2, fig. 4). In the former it is curved in the same way as in the specimen from Åland, but it is, to judge from the figure, considerably shorter although relatively stout. The section is said to be round everywhere; both the words »kreisförmig» and »rund» are used but whether circular really is

meant or only rounded I do not know, the terms are used as contrasted with rhombic (angulate); it seems probable that the spine becomes compressed from the sides anteriorly as in our specimen (and the section more elongate). KUMMEROW describes the spine of his specimen as being round at the base, and farther forwards irregularly angulate or keeled (unregelmässig gekantet). This seems to indicate, as pointed out by KUMMEROW, that the shape of the anterior part has been altered by pressure: the irregularity is not likely to be original. To judge from the figure (which is in dorsal aspect) this spine is relatively slender, and it seems to be curved.

Finely there is the specimen on which DAMES (1877, p. 800; Pl. 13, fig. 2) based his description of the spine. Only a portion about half as long as the glabella is preserved. It is straight, as is the posterior portion of the spines in other specimens, and placed like those, as well as like those circular in section at the base, it seems, however, to judge from the figure, to be directed less upwards, and, according to DAMES' description, in front of the base it becomes flattened on top and sharply keeled at the sides, and a keel is also formed along the median line ventrally, so that the section anteriorly is triangular. It seems as if the figure was meant to show the spine as seen obliquely from above, although the rest of the cranium is drawn in lateral aspect, and it seems as if the spine increased in width anteriorly. It appears more than unlikely that the spine originally had this shape, but quite natural that it should be altered in this way if the anterior part has been flattened by pressure. It is also natural that longitudinal keels should be formed by such a process, and their symmetry (if they really are quite symmetrical) may be a coincidence. As just mentioned, in KUMMEROW's specimen the spine is also keeled anteriorly, and there the keels are irregularly placed. That the spine in DAMES' specimen in question is directed more straight forwards than in others may also be a result of pressure. DAMES himself has stated that the test on the dorsal surface is crushed and that he considered this to be a result of pressure in the rock.

As a character distinguishing this species from *Hoplol. dissidens* (BEYR.), DAMES (1877, pp. 798, 801) mentioned the occurrence of a small tubercle in the hindmost part of each of the prolonged anterior glabellar furrows. These tubercles are shown in DAMES' figure (Pl. 12, fig. 4) of the lectotype seen in dorsal aspect. They do not appear to be right in the furrows, but to be placed low down on the lateral slopes of the median glabellar lobe and to protrude into the furrows. In DAMES' (Pl. 13, fig. 3) figure of a paratype seen in the same aspect they are not indicated. To judge from the Swedish specimens and from some of the figures of foreign ones available, these tubercles seem, at least generally, to be present not only in this species but also in *Hoplol. dissidens*, but not always to be placed equally far down or to protrude equally far into the furrows (cf. above p. 84). In the Swedish material one of the cranidia of *Hoplol. dissidens* (Ar. 2193; Pl. 8, figs. 3 a—b) shows in this respect a closer resemblance to DAMES' figure of the lectotype of *Hoplol. proboscideus*, than do those which belong to this latter species. As regards

the fragmentary cranium described and figured by ПОМРЕККИ — 1890, p. 46, Pl. 2, fig. 23 — as *Lichas* affn. *tricuspidatæ* BEYR., cf. above p. 84.

Affinities. — That this species appears to be closely related to *Hoplol. dissidens* (BEYR.) has been pointed out by several authors. The most important difference shown by the cranium is the occurrence of the stout median frontal spine instead of the anterior pair of small spines present in *Hoplol. dissidens*. The occipital ring has also a different shape; it is not as much produced posteriorly to the base of the median spine as in typical crania of that species. To judge from the specimens examined by me — most of these features are also shown or indicated in figures given of other specimens — the glabella tapers more posteriorly; the fronto-median glabellar lobe is relatively wider in front and decreases more in width to its narrowest portion, where its width is smaller than the greatest width of each of the tri-composite lobes; and both the median glabellar lobe and the tri-composite lobes are more gently convex transversely; the latter slope downwards towards the sides from the vicinity of the prolonged anterior lateral glabellar furrows, and the glabella as a whole is not less convex in this direction than in *Hoplol. dissidens*, in which only the distal portions of these lobes slope laterally.

In our specimens of both species the median glabellar lobe is raised to about an equal extent above the lateral lobes, or slightly more in those belonging to *Hoplol. dissidens*. According to DAMES (1877, pp. 798, 801), the median lobe is more convex in the middle and posteriorly and is considerably more raised above the lateral lobes in *Hoplol. proboscideus*. Possibly the specimens vary a little in these features or DAMES might have been misled by the greater convexity of the lateral lobes in *Hoplol. dissidens*. Anyhow the difference in these respects shown by the specimens on which DAMES based his statements does not seem to have been great. In his figures (Pl. 12, fig. 4 a, Pl. 13, fig. 2) of crania of *Hoplol. proboscideus* viewed in lateral aspect there is not much of the median lobe shown above the highest parts of the lateral lobes, and that it is somewhat raised above these lobes in *Hoplol. dissidens* also, he stated in the text (p. 798), although this is not shown in his figures.

It has already been mentioned (p. 92) that DAMES considered the occurrence of a small tubercle in the posterior part of each of the prolonged anterior lateral glabellar furrows as a distinctive feature of *Hoplol. proboscideus*, but that similarly placed tubercles, protruding from the lateral slopes of the median lobe of the glabella into the furrows, may also occur in *Hoplol. dissidens*.

DAMES (1877, pp. 798, 801) stated further that the large tubercle on the hindmost portion of each of the lateral glabellar lobes was not so distinctly marked off by a groove in *Hoplol. proboscideus* as in *Hoplol. dissidens*. As pointed out above (p. 81), there does not seem to be a really impressed groove around this tubercle even in the latter species, although the interspace between it and the surrounding tubercles might have the appearance of a groove, especially as regards the space in front of the tubercle, when there is a marked

difference between the degree of convexity of this hindmost portion of the lobe (which seems to represent the basal lateral lobe) and the portion in front of it. In *Hoplol. proboscideus*, where the entire tri-composite lobe is only gently convex, this difference is slight, and the »groove» in front of the tubercle seems always to be indistinct or the space does not even give the impression of being a groove. To judge from the Swedish material, the space behind the tubercle is quite as groove-like in this species as in *Hoplol. dissidens*.

The pygidium that seems to belong to *Hoplol. proboscideus* shows also characters indicating a relatively close relationship to *Hoplol. dissidens*, although there are some striking and important differences. The free ends of the second pair of pleuræ are narrower and directed more backwards; the hindmost portion, the posterior border, has a quite different shape, the postero-lateral margins being directed much more strongly inwards, and it bears a single rather broad spine instead of a pair of narrow posterior spines.

A species which seems to be even more closely related is *Hoplol. Plautini* SCHMIDT (SCHMIDT, 1885, p. 75, Pl. 2, figs. 17—24). The course of the prolonged anterior lateral glabellar furrows and the relation in width between the different parts of the fronto-median glabellar lobe respectively between this and the tri-composite lobes seem to be the same as in our species. (In these characters *Hoplol. dissidens* differs, as already mentioned). To judge from SCHMIDT's figures, the frontal lobe is, however, more broadly rounded anteriorly and does not extend so far in front of the tri-composite lobes, the anterior portions of the latter are less strongly bent down, and the glabella decreases less in width posteriorly. The prolonged anterior lateral glabellar furrows are apparently much deeper, there is no stout median frontal spine — no frontal spines at all according to SCHMIDT —, and it seems as if there might be some slight differences in the tuberculation.

According to SCHMIDT (p. 73) *Hoplol. Plautini* differs from *Hoplol. dissidens* (*tricuspidatus* in SCHMIDT's work) in the tuberculation of the test and regarding its nature in the former species he stated as follows (p. 77): »Die Oberfläche des Kopfschildes zeigt besonders auf der Glabella äusserst grosse länglich-conische Tuberkel von ziemlich gleicher Grösse, die von ganz feinen, dem blossen Auge kaum sichtbaren, umgeben sind. Am längsten werden diese Tuberkel vorn auf der Wölbung des Mittellobus, ohne das wir doch bestimmte Höcker hervorheben könnten. Der schmale Theil des Mittellobus zeigt meist nicht mehr als zwei grosse Tuberkel in einer Horizontalreihe. Auf den übrigen Theilen der Glabella und auf dem Augenhöcker wiederholt sich die nämliche Tuberkulirung». His figures are not quite in accordance with these statements. Two of them (figs. 18 a—b, representing the same specimen in different aspects) show on the apex of the frontal lobe what seems to represent the basal part of a small median spine, or anyhow of a tubercle larger than those surrounding it. In these figures there are only drawn a few large tubercles, two in each horizontal row, on the posterior part of the median lobe, but in another of his figures (19) the presence of small as well as large tubercles is clearly indicated both on this and on other parts of the glabella. It may be noted that

his figure 18 a shows that there is a large, conspicuous tubercle on each of the tri-composite lobes some distance from the posterior edge, and figure 18 b that there is another fairly large one close to the edge (this part is in the shadow in fig. 18 a) just as in *Hoplol. dissidens* and in *Hoplol. proboscideus*. It does not seem as if the difference in the character of the tuberculation was so marked as what one might infer from SCHMIDT's description alone, still it appears probable that on the cranium of *Hoplol. Plautini* there were present a relatively greater number of large or fairly large and, especially on the fronto-median glabellar lobe, more elongate tubercles.

The occipital ring seems to be somewhat more produced posteriorly to the base of the median spine than in our species and the spine is described as being cylindrical.¹

The pygidium referred to *Hoplol. Plautini* by SCHMIDT is of a type that seems to represent a transition between the type of pygidium belonging to *Hoplol. conicotuberculatus* (NIESZK.) (SCHMIDT, 1885, p. 85, Pl. 3, figs. 23—25; cf. also below p. 101, Pl. 7, figs. 1 a, b, c), and *Hoplol. furcifer* SCHMIDT, (SCHMIDT, 1907, p. 39, Pl. 2, fig. 9) and that which apparently belongs to *Hoplol. proboscideus*. From the latter it differs in the shorter and broader free ends of the second pair of pluræ, the longer and narrower emarginations between these and the posterior median portion of the pygidium, in the shape of the latter, the distal margins of which seem to be directed straight backwards and nearly at right angles to the posterior margin, and further in the much smaller median spine.

Horizon and Localities. — As already mentioned, this species is as yet known only from boulders. The specimens in the Swedish collections occur in a grey limestone slightly varying in appearance. No other specifically determinable forms have been found in the same boulders and it is not possible to decide with certainty on petrographical grounds whether the rock is Chiron Limestone or Lower Chasmops Limestone. DAMES and other authors who have described specimens found in North German boulders have stated that the rock is grey Orthoceras Limestone, but without proving this by palæontological evidence; presumably they judged only from the appearance of the rock. The pygidium which DAMES erroneously attributed to this spe-

¹ SCHMIDT stated that in one of his specimens (figs. 17 a—b) the occipital spine was not developed and that the posterior and anterior margins of the occipital ring were parallel. If it really is so it seems doubtful whether this specimen really ought to be placed together with those possessing such spines and a more sub-triangular occipital ring. Perhaps it might be regarded as representing a distinct variety. Other related species do not seem to vary in this character, and it does not appear as if the possession of an occipital spine could be a sex-character. If the spine had been broken off while the animal was alive and had not regenerated, it is conceivable that a later mould would not show any mark or scar, but hardly that the shape of the occipital ring could have altered. In other respects the specimen seems to agree well with the typical crania of *Hoplol. Plautini* and one would hardly expect that there should be a form belonging to the genus *Hoplolichas* in which a median occipital spine was not developed since all the other known members of this genus possess such a spine.

cies, and of which according to him (1877, p. 801¹) two specimens had been found, at different localities, together with cranidia, seems to be referable *Conolichas deflexus* (ANG.), as originally pointed out by SCHMIDT (1885, p. 101) (or possibly to a closely allied form). That species belongs, however, to the fauna of the Macrourus Limestones and the Kegel Formation (D₂), and it seems very unlikely that it (or any very closely allied form to which the pygidium might possibly belong) should occur in the Orthoceras Limestone. It appears thus as if DAMES was mistaken in his determination of the rock. The rock in the boulders from the North Baltic Area cannot be Macrourus Limestone as already stated by WIMAN, and the inference that the species occurs in the Lower Chasmops Limestone seems to be well-grounded.²

Of the specimens in the Swedish collections one cranidium was found at Haraldsby Holme, parish of Saltvik, Åland, the others in Sweden, and of these one cranidium at Kragsta, parish of Lohärad, Uppland, and one cranidium and the two pygidia at Visby in Gotland.

(Lectotype the original of DAMES, 1877, Pl. 12, figs. 4—4 a).

Hoplolichas proboscideus DAMES var. elongatus n. var.

Pl. 8, figs. 8 a—b.

1908. *Lichas proboscidea*, WIMAN, p. 108 (pars.).

Remarks. — One of the cranidia (from the North Baltic Area) mentioned by WIMAN (1908, p. 108) as belonging to *Hoplol. proboscideus* DAM. differs so decidedly in some of its characters from the typical cranidia of this species, that it appears to represent at least a distinct variety.

The front margins of the anterior border and of the glabella are much more strongly arched forwards than in the type form. The fronto-median lobe of the glabella is more produced anteriorly, extending about two-fifths of its length in front of the tri-composite lobes (in the type form only about one-fourth); the median frontal spine is stouter and longer and is placed close to the anterior margin of the glabella; the end is broken off, but the portion preserved is longer than the rest of the glabella, and the entire spine seems to have been considerably longer; it is circular in section at the base, and becomes anteriorly compressed from the sides and thinner, but this rather gradually; in lateral aspect it becomes very gradually narrower, and at the end of the portion preserved there is still a considerable distance between the dorsal and ventral margins; it is only gently curved and directed, even anteriorly, con-

¹ Cf. also DAMES' statement on p. 795, which clearly shows that he means that the specimens were found in the same boulders, not only at the same localities.

² The figure of the Asaphid pygidium illustrated by DAMES (1877, Pl. 12, fig. 4) as occurring in the same piece of rock as the lectotype of *Hoplol. proboscideus* recalls the pygidium of *Asaphus pratexus* TQT., a species represented in the Lower Chasmops Limestone but also, if *Asaph. ornatus* POMP. really is identical (cf. WIMAN 1908, p. 109), in strata (C₁) corresponding in age to the Chiron Limestone. WIMAN in 1908 recorded the cranidium from Kragsta as occurring in Chiron Limestone but this was evidently because he believed that it belonged to *Hoplol. dissidens*.

siderably more forwards than upwards (to what degree the missing end was curved upwards cannot of course be decided). Of the small spines behind the stout median frontal spine, only the bases are preserved; they are placed close to the median spine and somewhat nearer each other than in the type form, and they too appear to have been directed more forwards and also more outwards. The tri-composite lateral glabellar lobes are more strongly bent down in front. The prolonged anterior lateral glabellar furrows are more strongly curved in their anterior halves, and they converge more strongly, especially at first, but for a somewhat shorter distance, the narrowest portion of the fronto-median lobe consequently being situated somewhat farther forward than in the type form; the posterior portions of the furrows are somewhat less divergent than in this. (The occipital spine is not preserved).

Dimensions. — Cranium — length (spines excluded) approximately 40 mm.; glabella — length 32.5 mm., greatest width approximately 26 mm., basal width 18 mm.; fronto-median lobe — greatest width approximately 22 mm., least width 6.5 mm., basal width 10.5 mm.; tri-composite lobes — distance between anterior and posterior end 19 mm., (greatest) width across middle 9 mm.; length of median frontal spine, more (probably a good deal more) than 36 mm.

Horizon and Locality. — Boulder of North Baltic Chasmops Limestone, or possible Chiron Limestone, found at Gamla Uppsala (Old Uppsala) in Uppland.

Hoplolichas conicotuberculatus (NIESZKOWSKI, 1859).

Pl. 7, fig. 2.

1859. *Lichas conicotuberculata*, NIESZKOWSKI, p. 365, Pl. 1, figs. 7—10.
 1859. *Tribolites* . . . ?, NIESZKOWSKI, p. 377, Pl. 1, fig. 13.
 1877. *Hoplolichas conicotuberculata*, DAMES, p. 802, Pl. 14, figs. 2—6.
 1884. *Lichas conicotuberculatus*, BRÖGGER, p. 261.
 1885. *Lichas conicotuberculata*, SCHMIDT, p. 82, Pl. 3, figs. 14—25.
 1901. *Hoplolichas conicotuberculatus*, GÜRICH, Pl. 20, fig. 14 (copy after SCHMIDT).
 1908. *Lichas conicotuberculata*, WIMAN, p. 107.
 1908. *Lichas conicotuberculatus*, GÜRICH, p. 69, Pl. 15, figs. 3 a—b (copies after SCHMIDT).
 1927. *Lichas (Hoplolichas) conicotuberculatus*, KUMMEROW, p. 36, Pl. 2, fig. 5.

Diagnosis. — Glabella longer than wide, slowly narrowing posteriorly to about seven-eighths or eight-ninths its greatest width, narrowing somewhat more rapidly anteriorly, broadly rounded in front, gently convex in both directions, with long anterior and short posterior slope, its lobes without independent convexity; width of fronto-median lobe across narrowest portion between one-fourth and one-third its greatest width and less than one-fourth the entire width of glabella, its anterior margin very broadly rounded in middle and with the side portions curving rather strongly backwards; tri-composite lobes extending as far back as median lobe; prolonged anterior furrows well marked all the way to occipital furrow, converging rather strongly posteriorly for somewhat more than one-third their length, then slightly for about an equal distance, then diverging to occipital furrow. Anterior side-divisions of

occipital furrow transverse, in a line with median portion; occipital ring sub-triangular, with bifurcated median spine; occipital lobes elongated sub-ovate, moderately convex. Pygidium broad, sub-truncate in front and at base, the lateral outlines rounded, posteriorly with distinctly differentiated marginal border; rachis strongly convex, not marked off posteriorly, the surface sloping rather evenly downwards from its apex to border; pleural portions sloping steeply downwards laterally; free ends of two anterior pairs of pleurae rather short, broad, bluntly pointed, and recurved; posterior part of marginal border transversely elongate, with small median point and the lateral corners also produced into small, sub-triangular points.

Remarks. — This species is not known to occur in the Ordovician of Sweden itself, but, as already recorded by WIMAN (1908, p. 107), a cranidium has been found in a boulder of Lower Chasmops Limestone from the North Baltic Area.

The specimen (Pl. 7, fig. 2), which is slightly distorted, agrees closely in characters with typical cranidia of the species from the East Baltic Kuckers Formation (C₂).

The cranidium recorded by BRÖGGER (1884, p. 260) from the Norwegian Etage 4 c, also shows the typical characters of the species.

NIESZKOWSKI (1859, p. 365, Pl. 1, figs. 7—10) figured both a cranidium, a labrum, and a pygidium as representatives of his new species. I have selected the cranidium (figs. 7—8) as lectotype.

Horizons and Localities. — Lower Chasmops Limestone. — In a boulder from the North Baltic Area found at Öster Edsvik on the island Björkö in Uppland.

Etage 4 c (BRÖGGER's). — Norway: Gravestrand at Frierfjord.

Kuckers Formation (C₂)¹ — Esthonia (Lectotype, cranidium, NIESZKOWSKI, 1859, Pl. 1, figs. 7—8).

North Germany, in a boulder.

Hoplolichas curvifrons n. sp.

Pl. 7, figs. 1 a—d.

?*Lichas conicotuberculata*, SCHMIDT, 1885, Pl. 3, figs. 13 a—c.

Diagnosis. — Glabella with projected length about equal to greatest width, gradually tapering anteriorly and posteriorly, posteriorly to slightly more than three-fourths its greatest width, broadly rounded in front, gently convex transversely, its lobes without independent convexity, strongly curved longitudinally with long, steep, convex anterior slope and short, more gentle posterior slope; width of fronto-median lobe across narrowest portion less than one-third of its greatest width or of entire width of glabella, its anterior margin nearly straight in middle and with the side portions curving rather gently backwards

¹ The entire cephalon from Reval from the transition zone between the Echinospaerite Limestone (C₁) and the Kuckers Formation (C₂) figured by SCHMIDT (1885, Pl. 3, figs. 13 a—c) does not appear to belong to this species (cf. below, p. 103).

and upwards; tri-composite lobes not extending quite as far back as median lobe; prolonged anterior furrows suddenly becoming shallow posteriorly and continuing as rather weak grooves to occipital furrow, converging rather strongly posteriorly for about half their length, then slightly for some distance, then diverging to occipital furrow, the shallow hindmost portions more slightly than those just in front. Anterior side-divisions of occipital furrow arched forwards, extending farther forward than straight median portion. Occipital ring sub-triangular (probably with stout, simple median spine); occipital lobes rather broadly sub-ovate, convex. Pygidium broad, sub-truncate in front and at base, the lateral outlines rounded, posteriorly with distinctly differentiated marginal border; rachis strongly convex, not marked off posteriorly, the surface sloping rather evenly downwards from its apex to border; pleural portions curving abruptly downwards laterally; free ends of two anterior pairs of pleurae rather short, broad, bluntly pointed, and recurved; posterior part of marginal border transversely elongate, with small median point and slightly projecting, rounded postero-lateral corners

Description. — Cephalon strongly convex, sub-semioval in general outline, but with median portion — including foremost parts of free cheeks — projecting abruptly, interrupting regularity of anterior curved outline at level of antero-lateral angles of glabella.

Glabella anteriorly gently convex from side to side, posteriorly still more gently so, the lobes without independent convexity, strongly curved longitudinally, highest opposite middle of palpebral lobes, with long, steep, moderately convex anterior slope and short, more gentle, and less convex posterior slope; projected length somewhat shorter than distance between anterior and posterior margin and about equal to greatest width, which is across anterior portions of tri-composite lobes between a point on each side situated about halfway between the point where the palpebral furrow branches off and the anterior extremity of the anterior glabellar furrow; tapering anteriorly and posteriorly, posteriorly to slightly more than three-fourths its greatest width, broadly rounded in front and slightly overhangig anterior margin. Fronto-median glabellar lobe expanded in front, but without marked antero-lateral extensions, tapering posteriorly to nearly opposite middle of palpebral lobes, where its width is about three-tenths the width in front and somewhat less than three-tenths the entire width of glabella, then increasing in width to nearly half the frontal width at occipital furrow; its anterior margin very slightly convex upwards but not arched forwards in middle, side portions curving rather gently backwards and upwards. Tri-composite lobes elongate, distance between extremities more than twice the width, greatest width across middles, tapering anteriorly and posteriorly, front ends pointed; their narrow hindmost portions — which seem to represent the basal lateral lobes — marked off from median lobe by rather weak grooves only.

Prolonged anterior glabellar furrows narrow, but sharply impressed for the greater part of their length, suddenly becoming shallow posteriorly and continuing as weak grooves to occipital furrow, converging rather strongly

posteriorly for about half their length, then more slightly to nearly opposite middle of palpebral lobes, then curving outwards and diverging, the shallow hindmost portions more slightly so than those just in front. Dorsal furrows about as strong as prolonged anterior glabellar furrows; preglabellar and occipital furrows, excepting posterior side-divisions of latter, rather shallower. Occipital furrow nearly straight in middle, side-divisions curved, anterior ones extending a little in front of median portion. Occipital ring (incompletely preserved) sub-triangular, presumably it had a stout, simple median spine; lateral parts of main portion of ring rounded longitudinally, narrowing and sloping steeply downwards towards the sides; occipital lobes rather broadly sub-ovate, with distal ends narrowest, extending a little farther forward than main portion of ring, their surfaces convex and sloping steeply downwards postero-laterally. Anterior border of cranidium narrow in front of median part of glabella, widening at sides, with flattened surface sloping steeply downwards anteriorly, marked off postero-laterally from convex anterior portions of fixed cheeks by shallow grooves (continued on free cheeks).

Fixed cheeks sloping steeply downwards both posteriorly and anteriorly from above palpebral lobes; anterior portions very narrow near the palpebral lobes, widening anteriorly, gently convex transversely; posterior portions (not completely preserved) subtriangular, in front of borders gently convex in both directions. Palpebral lobes sub-crescentic, situated far back, their length about equal to their real distance from posterior margin of cranidium, the projected distance being much smaller. Palpebral furrows strongly curved, well marked anteriorly and posteriorly, weak in middle, bending round behind eyelobes and continued on fixed cheeks by well-marked furrows, which mark off the band-like, raised, and rounded lower eyelids. Posterior borders of fixed cheeks (incompletely preserved) rather narrow near the occipital ring, widening laterally, with rounded surfaces, marked off by distinctly impressed furrows, which are directed relatively strongly forwards.

Free cheek (imperfectly preserved) steeply inclined. Inner portion rather small, longer than wide (high), gently convex longitudinally, scarcely rounded in the other direction; separated from border portion by curved furrow — sub-parallel to lower eyelid furrow — which forms the continuation of the posterior border-furrow on the fixed cheek and is distinctly impressed for the greater part of its length, but weakens proximally and continues as a shallow groove behind the small, subtriangular foremost portion of the free cheek and on the cranidium; lower eyelid and eyelid-furrow well developed. Lateral border sloping steeply downwards, but with convex surface so that its slope proximally — especially posteriorly where the border is broad — is less steep than the slope of the portion inside the border; very narrow anteriorly, but widening rapidly backwards till it is wider than inner portion, and apparently produced into a large, broad spine (broken off in the specimen described). Anterior branches of facial sutures running from palpebral lobes in curves gentle convex outwards — with the strongest curvature anteriorly — to border, then nearly parallel, or slightly converging, across this; posterior branches curving

strongly outwards at first, then, it appears, straighter backwards across border.

[Rostral shield and labrum not known from Swedish specimens.]

Thoracic pleurae (only fragments known) steeply bent down beyond rather weak fulcra, divided into narrower anterior and broader posterior bands by well-impressed furrows, which weaken outside fulcra and die out before reaching ends of pleurae; posterior bands and proximal parts of anterior bands raised and rounded, distal parts of latter and unfurrowed ends flattened and forming long, rather indistinctly defined facets; extremities obliquely truncate so that the extreme tips become pointed; on the posterior edge near the pointed tip are a couple of small tooth-like projections.

Pygidium broad, greatest width about five-thirds the sagittal length, sub-truncate in front and at base, lateral outlines convex, posteriorly with distinctly differentiated marginal border; inner margin of border (apparently corresponding to inner margin of doublure) distinctly marked also on anterior bands of second pair of pleurae, traceable on posterior bands of latter, very slightly indicated on posterior and not at all on anterior bands of first pair of pleurae. Rachis strongly convex, not marked off posteriorly from post-rachial piece, the surface sloping rather evenly downwards from rounded apex of rachis to posterior border, its width anteriorly not quite equal to one-third the greatest width of pygidium, tapering posteriorly; anteriorly with two well-defined, raised, and rounded rachial rings. Dorsal furrows narrow, but rather deep, converging posteriorly and ending in small sub-triangular, flattened areas situated one on each side between the swollen pleural band of the basal pleura, the swollen end of the post-rachial piece, and the marginal border (cf. below).

Pleural portions of pygidium with the surface flattened in front near the dorsal furrows, curving abruptly downwards laterally and somewhat less abruptly postero-laterally and posteriorly to marginal border, of which the inner part has a more gentle slope, or (posteriorly) is nearly horizontally extended, the slope becoming steeper again on marginal parts.

Anterior two pairs of pygidial pleurae sub-equal, relatively narrow, ending in rather short, broad, tapering, bluntly pointed, recurved free ends, hardly projecting on margin; free ends of first pair directed slightly inwards, with their inner edges covering the antero-lateral edges of the following pair, extending about as far backward as transverse middle line of posterior part of marginal border; free ends of second pair directed more strongly inwards, separated from posterior part of marginal border by very narrow emarginations and extending just beyond its lateral parts but not quite as far backward as its projected median point. Pleural furrows narrow, deeply impressed to marginal border (or corresponding parts on first pair of pleurae), then growing shallow and dying out at base of free ends, beginning in dorsal furrows much nearer anterior than posterior margins of respective pleurae; those of the anterior pair becoming sub-median near the border part and on it curving somewhat closer to posterior margins; those of second pair very gradually diverging from anterior margins, but all the way to border running much

closer to them than to posterior margins, then bending suddenly more backwards so as to end closer to latter. First and second interpleural furrows about as strong as pleural furrows, diverging gradually to marginal border, anterior pair continuing in about the same direction as before across border to base of free ends, but growing slightly shallower; second pair growing distinctly shallower and bending more outwards on border so as to converge slightly with first pair. Bands of pleurae strongly raised and rounded, becoming less raised near the more flattened free ends. Narrow anterior bands of second pair of pleurae somewhat less raised than broad posterior bands of same and preceding pair and raised only to border, which here is very distinctly defined, the surface of the pleural bands becoming suddenly flattened and the downward slope more gentle; posterior bands of same pleurae also becoming less steeply inclined on proximal part of border, but still distinctly swollen, the border part here thus less distinctly defined.

Basal pair of pygidial pleurae each with short, sub-triangular, swollen pleural band reaching to border and bounded on outside by second interpleural furrow, on inside by prolonged dorsal furrow and beyond this separated from swollen end of post-rachial piece by small, sub-triangular, flattened area, which possibly represents a nearly squeezed out posterior (inner) pleural band. Posterior part of marginal border with sub-parallel sides, rounded postero-lateral angles, and produced in middle into short, rather blunt point; its posterior margin slightly arched forwards and upwards between median point and postero-lateral angles: its surface flattened anteriorly, curving rather steeply downwards posteriorly and postero-laterally.

Surface of test with conical tubercles of various sizes and smaller granules between and on the tubercles. On the glabella the highest and most conspicuous tubercles occur on the posterior parts, anteriorly they become lower, some being almost effaced; on the median lobe there are two (one of them broken off in the specimen) especially large tubercles situated one on each side close to the dorsal furrow and a little in front of the posterior margin, and two somewhat smaller ones just behind the narrowest part of the lobe. On the borders of the cephalon there are only granules and very small tubercles; the same appears to be the case as regards the preserved parts of the main portion of the occipital ring, but on these the surface is worn and the ornament difficult to discern; possibly there may have been a few somewhat larger tubercles also. On the pygidium there are fairly large tubercles on the rachis and post-rachial piece and a few along the median lines of the four posterior pairs of pleural bands, but not on the anterior bands of the first pair of pleurae; on the latter and on the marginal parts there are only small tubercles and — as on all parts — granules.

Dimensions. — (Of the cranium and pygidium described): Glabella — sagittal distance between anterior and posterior margin 13 mm., greatest width just under 12 mm., basal width just over 9 mm.; fronto-median lobe — greatest width 10 mm., least width 3 mm., basal width just under 5 mm.; tri-composite lobes — distance between anterior and posterior ends 9.5 mm., greatest width

4.5 mm.; pygidium — distance from anterior margin of first rachial ring to base of posterior median free point 9 mm., greatest width 15.5 mm., anterior width of rachis 5 mm.

Remarks and Affinities. — In our State Museum of Natural History there are a cranidium, a fragmentary free cheek, portions of a few thoracic segments, and a pygidium which appear to represent a new species. The parts occur in a boulder of gray limestone — either Chiron or Lower Chasmops limestone — from the North Baltic Area found at Vätö in Uppland. They are detached, but in close association, and belong probably to one and the same individual. Since, however, one can not be quite sure of this, the cranidium with the free cheek, which latter is only rather slightly out of position, is selected as holotype of the new species, which I have called *Hoplol. curvifrons*.

This species appears to be rather closely allied to *Hoplol. conicotuberculatus* (NIESZK.), but differs in several features. The cranidium of the entire cephalon figured by SCHMIDT in 1885 (Pl. 3, figs. 13 a—c) as belonging to *Hoplol. conicotuberculatus* differs also decidedly in several characters from typical cranidia of that species and appears to resemble our form very closely and is probably referable to the same species. The specimen is from Reval, from the transition zone between the Echinospaerite Limestone (C₁) and the Kuckers Formation (C₂). The specimens representing the true *Hoplol. conicotuberculatus* which are figured by NIESZKOWSKI (1859, Pl. 1, figs. 7—9), SCHMIDT (1885, Pl. 3, figs. 14—25), and DAMES (1877, Pl. 14, figs. 2—6) are all from the Kuckers Formation. There are several cranidia of that species from the latter formation in Swedish collections and they agree well with the typical form as described and figured by SCHMIDT and others.

In the cranidium of the new species the glabella is much more strongly curved longitudinally, and more tapering posteriorly; the fronto-median lobe is broader across its narrowest portion in relation to the entire width of the glabella, and the course of its anterior margin is somewhat different; the prolonged anterior glabellar furrows have a somewhat different course and suddenly become shallow posteriorly¹; the anterior side-divisions of the occipital furrow are not transverse but curved forwards; and the occipital lobes are more broadly sub-ovate and more convex. The median portion of the occipital ring is damaged in the holotype and the occipital spine not preserved; but in the cephalon from Reval, which seems to belong to this species, it has a single median spine. Only a portion of the spine is preserved and it is not possible to decide with absolute certainty whether it might not have been divided farther back, but this does not seem probable, and anyhow the undivided portion preserved is much longer and much narrower than the undivided base of the bifurcated occipital spine in *Hoplol. conicotuberculatus*.

Another difference, which perhaps deserves to be mentioned, is found in the relative position of the two pairs of conspicuous tubercles on the hindmost

¹ As regards the cephalon from Reval, this latter character was pointed out by SCHMIDT (1885, Explanation of Pl. 3, fig. 13).

portion of the median glabellar lobe. In our specimen and in SCHMIDT's figure of the cephalon from Reval they are placed farther apart than in any of the typical cranidia of *Hoplol. conicotuberculatus* examined by me, or in the figures of such given by SCHMIDT.

The pygidium of the new species is closely similar to that of *Hoplol. conicotuberculatus*, but the postero-lateral corners of the posterior part of the marginal border are not produced into small points, but rounded.

Horizons and Localities. — Chiron or Lower Chasmops Limestone. — In a boulder from the North Baltic Area found at Vätö in Uppland.

?Transition-zone between the Echinospaerites Limestone (C₁) and the Kuckers Formation (C₂). — Reval.

Genus *Platylichas* GÜRICH, 1901.

Genotype: *Platylichas margaritifer* (NIESZKOWSKI, 1857).

Synonyms: *Lichas* NIESZKOWSKI 1857 pars., auct. pars. — *Lichas* (»Ergänzungsgruppe») SCHMIDT 1885 pars. — *Lichas* (*Platylichas*) GÜRICH 1901, REED 1902. — *Platylichas* + *Lingucephalichas* PHLEGER 1936.

Diagnosis. — Cranidium with dorsal furrows nearly or quite obsolete outside basal lateral glabellar lobes, their anterior portions bending strongly inwards to follow postero-lateral edges of bi-composite lobes some distance and finally to merge into basal lateral glabellar furrows; prolonged anterior lateral glabellar furrows reaching occipital furrow; basal lateral glabellar furrows generally well marked, sometimes weak or obsolete; occipital lobes well defined. Pygidium with prolonged dorsal furrows not reaching posterior margin; rachis with three to four ring-furrows, indistinctly defined behind and continued by generally relatively narrow post-rachial piece; pleural portions composed of three pairs of furrowed pleurae, all with free terminations; third pair of pleurae posteriorly confluent with post-rachial piece.

Platylichas bottniensis (WIMAN, 1908) Pl. 10, figs. 1—14.

1854 & 78. *Lichas laticeps?*, ANGELIN, p. 72, Pl. 37, fig. 5.

1908. *Lichas bottniensis*, WIMAN, p. 107, Pl. 7, fig. 16.

1925. *Platylichas bottniensis?*, WARBURG, p. 280, Pl. 7, fig. 19.

1925. *Lichas?* sp. ind., WARBURG, p. 306, Pl. 8, fig. 22.

1930. *Platylichas bottniensis*, THORSLUND, p. 301, Pl. 4, fig. 2.

Diagnosis. — Cranidium with anterior portion sub-semielliptical and anterior margin broadly rounded, gently convex, curved downwards in front; anterior border narrow, bent downwards with general curvature of cranidium and weakly defined in middle; fronto-median lobe of glabella without independent convexity, flattened posteriorly, its anterior slope moderately convex, its width across narrowest portion about one-fourth frontal width and about half the basal width; bi-composite lobes with very slight independent convexity, generally defined from basal lobes incompletely or very weakly, the basal lateral furrows being as a rule obsolete or very fine and shallow proximally

seldom distinctly defined throughout; basal lobes of moderate length, without independent convexity, quite undefined distally; occipital lobes elongated sub-ovate. Pygidium with lateral margins of anterior pair of pleurae strongly rounded; rachis moderately convex, with two distinctly impressed ring furrows and a third weaker one; pleurae with short free ends only slightly, or hardly at all, protruding on margin; basal pair of free ends broad, separated by shallow, obtusely angulate emargination.

Description. — Cranidium with length nearly equal to width between palpebral lobes, gently convex, its anterior margin broadly rounded.

Glabella somewhat wider than long. Fronto-median lobe without independent convexity, flattened posteriorly, anterior slope moderately convex; clavate, with rather narrow (longitudinally), pointed antero-lateral extensions; neck of lobe somewhat wider anteriorly than at occipital furrow, narrowing posteriorly to a little behind middle, where its width is about one-fourth frontal width of lobe, then widening posteriorly to about half that width. Bi-composite lobes with very slight independent convexity, posteriorly generally confluent with basal lateral lobes; irregularly sub-ovate, narrowing posteriorly, with obtusely pointed anterior extremities, the longer axes directed obliquely forwards and outwards and nearly twice as long as the width across middle of lobes; generally very slightly notched on inner sides a little behind middle by a slight bend or widening of the prolonged anterior glabellar furrows. Basal lateral lobes of moderate length, without independent convexity, quite undefined from fixed cheeks and generally proximally confluent with bi-composite lobes.

Prolonged anterior lateral glabellar furrows narrow, rather deeply impressed, curving from their points of origin in dorsal furrows inwards and upwards a little more than half-way to median line of glabella, then making a rather sudden, but not sharp, bend backwards and converging posteriorly for about an equal length, then diverging, for a short distance very slightly, then either rather strongly all the way to occipital furrow or first taking a more sudden outward turn and then bending more backwards (the latter feature most pronounced in casts, but on both casts and testiferous specimens the course of these parts of the furrows varies much and may even be different on the two sides of one and the same specimen). Inner extremities of middle pair of furrows apparently represented by the slight bend or widening of the prolonged anterior furrows indentating inner sides of bi-composite lobes. Basal lateral furrows on surface of test in rare cases only distinctly defined and normally developed (on casts rather more often), generally obsolete or very fine proximally, distally always defined, but generally shallow and narrow, running obliquely outwards and forwards to merge into the somewhat broader and deeper dorsal furrows, which continue in a slightly more outward direction along the distal two-fifths of the postero-lateral margins of the bi-composite lobes, then make a sudden bend forwards.

Occipital furrow narrow, deeply impressed. Occipital ring of moderate width; main portion as usual narrowing distally, gently arched transversely,

flattened or gently rounded longitudinally, with minute median tubercle rather close to posterior margin. Occipital lobes flattened, elongated sub-ovate with pointed postero-lateral extremities. Anterior border of cranidium rather narrow, of nearly uniform width, turned downwards with general curvature of cranidium and weakly defined in middle, becoming more horizontally extended and well defined at sides, marked off from fixed cheeks by distinctly impressed, although not deep, narrow furrows or grooves, which curve outwards and slightly backwards. Anterior border-furrows narrow, very shallow and fine, sometimes almost obsolete in middle, distinctly impressed at sides.

Anterior portions of fixed cheeks narrow, short, curving steeply downwards anteriorly with convex surfaces. Posterior portions of moderate width, gently convex and sloping rather gently downwards to border-furrows and small, flattened, sub-triangular areas situated in front of broad distal portions of borders. Palpebral lobes large and prominent, situated about their own length from posterior margin of cranidium, marked off internally by furrows that are distinctly impressed but rather weak in middle. Posterior borders narrow near the dorsal furrows, rapidly increasing in width for about half their length, then becoming parallel-sided, flattened, marked off by narrow, distinctly impressed furrows. Anterior branches of facial sutures converging rather slightly anteriorly; posterior branches running from palpebral lobes obliquely outwards and backwards.

Labrum roughly sub-circular, posterior margin with moderately wide, rather shallow, rounded excavation. Central body gently convex, defined by moderately strong furrows posteriorly and laterally, wider than long, sub-oval with base truncate; middle furrows of moderate strength and length, rather oblique. Borders and anterior wings of usual *Platylichas*-type; anterior portion of posterior border separated from lateral borders by the continuation of the lateral furrows, swollen, appearing to form a posterior lobe of central body.

Thoracic pleurae (only fragments known) with deeply impressed, long pleural furrows, and weak, remote fulcra; their distal portions curved backwards, with pointed extremities.

Pygidium about two-thirds as wide as long, with fulcrum on anterior edge about frontal width of rachis distant from it, antero-lateral angles broadly rounded, postero-lateral margins fairly straight. Rachis moderately convex, with slightly protruding apex, with frontal width slightly more than one-fourth width of entire pygidium, extending rather less than one-third length of pygidium, tapering posteriorly, rounded behind; marked by two distinctly impressed ring furrows and a third which is weaker, in some of the specimens obsolete in middle. Dorsal furrows narrow, rather deep, continued behind rachis, but ending at considerable distance from margin, converging at sides of rachis and behind it about half-way to ends, then becoming sub-parallel, but curving slightly outwards near extremities. Post-rachial piece gently convex anteriorly, flattened posteriorly, across narrowest portion in some specimens narrower than proximal bands of basal pleurae, in others about equalling them in width, in some broader.

Pleural portions of pygidium with flattened, posteriorly tapering areas in front near the rachis, beyond these bent very slightly downwards, or becoming slightly concave. Pleural and interpleural furrows narrow, rather deeply impressed. Anterior two pairs of pleurae of moderate width, with short broad-based, backwardly directed, pointed free ends only slightly projecting on margin. First pair of pleurae increasing in width to fulcra, then tapering to free points, with distal margins broadly rounded, proximal margins nearly straight and directed slightly more outwards than backwards to bases of free ends, then bending more backwards. Proximal margins of second pair of pleurae directed more backwards than outwards, slightly convex inwards to bases of free ends, then bending backwards. Basal pair of pleurae sub-triangular, with posterior margins nearly straight from rounded postero-lateral angles to rather approximate pointed extremities, which are separated by shallow obtusely angulate emargination. Doublure of pygidium wide.

Surface of cranidium and pygidium closely covered by small tubercles and granules of various sizes. Surface of labrum with punctæ and on lateral margins the usual ridges.

Dimensions. — The dimensions of one small and one relatively large cranidium (a = holotype, slightly pressed; b = original to Pl. 10, figs. 3 a—c) are: sagittal distance between anterior and posterior margin a) 13 mm., b) 25 mm.; width inside (middle of) palpebral lobes a) 14 mm., b) 27 mm.; glabella — sagittal distance between anterior and posterior margin a) 11 mm., b) 21 mm., greatest width a) 12.5 mm., b) 25 mm.; fronto-median lobe — greatest width a) 12 mm., b) 23 mm., least width a) not quite 3 mm., b) 6 mm., basal width a) not quite 6 mm., b) just over 11 mm.; bi-composite lobes — distance between anterior and posterior extremities a) 6 mm., b) 12 mm., width (not projected) across middle a) just over 3 mm., b) 7 mm. In a large incomplete pygidium (U.M.) the sagittal length is 44 mm., the greatest width has evidently been about 68 mm., and the anterior width of the rachis about 18 mm.

Remarks. — A great number of specimens of this species have now been collected in the lower part of the Kullberg (Lower Leptaena) Limestone of Dalarne (at Amtjärn and, a few specimens, at Kullberg) and in boulders of Lower Chasmops Limestone at Ringsö in Södermanland. All these specimens are in the Uppsala Museum. At both places pygidia and labra have been found in association with the cranidia.¹ The cranidia agree on the whole well in their characters with the holotype (from the North Baltic Lower Chasmops Limestone), some more closely than others. As mentioned in the description they show variations in some features, e.g. the character of the basal pair of

¹ In my paper of 1925 (p. 291) I suggested that some labra, from Kullberg, described and figured there (p. 290, Pl. 7, figs. 39—41) under the designation *Platyl.* sp. ind. d. possibly belonged to *Platyl. bottniensis*. This is evidently not the case. They are quite different from those here in question, which evidently belong to our species. I have now come to the conclusion that they do not belong to any member of the family Lichidae, but are probably referable to *Sphaerexochus Hisingeri* WARB. (WARBURG, 1925, p. 384, Pl. 11, figs. 16—19).

lateral glabellar furrows. The holotype is slightly pressed, and in consequence of this somewhat more gently curved downwards and slightly more narrowly rounded in front than the unpressed specimens.

The fragmentary pygidium described and figured by me in 1925 (p. 306, Pl. 8, fig. 22) as *Lichas?* sp. ind. belongs to this species and evidently also the fragment of a pygidium, which ANGELIN (1854, p. 72, Pl. 37, fig. 5) with a mark of interrogation attributed to his species *Lichas laticeps*. The latter is a Silurian form and identical with *Dicranopeltis Salteri* (FLETCH.) (cf. LINDSTRÖM, 1885, p. 60). The pygidium attributed to it by ANGELIN is from the Lower Chasmops Limestone of Öland.

The species is also represented from the Lower Chasmops Limestone at Furudal in Dalarne by a cranidium in our State Museum of Natural History.

Affinities. — The cranidium of this species shows likeness to the cranidia of two other species which have been found in the Kullberg Limestone in Dalarne, viz. *Platyl. latus* (TQT.) and *Platyl. robustus* WARB. (cf. below, pp. 108, 109) which both, however, seem only to occur in the upper part of this limestone, and both differ decidedly in some characters as a comparison of the diagnoses of the species will show.

The considerably younger *Platyl. docens* (SCHMIDT) (SCHMIDT 1885, p. 121, Pl. 5, figs. 27 a—c) seems to be rather closely related as has been pointed out by WIMAN (1908, p. 107), but to judge from SCHMIDT's description and figures, the cranidium (the only portion known) differs in the following characters: the neck of the fronto-median glabellar lobe is less contracted near its middle and relatively narrower at base; the prolonged anterior lateral glabellar furrows are more evenly curved inside the bi-composite lobes; and the palpebral lobes are narrower and less prominent and placed farther back.

Horizons and Localities. — Lower Chasmops Limestone. — In North Baltic boulder found at Öster Edsvik on Björkö in Uppland (holotype U. M., WIMAN, 1908, Pl. 7, fig. 16, below Pl. 10, figs. 1 a—b). Dalarne: Furudal. In boulders at Ringsö in Södermanland. — Kullberg (Lower Leptaena) Limestone, lower part. — Dalarne: Amtjärn, Kullberg.

***Platylchas robustus* WARBURG, 1925.**

Pl. 11, figs. 1—3.

1925. *Platylchas robustus*, WARBURG, p. 277, Pl. 7, figs. 10—11.

1930. » » THORSLUND, Pl. 4, fig. 4. (Copy after WARBURG).

Diagnosis. — Cranidium with anterior portion sub-semielliptical in outline, and anterior margin arched strongly forwards, flattened convex; anterior border of moderate, nearly uniform width, well defined, sloping rather gently downwards in front; fronto-median lobe of glabella without independent convexity, its anterior slope very gently convex, its width across narrowest portion about one-fifth frontal width and less than half width at base; bi-composite lobes with gentle independent convexity, higher than median lobe, completely

defined; basal lobes of moderate length, quite undefined distally; occipital lobes elongated sub-ovate.

Remarks. — A nearly complete cephalon (Pl. 11, figs. 1 a—c) of this species was recently found in the upper part of the Kullberg (Lower Leptaena) Limestone at Amtjärn in Dalarne and, in association with it, an isolated, relatively small labrum (Pl. 11, fig. 2). The specimens are in the Uppsala Museum. A large cranidium (Pl. 11, fig. 3) in the Museum of the Geological Survey, occurring in a boulder of Macrourus Limestone found at Kåketorp on Öland, belongs also to this species.

The antero-lateral margins of the cephalon have a slightly sigmoid curve, being proximally gently concave, distally gently convex. The genal spines, of which only the basal parts are preserved, seem to have been directed more outwards than backwards. The palpebral lobe, not preserved in the holotype, is large and prominent, of the usual *Platylichas* type. The visual surface of the eye and the lower eyelid are strongly rounded. From the eye-lobes the surfaces of the free cheeks slope gently downwards laterally and somewhat more steeply anteriorly, the steepest slope being towards the incurved portions of the margin. The posterior border-furrows continue some distance out on the free cheeks, but not out on the genal spines, grow narrower distally and approach the posterior margins of the cheeks.

The labrum agrees with the specimen found at Sättra in association with the holotype (cf. WARBURG 1925, p. 279, Pl. 7, fig. 11) as far as the characters of the latter are known, in other characters it is of the general *Platylichas*-type.

Horizons and Localities. — Kullberg (Lower Leptaena) Limestone. — Dalarne: Sättra (holotype, cranidium, U.M.; WARBURG, 1925, Pl. 7, fig. 10), Kullberg, Amtjärn. — Macrourus Limestone. — In boulder found at Kåketorp (north of Eriksöre) in Öland.

***Platylichas latus* (TÖRNQUIST, 1884).**

?Pl. 12, figs. 19—20 c.

1884. *Lichas laxatus* var. *lata*, TÖRNQUIST, Pl. 1, fig. 28.

1884. » » (var. *dilatata*), TÖRNQUIST, p. 31 (32).

1925. *Platylichas latus*, WARBURG, p. 283, Pl. 7, figs. 12—14, ?fig. 16.

?1927. *Lichas (Platylichas) Westergårdsi*, KUMMEROW, p. 30, Pl. 1, figs. 23 a—c.

Diagnosis. — Cranidium with anterior portion sub-elliptical in outline and anterior margin rather broadly rounded, strongly convex, the anterior downward slope commencing less than half-way from posterior to anterior margin of glabella; anterior border narrow, bent steeply downwards and weakly defined in middle; fronto-median glabellar lobe with independent convexity strongest just in front of middle becoming slight near base, raised above lateral lobes, postero-lateral portions often with slight convexity of their own and forming small weakly defined knobs, its width across narrowest portion less than one-third but over one-fourth frontal width and more than half

basal width; bi-composite lobes generally completely defined, with gentle independent convexity, not very oblique; basal lobes of moderate size, distally undefined or indistinctly defined; occipital lobes sub-ovate, gently convex.

Remarks. — Of this species there are now available, in the Uppsala Museum, a few cranidia from the Kullsberg (Lower Leptaena) Limestone of Dalarne in addition to those mentioned by me in 1925 (p. 283). In the same museum there are further two fragmentary labra from Kullsberg, which probably belong to this species. They are of the same type as the labrum from the Boda (Upper Leptaena) Limestone of Kallholn that was described and figured by me in 1925 (p. 290, Pl. 8, fig. 42) as *Platylichas* sp. ind. c., and seems to belong to *Platyl. cicatricosus* (Lovén) (cf. below p. 115).

The cranidia vary in the degree of convexity. In all the glabella is curved steeply downwards anteriorly; but the downward slope does not always begin with equal steepness or at exactly the same level — though always nearer the posterior than the anterior margin of the glabella — and the independent convexity of the lobes, especially as regards the neck of the fronto-median lobe, as well as the convexity of the hinder part of the glabella as a whole, varies. In 1925 (p. 283) I stated that the small cranidia were more convex than the larger, but it does not seem as if the degree of convexity depended so much on the size as appeared from the material then available. The new material contains some specimens of large size for this species — the greatest width of the glabella in one of them being nearly 13 mm. — which are relatively strongly convex. There is further a small cranidium — with the glabellar width under 8 mm. — in which the hinder part of the glabella is considerably more flattened than in the larger specimens and (especially) the fronto-median lobe more gently convex transversely.

Another statement made by me in 1925 concerning this species needs correction or rather a clearer expression I stated then (1925, p. 284) that from their anterior points of origin the dorsal (axial) furrows ran backwards and upwards in curves convex outwards — with the strongest bend at the points where the palpebral furrows branch off — until merging into the basal lateral glabellar furrows and that the latter continued in a more inward direction. »More inward» was meant as compared to the general direction of the dorsal furrows. The basal lateral glabellar furrows are not directed more inwards than the portions of the dorsal furrows next the junction but continue in about the same or, generally, in a slightly more backward direction. From the points of junction they become gradually shallower (and in casts broader), but in all the specimens from Dalarne (of which most are casts) they are distinctly defined, except sometimes close to the shallow ends of the anterior lateral glabellar furrows.

In the Museum of the Geological Survey there is a cranidium from the Macrourus Limestone of Öland which appears to belong to our species. In this specimen, however, which is preserved with its test, the basal lateral glabellar furrows are effaced for the greater part of their length. The distal portions only are represented. They form as usual the continuations of the

dorsal furrows — a slight bend in the combined furrow marking the point of junction — but very soon they become weak and die out less than half-way to the prolonged anterior lateral glabellar furrows. This difference does not appear to be of specific importance. The strength of the proximal portions of the basal lateral glabellar furrows varies in several species of *Platylichas*. In *Platyl. bottniensis* they are, as stated above, as a rule effaced or extremely fine, but in some specimens normally developed; to judge from the material examined (which consists of a great number of specimens), they are more often distinctly impressed on the internal casts than on the surface of the test. It is quite likely that in *Platyl. latus* this character is equally variable and that further finds will show that also in the Kullberg Limestone of Dalarne there occur specimens of our species in which the proximal portion of these furrows are effaced.

In this specimen from Öland the posterior part of the glabella is relatively strongly flattened; the glabellar lobes are relatively gently convex transversely, the anterior and mid-most portions of the fronto-median lobe especially more gently convex than in the cranidia from Dalarne. It looks, however, as though the specimen had been somewhat compressed in the rock and did not in these respects show quite the original characters.

Among the Macrourus Limestone fossils from Öland in the Museum of the Geological Survey there is further a specimen showing the impression and part of the inside of a labrum, which agrees in characters with the labra from Kullberg mentioned above (p. 110) as probably belonging to our species.

KUMMEROW's species *Lichas (Platylichas) Westergårdsi* (KUMMEROW, 1927, p. 30, Pl. 1, figs. 23 a—c) appears to be identical with *Platyl. latus* (TQT). The cranidium figured (the holotype of his species) seems to agree closely with specimens from Dalarne. His description states that the portion of the glabella which is curved downwards is of somewhat less than half the entire length (»Der herabgebogene Teil beträgt nicht ganz die Hälfte der Länge»). It is, however, evident that in KUMMEROW's terminology the glabella includes the occipital ring. The figure in lateral aspect (23 c) shows that the downward slope begins nearer the posterior than the anterior margin of the glabella proper. The slope is rather gentle at first and does not begin quite as far back as in some of the Swedish specimens, but, as mentioned above, there are variations in these respects. The specimen had been found in a boulder, of which the geological age could not be decided. KUMMEROW had a second specimen which he referred to his new species. This had been found in a boulder of Macrourus Limestone, and he seems to be of the opinion that his holotype originated from strata of the same age. This seems more than probable if it really belongs to *Platyl. latus*, but whether KUMMEROW's second specimen is referable to the same species appears doubtful. It is not figured, but according to KUMMEROW's statements it differs from the other in having the bi-composite lateral glabellar lobes raised above the median lobe. In all the Swedish cranidia of *Platyl. latus*, as well as in the specimen figured by KUMMEROW, the median lobe is higher than the bi-composite lobes. It appears

rather probable that KUMMEROW's second specimen belongs to the form which will be described below as *Platyl. Dalmani* and which appears to be closely allied to *Platyl. latus*, but differs from it in this character.

KUMMEROW (Op. cit. p. 31) expressed the opinion that his species probably was identical with that described by WIGAND (1888, p. 67) as *Lichas* cfr. *cicatricosus* LOVÉN. [WIGAND meant of course the form represented by the cranidium which SCHMIDT in 1885 had attributed to LOVÉN's species; cf. below under *Platyl. Lichas? mastocephalus* (ÖPIK)]. WIGAND figured three specimens as *Lichas* cfr. *cicatricosus*, concerning two of them, however, a very fragmentary cranidium and a fragment of a large pygidium (Op. cit. Pl. 8, figs. 6 a—c), he remarked that it was very doubtful whether they belonged to the species in question and that they were placed there only because they evidently belonged to the same group. As far as can be judged from the figures the cranidium belongs neither to *Platyl. latus* nor to *Platyl. Dalmani*; the pygidium is much too large for those small forms and it is quite unlike the pygidia from Dalarne, that appear to belong to *Platyl. latus* (cf. WARBURG 1925, p. 285, Pl. 7, fig. 16).

The other specimens (cranidia) mentioned by WIGAND seem to have been regarded by him as belonging to one and the same species, although they did not quite agree in all characters. The form is not properly described, nor does the figure (Op. cit., Pl. 8, fig. 5), which is in dorsal aspect, give a clear idea of all the characters. It appears as if the bi-composite lobes were higher than the median lobe of the glabella. This would be a difference from *Platyl. latus* (and from KUMMEROW's figured specimen) and in accordance with *Platyl. Dalmani*. The prolonged anterior lateral glabellar furrows, as shown in the figure, however, have a different course than in our two forms, and it does not seem as if the specimen belonged to either of them. According to WIGAND's statements the course of these furrows is not the same in all his specimens, and it is quite possible, of course, that one or several of those that he did not figure may belong to *Platyl. latus* or to *Platyl. Dalmani*. According to KUMMEROW (1927, p. 31) some, at least, of WIGAND's specimens have been found in boulders originating from strata of Macrourus Limestone age.

Horizons and Localities. — Most of the specimens of this species that have been collected in the Kullsberg (Lower Leptaena) Limestone of Dalarne, e. g. those from Kullsberg, are known to have come from the upper part of the formation, and it appears probable that the others also originated from that part.

Kullsberg (Lower Leptaena) Limestone (probably in upper part only). — Dalarne: Furudal (holotype L. M.; TÖRNQUIST, 1884, Pl. 1, fig. 28; WARBURG, 1925, Pl. 7, fig. 10), Kullsberg, Skålberget, Sätra, Amtjärn.

? In boulders of Macrourus Limestone found in Öland at Eriksöre and Segerstad.

? In North German boulders.

Platylichas Dalmani n. sp.

Pl. 12, figs. 17—18 b.

Diagnosis. — Cranidium with anterior portion sub-elliptical in outline and anterior margin rather broadly rounded, strongly convex, the anterior downward slope commencing less than half-way from posterior to anterior margin of glabella; anterior border narrow, bent obliquely downwards in middle and throughout distinctly defined from glabella; fronto-median glabellar lobe in posterior half very weakly rounded or flattened transversely, postero-lateral portions with slight convexity of their own (always?) forming small, weakly defined knobs, its width across narrowest portion about one-fourth, or less than one-fourth, frontal width and about half basal width; bi-composite lobes completely defined, with relatively strong independent convexity, posteriorly raised above median lobe, not very oblique; basal lobes of moderate size, distally undefined; occipital lobes subovate, gently convex.

Description. — Cranidium with sharply impressed, rather narrow furrows, its length nearly equal to the width between the palpebral lobes, strongly convex, curved steeply downwards anteriorly, its anterior margin rather broadly rounded.

Glabella wider than long, strongly convex longitudinally, the anterior downward slope commencing less than half-way from posterior to anterior margin. Fronto-median lobe in posterior half very gently rounded or flattened from side to side, its postero-lateral portions with slight convexity of their own (always?) forming small weakly defined knobs; clavate, with rather narrow (longitudinally), pointed antero-lateral extensions; neck of lobe anteriorly rather wider than at occipital furrow, narrowing posteriorly for about half its length to about one-fourth, or less than one fourth, the frontal width of lobe, then widening very gradually for some distance, and then expanding suddenly at base to about twice the least width. Bi-composite lobes with relatively strong independent convexity, especially posteriorly, where they are raised above median lobe; sub-ovate, narrowing slightly posteriorly, with pointed anterior extremities, the longer axes directed obliquely forwards and outwards and nearly two-thirds as long as the width across middle of lobes. Basal lateral lobes of moderate size, without independent convexity, with truncate inner ends, distally not defined from fixed cheeks.

Occipital ring of moderate width; main portion as usual narrowing distally, strongly arched transversely, flattened longitudinally, with small median tubercle near posterior margin. Occipital lobes gently convex, sub-ovate with pointed postero-lateral extremities, sloping steeply downwards posteriorly. Anterior border of cranidium narrow, with flattened surface, in middle turned steeply downwards, though not as steeply as adjacent part of glabella, becoming more horizontally extended and widening slightly distally; defined from glabella by narrow furrow, which becomes shallow and very fine proximally, but is distinctly impressed throughout.

Fixed cheeks (imperfectly preserved) sloping very steeply downwards both anteriorly and posteriorly from level of palpebral lobes.

Surface of cranidium coarsely tuberculate, closely set, relatively high sub-conical tubercles of various sizes, but on the average large for such small specimens, occurring on all portions, except in the furrows and on the anterior border.

[Thorax and pygidium not recognized].

Dimensions. — All the specimens examined are small. In the largest one the projected sagittal length seems to have been about 8 mm. and the width between the palpebral lobes about 8.5 mm.; the sagittal length between the posterior and the anterior margin of the glabella is 6.5 mm. and the greatest width of the glabella 7.5 mm. In the smallest specimens the greatest width of the glabella is, or has evidently been, about 6 mm.

Remarks. — The above description is based on five small more or less fragmentary cranidia, which have been found on Öland in boulders of Macrourus Limestone, and of which four are now in the Museum of the Geological Survey and one (Ar. 6077) in the State Museum of Natural History. The material is rather meagre for the foundation of a new species, but since the specimens, as far as they are preserved, agree well and show some distinctive characters, I have thought it best to give them a specific designation. The holotype of this new species is the cranidium (S.G.U., collected at Eriksöre) illustrated below in figs. 18 a—b on plate 12. It is a poor specimen in which several portions are missing, but it shows the chief distinctive characters clearly. A portion of the upper part of the left bi-composite lobe is broken off, and in the figure (18 b) illustrating the specimen in lateral aspect the right bi-composite lobe is shown behind and above the median glabellar lobe.

Possibly the labrum from the Macrourus Limestone which I with a mark of interrogation has attributed to *Platyl. latus* (cf. above p. 111, below Pl. 12, fig. 19), belongs to this new species instead. It is, however, too large to fit any of the known cranidia.

As mentioned above (p. 111) it appears rather probable that one of the cranidia referred by KUMMEROW in 1927 (p. 30) to his new species *Platyl. Westergårdsi* belongs to *Platyl. Dalmani*. This specimen, which, according to his statements, had been found in a boulder of Macrourus Limestone, is not figured by KUMMEROW. The specimen figured, the holotype of his species, is probably referable to *Platyl. latus* (TQT., 1884) (cf. above, p. 111), and the specimen in question is said to differ in having the bi-composite lobes raised above the median lobe of the glabella.

Affinities. — This new species appears to be rather closely related to *Platyl. latus*, though it differs decidedly in some characters. The bi-composite glabellar lobes have a more pronounced independent convexity especially posteriorly where they are higher, instead of lower, than the neck of the fronto-median lobe; the latter is less convex, for the greater part of its length almost flat in transverse direction, and its width across the narrowest portion is relatively smaller; the anterior border is proximally turned less steeply down-

wards, has a flatter surface, and is better defined, the anterior border furrow being distinctly defined throughout; and the surface is more coarsely tuberculate.

Horizon and Localities. — *Macrourus* Limestone. — Öland, in boulders found at Eriksöre (holotype, cranidium, S.G.U.; below, Pl. 12, figs. 18 a—b), Segerstad, Skärslöf.

***Platylichas cicatricosus* (LOVÉN, 1846).**

Pl. 12, figs. 13, 15—16. fig. 14?

1846. *Lichas cicatricosus*, LOVÉN, p. 56, Pl. 1, fig. 8.

1854 et 78. *Lichas cicatricosus*, ANGELIN, p. 74 (pars), Pl. 38, fig. 6 b (non figs. 6, 6 a).

1925. *Platylichas cicatricosus*, WARBURG, p. 280, Pl. 7, fig. 17, textfig. 19.

1925. » sp. ind. a, WARBURG, p. 288, Pl. 7, fig. 15.

? 1925. » sp. ind. c, WARBURG, p. 290, Pl. 8, fig. 42.

Diagnosis. — Cranidium with anterior portion sub-semielliptical in outline and anterior margin rather strongly rounded, strongly convex, the strong anterior downward slope commencing at about middle of glabella; anterior margin narrow, well defined; fronto-median lobe of glabella with expanded hindmost portion flattened, in front of this with marked independent convexity, raised above lateral lobes, its width across narrowest portion about one-third frontal width and about two-thirds width at base; bi-composite lobes completely defined, with marked independent convexity, relatively slightly oblique; basal lobes of moderate length; occipital lobes sub-ovate, gently convex. Pygidium broadly sub-elliptical, with gently rounded antero-lateral angles; rachis strongly convex, with three ring-furrows and a fourth faintly indicated; anterior pair of pleurae narrower than following ones, the third the broadest, all with short free points, those of third pair approximate, separated by narrow emargination; third pair of pleural furrows connected with ends of dorsal furrows by weak grooves.

Remarks. — In 1925 (pp. 282, 288) I pointed out that there were reasons to believe that the small cranidium then described and figured (Pl. 7, fig. 15) as *Platylichas* sp. ind. a belonged to *Platyl. cicatricosus* (founded on the pygidium), and I now feel convinced that this is the case. Among the West Baltic Leptaena Limestone fossils found in boulders on Öland, which are in our State Museum of Natural History, there are both a small pygidium (Ar. 6094) belonging to this species, and three more or less fragmentary cranidia (Ar. 6100—02) of the form in question. There are also a few labra (Ar. 6095, 97, 99), and it appears probable that they also belong to *Platyl. cicatricosus*. No other forms of Lichidae have been found in those boulders. The labrum from the Upper Leptaena Limestone at Kallholn in Dalarne described and figured by me in 1925 (p. 290, Pl. 8, fig. 42) as *Platylichas* sp. ind. c. is of the same type as those from Öland.

Horizon and Localities. — Boda (Upper Leptaena) Limestone. — Dalarne: Vestaná (holotype, pygidium, R.M. Ar. 6103; below Pl. 12, fig. 13), Lissberg, ? Kallholn (labrum). — Öland, in boulders from the West Baltic Area found at Hultersta and Näsby.

Platylichas angulatus WARBURG, 1925.

1925. *Platylichas angulatus*, WARBURG, p. 286, Pl. 7, figs. 28—30.

Diagnosis. — Cranidium with anterior portion sub-angular and anterior margin broadly rounded, flattened on top, curved steeply downwards and overhanging anteriorly, curved somewhat less steeply downwards postero-laterally; anterior border narrow and bent downwards in front; fronto-median glabellar lobe with very slight independent convexity in middle, more flattened posteriorly; its width across narrowest portion about two-sevenths anterior width and about half width at base, with large tubercle (base of small spine?) situated on median line at less than two-thirds distance from posterior to anterior margin; bi-composite lobes completely defined, moderately convex transversely, distinctly, but not highly, raised above median lobe; basal lobes of moderate size, slightly rounded, indistinctly marked off from fixed cheeks by weak, narrow impressions; occipital lobes sub-triangular.

Remarks. — This species was founded on two cranidia from the Upper Leptaena Limestone at Kallholn in Dalarne. The original to figs. 29—30 on plate 7 in my work of 1925 I have selected as lectotype.

No further material has been collected.

Horizon and Locality. — Boda (Upper Leptaena) Limestone. — Dalarne: Kallholn (lectotype, cranidium, U. M.; WARBURG 1925, Pl. 7, figs. 29, 30).

Platylichas? mastocephalus (ÖPIK, 1937).

Pl. 14, figs. 1 a—c.

1885. *Lichas cicatricosa*, SCHMIDT, p. 122 (pars), Pl. 5, figs. 25 a—c. (non fig. 26).
 1902. *Lichas cicatricosus*, WIMAN, p. 170, Pl. 5, figs. 8—9.
 1902. *Lichas cicatricosus*, SCHMIDT non LOVÉN, REED, pp. 73—74 (pars), text-fig. 6 a (outline-copy after SCHMIDT) (non fig. 6 b).
 1937. *Trochurus mastocephala*, ÖPIK, p. 69, Pl. 23, figs. 3—4, ? fig. 5; ? Pl. 26, fig. 2; text-fig. 21; ? text-fig. 22.

Description (of Swedish specimen). — Glabella defined by distinct furrows, except posteriorly at sides where it coalesces with fixed cheeks, the boundaries, however, being indicated by very slight impressions; wider than long, convex longitudinally, steeply curved downwards anteriorly and overhanging front margin, the steep downward slope beginning behind middle, median portion considerably lower than strongly convex bi-composite lobes; anterior outline rounded-sub-triangular; anterior margin evenly and rather strongly arched forwards. Fronto-median lobe with very slight independent convexity behind middle; expanded in front, with narrowly pointed antero-lateral extensions overhanging bi-composite lobes for nearly their full width, narrowing posteriorly to a short distance behind middle, width here about one-fifth anterior width, then increasing in width again to inner extremities of basal lateral glabellar furrows; hindmost portion nearly parallel-sided, its width about three-sevenths the frontal width. Bi-composite lobes in dorsal aspect sub-

circular with a flattening of the curvature postero-laterally, in frontal aspect sub-oval with the longer axes directed obliquely inwards and upwards, very convex, raised considerably above neck of fronto-median lobe, proximal slopes rather short, lateral slopes long, anterior slopes longer and steeper than posterior slopes, the surfaces overhanging front margins. Basal lobes quadrilateral, shortest on the inner sides; their surfaces very slightly rounded, sloping downwards posteriorly and very slightly upwards distally, confluent with surfaces of fixed cheeks, their lateral boundaries, however, being indicated by very slight impressions. Prolonged anterior lateral glabellar furrows narrow, strongly impressed, somewhat broader and shallower posteriorly behind junction with basal lateral glabellar furrows. Middle lateral glabellar furrows represented only by very slight indentations on inner margins of bi-composite lobes nearly opposite highest parts of lobes. Basal lateral glabellar furrows somewhat shallower than prolonged anterior furrows, nearly straight, directed outwards and only slightly forwards, a slight bend marking the junction with the narrower dorsal furrows.

Anterior border of cranium narrow, rounded, bent downwards in front, marked off by narrow furrow, which is distinctly impressed, though relatively shallow in middle, but appears to grow deeper laterally. Occipital furrow with relatively wide and deep, straight median portion; side-divisions narrower, nearly straight, anterior ones nearly transverse. Main portion of occipital ring (imperfectly preserved) broad in middle, narrowing behind occipital lobes. Occipital lobes sub-triangular, with rounded surfaces, sloping very steeply backwards posteriorly.

Fixed cheeks (imperfectly preserved) sloping steeply downwards both anteriorly and posteriorly, anterior slope (apparently) the steepest, posterior slope gently convex.

Surface of cranium, of which the test is not preserved, closely covered by rounded tubercles of different sizes. On the frontal lobe there are two large tubercles, or small spines (only the bases are preserved on the specimen examined), placed close together, one on each side of the median line, rather less than one-fourth the length of glabella (measured along the surface) from anterior margin; the base of a large tubercle or small spine is also present on the highest part of the right bi-composite lobe (the left is not preserved).

Dimensions. — The dimensions of the cranium described above are: glabella — distance from posterior margin to extremity 7 mm., greatest width (across bi-composite lobes) nearly 9 mm.; fronto-median lobe — greatest width approximately 7 mm., least width about 1.4 mm., basal width just over 3 mm.; bi-composite lobes — distance between anterior and posterior extremities 4 mm., greatest width 3 mm.

Remarks and Affinities. — The fragmentary cranium described above is the specimen from the Middle Baltic Borkholm Formation (F₂) found in a boulder at Öjle Myr in Gotland and figured by WIMAN (1902, Pl. 5, figs. 8—9) as belonging to *Platyl. cicatricosus* (LOVÉN). It is the only specimen found in Sweden.

Cranidia of this species from the East Baltic Borkholm Formation (F₂) have earlier been described and one specimen figured by SCHMIDT (1885, p. 122, Pl. 5, figs. 25 a—c), who associated them with some pygidia and ascribed the specimens to *Platyl. cicatricosus* (LOVÉN), basing his identification on the pygidia. These, however, do not belong either to LOVÉN's species (as pointed out by REED already in 1902, p. 73) or to the species in question but to *Amphilichas* (cf. WARBURG, 1925, p. 257; above, p. 13).

Horizon and Localities. — Borkholm Formation (F₂). — In a boulder from the Middle Baltic Area found at Öjle Myr in Gotland.

Borkholm Formation (F₂). — Esthonia (Holotype, ÖPIK, 1937, Pl. 23, fig. 4).

Since my paper was already accepted for printing I received Professor ÖPIK's paper on »Trilobiten aus Estland», in which (p. 69) this species is described under the name of *Trochurus mastocephala* n. sp.

I cannot follow ÖPIK in placing it in *Trochurus*. In most of its chief characters it seems to resemble the typical members of *Platylichas*. I admit that there are several differences, but they hardly seem to be of generic importance. In some of the features in which it differs from *Platylichas* it differs from *Trochurus* as well, although it resembles some forms belonging to the same group of genera. There are also other differences from *Trochurus*, and those seem to be of greater systematic importance. The pygidium which ÖPIK (op. cit.) refers to this species differs also in some respects from the pygidia of typical *Platylichas*, but it appears to agree better with them than with the pygidium of *Trochurus*, and as ÖPIK points out it might be compared with that of *Platylichas laxatus* Mc Coy (syn. *Pl. sexspinus* ANG.). From the pygidium of *Trochurus* and allied genera it differs, to judge from ÖPIK's figures, in having a basal pair of pleural furrows, and in other features as well.

Our specimen seems, as far as it is preserved, to agree well with the cranidia from Esthonia. As mentioned in the description, there are the bases of two large tubercles on the frontal lobe. On the tri-composite lobe the traces of one large tubercle only is discernible, but the surface is very badly preserved.

***Platylichas laxatus* (M^c COY, 1846).**

Pl. 12, figs. 1—12.

1846. *Lichas laxata*, M^c COY, p. 51, (pars), Pl. 4, fig. 9.
 1846. *Calymene? forcipita*, M^c COY, p. 48 (pars), Pl. 4, fig. 14 (pygidium only).
 1848. *Lichas laxatus*, SALTER, p. 340, Pl. 8, figs. 4—6.
 ?1851. *Lichas laxatus*, SALTER, p. 172, Pl. 9, fig. 5 (according to REED, 1906, p. 102).
 1854 & 78. *Lichas sexspinus*, ANGELIN, p. 74, Pl. 38, figs. 7—8 a.
 1854 & 78. *Lichas aculeatus*, ANGELIN, p. 75, Pl. 38, figs. 11—11 a.
 1866. *Lichas laxatus*, SALTER, p. 324, Pl. 19, figs. 1—3 (copies after SALTER, 1848).
 1866. *Lichas segmentatus*, LINNARSSON, p. 18, Pl. 2, fig. 4.
 1867. *Lichas laxatus*, MURCHISON, p. 204, foss. 46, fig. 5.

1869. *Lichas laxatus*, LINNARSSON, p. 66.
 1869. *Lichas laxatus*, BAILY, p. 40, Pl. 13, fig. 7 a, b.
 ?1878. *Lichas* sp. ind. NICHOLSON and ETHERIDGE, p. 135, Pl. 9, figs. 13—14. (according to REED 1906, p. 102).
 ?1885. *Lichas laxata*, SCHMIDT, p. 125, Pl. 6, fig. 24.
 1896. *Lichas laxatus*, REED, p. 427.
 1906. *Lichas laxatus*, OLIN, p. 53, Pl. 1, figs. 27—28.
 1908. *Lichas laxatus*, WIMAN, p. 133, Pl. 8, fig. 23.

Diagnosis. — Cranidium with anterior portion sub-semielliptical in outline and anterior margin arched rather strongly forwards, flattened convex, gently curved downwards in front; anterior border of nearly uniform width, relatively wide, nearly horizontally extended, well defined; fronto-median lobe of glabella flattened or gently convex posteriorly, lower than bi-composite lobes, its width across narrowest portion generally about one-sixth frontal width and about one-third width at base; bi-composite lobes with marked independent convexity, relatively slightly oblique; basal lobes very small, depressed; occipital lobes sub-triangular to sub-ovate, with flattened or gently raised surfaces. Pygidium (excluding spines) sub-semielliptical to sub-triangular; rachis moderately convex, with four ring-furrows, the fourth weaker than the others and often interrupted in middle; all three pairs of pleurae ending in long spines.

Description of Swedish and Norwegian material. — Cephalon broadly sub-triangular in outline, the margin broadly rounded anteriorly, becoming sinuate on either side in front of eyes, then broadly convex to extremities of genal spines.

Glabella, generally slightly longer than wide, sometimes the length about equalling the greatest width, which is across anterior parts of bi-composite lobes, tapering rather strongly posteriorly, rounded in front, gently curved downwards anteriorly and with the surface rather gently convex from side to side also. Fronto-median glabellar lobe clavate, expanded rather suddenly in front with lateral extensions overhanging nearly the whole of bi-composite lobes; its anterior margin arched rather strongly and evenly forwards; its neck lower than bi-composite lobes, flattened or very gently convex transversely, narrowing posteriorly to about its middle, its width at this place generally about one-sixth the width of expanded frontal portion of lobe, or sometimes less -- at least on interior casts — then increasing slightly in width again for a short distance, and then suddenly expanding at base, generally to about half anterior width of lobe; this wider posterior portion showing, at least in some specimens, a slight independent convexity. Bi-composite lobes with marked, often rather strong, independent convexity, extending more than half the length of glabella, about four-sevenths as wide as long, with the longer axes directed forwards and — for a species of *Platylichas* — comparatively slightly outwards; sub-ovate to sub-elliptical, widening (slightly) anteriorly, strongly rounded proximally, sub-truncate distally; in some specimens slightly notched on their inner sides at about mid-length. Basal lateral glabellar lobes very small, much depressed proximally, rising slowly distally and coalescing

with fixed cheeks, often (in casts) the proximal part of the area of each lobe appears as a widening of adjacent furrows at their junctions.

Prolonged anterior glabellar lateral furrows well impressed to bases of bi-composite lobes, their short hindmost portions from there to occipital furrow weak; curving from their anterior points of origin upwards, inwards, and very slightly backwards about two-thirds the way to median line of glabella, then making a rather sudden, but not sharp, bend and continuing in a more backwardly direction for about an equal distance, then curving outwards, at first very slightly but soon strongly. Middle pair of lateral glabellar furrows apparently represented, in some specimens, by slight notches on inner sides of bi-composite lobes. Basal pair short, indistinctly marked.

Dorsal furrows about as strong as prolonged anterior lateral glabellar furrows, obsolete outside basal lateral glabellar lobes; their anterior portions curving obliquely backwards, upwards, and rather slightly inwards outside anterior halves of bi-composite lobes, then bending downwards and slightly more inwards at an angle of about 25° to sagittal line to merge finally into indistinctly defined basal lateral glabellar furrows; their posterior portions, outside occipital ring, curving outwards and backwards — and outside occipital lobes downwards.

Occipital furrow well marked and nearly straight behind median lobe of glabella; anterior side-divisions short, generally nearly straight, and directed slightly forwards, not deeply impressed; posterior side-divisions longer, rather gently curved, deeply impressed. Main portion of occipital ring of moderate width, narrowing behind occipital lobes, flattened longitudinally; its posterior part (including the whole of the portions behind occipital lobes) somewhat compressed from the sides, and, at least in some specimens and probably always, raised in the middle into a short, sharply keeled ridge. Occipital lobes not reaching quite as far outwards as main portion of ring, sub-triangular to sub-ovate (in casts), with flattened or gently raised surfaces sloping downwards postero-laterally. Anterior border of cranidium relatively wide, flattened or gently rounded, nearly horizontally extended, strongly arched forwards, marked off from glabella by narrow, well-impressed furrow.

Cheeks wide; proximal, convex portions well defined from posterior borders, indistinctly defined from flattened lateral portions of free cheeks and from small, sub-triangular, flattened areas situated on fixed cheeks next the facial sutures and in front of broadest parts of borders; distal portions sloping gently downwards, produced into not very long, broad-based, tapering, pointed spines which curve outwards and backwards. Palpebral lobes situated far back, large and very prominent. Palpebral furrows well marked anteriorly and posteriorly, interrupted or indistinct in middle. Posterior borders flattened, very narrow at dorsal furrows, rapidly increasing in width laterally behind raised portions of cheeks, then parallel-sided as far as facial sutures, beyond them narrowing; defined by distinct furrows dying out at bases of spines. Anterior branches of facial sutures sub-parallel until reaching anterior border of cranidium, then curving rather gently inwards, between it and the elongated sub-triangular

foremost portions of the free cheeks, which like adjacent marginal portions of free cheeks are curved strongly downwards. Posterior branches of facial sutures curving outwards, downwards, and backwards.

Labrum (a pressed specimen, which in unpressed condition seems to have had the following characters) with greatest width behind middle and about equal to distance from anterior extremity to a line joining postero-lateral extremities, only rather slightly tapering anteriorly; anterior margin rather broadly rounded, postero-lateral margins rounded, posterior excavation rather shallow, of moderate width. Anterior wings (probably) steeply inclined, truncate. Central body moderately convex, anterior width somewhat greater than length, narrowing considerably and decreasing in height posteriorly; marked posteriorly by pair of strong, rather long, oblique middle furrows. Lateral and posterior furrows well marked, the former continued, but weakening(?), beyond extremities of latter, which curves strongly forwards at sides. Borders of usual type; lateral borders rather strongly convex anteriorly; posterior border moderately raised in front of posterior excavation.

Thorax (imperfectly preserved and only in pressed specimens) with the rachis apparently moderately or gently convex and anteriorly nearly parallel-sided, posteriorly tapering slightly. Dorsal furrows narrow, sharply impressed. Pleuræ flattened and horizontally extended to fulcræ, which appear to be weak and rounded and are situated about one-third the width of pleural portions distant from dorsal furrows; extra-fulcræ portions, apparently, curving gently downwards and backwards, with relatively long, backwardly directed, pointed ends. Pleural furrows strong and long.

Pygidium (excluding pleural spines) sub-semielliptical to sub-triangular, sagittal length about three-fourths width at anterior margin and slightly more than half the (greatest) width across anterior spines. Rachis extending somewhat more than half the sagittal length of pygidium, anteriorly occupying about one-third its width, tapering posteriorly, rounded and indistinctly defined behind, moderately convex anteriorly, more gently convex across middle, then becoming more convex again posteriorly with apex rounded and slightly protruding; with four ring-furrows, the fourth weaker than the others and generally interrupted in middle (often effaced in specimens that are not very well preserved). Dorsal furrows distinctly impressed, narrow, nearly straight at sides of rachis, bending more inwards at its extremity and produced behind it about half-way to posterior margin — to inner margin of doublure — converging for part of this distance, posteriorly becoming sub-parallel or, more often, curving outwards and sometimes weakening.

Pleural portions of pygidium with sub-triangular, posteriorly tapering, flattened areas in front adjacent to dorsal furrows, beyond these areas sloping very gently downwards; with three pairs of furrowed pleuræ, separated by narrow, sharply impressed interpleural furrows, and ending in unusually long, tapering, acutely pointed, backwardly directed spines. Anterior two pairs of spines of sub-equal length, and sub-equal in length to inner attached portions of pleuræ, proximally close together, diverging gradually postero-laterally;

distal margins of first pair directed only slightly outwards; distal margins of second pair directed nearly straight back. Basal pair of spines about as long as the others, or slightly shorter, pointing nearly straight back, placed at considerable distance from bases of second pair. Pleural furrows about as strong as interpleural furrows; first pair directed at 55° to 60° , second pair at 35° to 40° to sagittal line, both distinctly impressed to marginal portion of pygidium (= the portion above the doublure) and continued by weaker, more backwardly directed, short grooves. First and second interpleural furrows sub-parallel to first and second pleural furrows respectively, but bending more outwards on marginal portion especially the second ones. Third pair of pleural furrows beginning in dorsal furrows at considerable distance from anterior margins of pleurae, sub-parallel to second pleural and interpleural furrows, in some specimens connected with extremities of dorsal furrows by curved grooves, which are most distinct distally and weaken proximally (the distal portions, at least, probably discernible in all well-preserved specimens); sometimes also connected by weaker grooves with second interpleural furrows; the grooves, which correspond to inner margin of doublure, thus marking off marginal border-portions — in unpressed specimens slightly raised — bearing the third pair of spines and confluent with post-rachial piece. Traces of similar grooves, corresponding to inner margin of doublure, discernible in a few specimens on anterior band of second pleura. Bands of pleurae with gently raised surfaces; posterior bands of first two pairs distally higher than adjacent portions of anterior bands of same and following pleurae, and next the latter with slight swelling or bend indicating inner margin of »border». Doublure of pygidium rather narrow, increasing very gradually in width posteriorly.

Dorsal surface of cephalon and pygidium rather closely set with small, sub-conical tubercles with smaller tubercles and granules between them. Small close-set tubercles occur also on antero-lateral portions of central body, and, apparently (for the surfaces of those parts are not well preserved), still smaller ones or granules on most other parts of labrum; on its lateral borders the usual ridges are present.

Dimensions. — There are taken from one medium-sized cranidium (a = S.G.U. sp., with test preserved anteriorly), one small (b = R.M. Ar. 2216, internal cast), and one incomplete, large cranidium (c = O.M. H 2568, with test preserved on most parts): sagittal distance between anterior and posterior margin a) 16 mm., b) 9 mm.; width inside palpebral lobes (approximately) a) 12 mm., b) 6.5 mm.; glabella — sagittal distance between anterior and posterior margin, a) 12 mm., b) 6.5 mm., greatest width a) 11 mm., b) 6 mm., c) 22 mm.; fronto-median lobe — greatest width a) 10 mm., b) 5.5 mm., c) 18 mm., least width a) 2 mm. (about, test not preserved here), b) 1 mm. (about), c) 4 mm., basal width a) 4 mm., b) 2.5 mm.; bi-composite lobes — distance between anterior and posterior extremities a) 7 mm., b) 2.5 mm., c) 11 mm., greatest width a) 4 mm., b) 2 mm., c) 7 mm. In a medium-sized incomplete pygidium (O.M. H 2563) the sagittal length is 12 mm., the width at the anterior margin estimated at about 20 mm., the anterior width of the rachis is a little under

7 mm., and its length about 6 mm. The sagittal length of a pressed labrum (St. H.) is 10 mm.

Remarks. — So long ago as 1869 LINNARSSON (1869, p. 66) pointed out that ANGELIN's species *Lichas sexspinus* (ANGELIN, 1854, p. 74, Pl. 38, figs. 7—8 a) and *L. aculeatus* (Op. cit., p. 75, Pl. 38, figs. 11—11 a), as well as his own *L. segmentatus* (LINNARSSON, 1866, p. 18, Pl. 2, fig. 4) seemed to be identical with M^c COY's *L. laxatus*. That the fragmentary pygidium on which LINNARSSON in 1866 founded his species really belongs to the form described is not quite evident from the figure, but this arises from the fact that the figure is drawn from a strongly pressed and somewhat distorted specimen, and has been a little »restored», but not correctly.

According to ANGELIN's diagnoses of his two species *L. aculeatus* should differ from *L. sexspinus* in having the median lobe of the glabella relatively narrower and in the possession of a median spine on the occipital ring. These differences as well as others are shown in ANGELIN's figures, which, however, are incorrect. The originals are, as far as they are preserved, very alike in characters (cf. below, Pl. 12, figs. 6 a—b, 10). In the original of *L. aculeatus* (R.M. Ar. 2216) the median portion of the occipital ring is not preserved. Possibly ANGELIN had examined it, before it was as much damaged as it is now. That it once had a spine does not appear likely. Probably ANGELIN had observed the raised ridge, which presumably always is present on this portion (cf. description), or traces of it, in this or in some other specimen and believed it to be the base of a spine. Possibly the spine was originally intended to be drawn on the figure of the cranidium of *L. sexspinus*. In the original of this (O.M.) the scar of the broken off ridge is quite distinct, the occipital ring being well preserved except at that place.

This species has an unusually great vertical range. In Sweden it occurs both in the Chasmops Limestone and in the Trinucleus Shales. Especially in the red Trinucleus Shales of Västergötland has a great number of specimens been found. Among them there are both detached portions of the different parts of the dorsal shield and one labrum, and also a good number with different portions in attachment, but the specimens are generally much pressed. ANGELIN's original of his *Lichas aculeatus* is from Kinnekulle and occurs in a flinty limestone, which appears to be Chasmops Limestone. Thus ANGELIN's statement that it is from his Regio D b (the Trinucleus Etage), seems to be incorrect. Several specimens have been found in the Chasmops Limestone at other places in Västergötland, and a few in the upper part of this étage in Skåne. From Dalarne the species is represented in the Uppsala Museum by a distorted cranidium found at Osmundsberg in pelmatozoan limestone apparently belonging to the Boda Limestone. A cranidium has also been found in a boulder of Östersjö Limestone from the North Baltic Area.

In the Oslo Museum the species is represented by a great number of specimens from the Norwegian Chasmops Limestone. Among them are ANGELIN's originals of his *Lichas sexspinus*, which are refigured here (Pl. 12, figs. 10—12). His figure of the pygidium is evidently drawn from two specimens.

According to BRÖGGER (1884) specimens which appeared referable to this species have also been found in Norway at some different horizons in the Trinucleus Etage. Those specimens were not in the Oslo Museum.

The Norwegian specimens, not being pressed as a rule, are generally in a better state of preservation than the Swedish ones. The above description is based on both the Swedish and the Norwegian material.

The pygidium which SCHMIDT in 1885 (p. 125, Pl. 6, fig. 24), correctly as it seems, referred to this species is from the lower part of the Lyckholm Formation (F₁).

In the British Isles *Platyl. laxatus* occurs in strata of Ashgillan age, but it has also been reported from lower horizons. The cranidia found in Scandinavia agree closely in characters with Irish specimens¹ — and with those from Wales as described and figured by SALTER (1848, p. 340, Pl. 8 figs. 4, 6) — but the pygidia do not quite agree with SALTER'S (op. cit. Pl. 8, fig. 5) figure of the pygidium as has already been pointed out by LINNARSSON (1866, p. 18) and SCHMIDT (1885, p. 126). In this figure — the original I have not seen — the border is more pronounced, being very distinctly marked, not only posteriorly, but also on the anterior bands of the second pair of pleurae; the bases of the second pair of spines are separated by a considerable portion of the margin from those of the first; and both these pairs of spines seem to form the continuation of only the posterior bands of the pleurae.

The Scandinavian specimens vary, however, as mentioned in the description, in the characters of the marginal portion, partly, it appears, owing to the state of preservation. In some that do not appear to have been pressed, the border is posteriorly fairly well marked and rounded, and naturally narrower than in specimens where those portions have become flattened. In a few specimens the border is also indicated on the anterior band of the second pleura. Probably this feature is more pronounced in SALTER'S specimen. In a pygidium from Keisley in England (Sedgwick Museum, Cambridge A 3492) — mentioned by REED in his paper of 1896 (p. 427) — which otherwise agrees well with Scandinavian specimens, this is the case. As far as I can now remember, there were in the Dublin Museum also pygidia which agree better with SALTER'S figure than do any among the Scandinavian material, but I do not think that they differed much from the latter, and I suspect that the figure is exaggerated and embellished, as SALTER'S figures often are.

Affinities. — This species does not appear to be closely related to any other Swedish form. REED'S (1935, pp. 29, 32, Pl. 3, figs. 13—16, 17—18) *Platyl. crescenticus* (cephalon) and *thraivensis* (pygidium) from Girvan apparently

¹ The holotype (MC COY, 1846, Pl. 4, fig. 9) I have had the opportunity of examining in the National Museum at Dublin. It consists only of the impression of a part of the cranidium. There is, in the same museum, another cranidium from the same locality, which has the characters that have been considered typical for the species, and as far as the holotype shows the characters it resembles that specimen. The fragmentary, badly distorted pygidium — in the same museum — named *Calymene? forcipita* by MC COY, apparently belongs to *Platyl. laxatus*, as originally pointed out by SALTER.

show many similarities, but, as far as can be judged from his figures and descriptions, there are differences as well.

Horizons and Localities. — Red Trinucleus Shales. — Västergötland: Kongslena. Gray Trinucleus Shales. — Västergötland: Bestorp. Pelmatozoan limestone apparently belonging to the Boda (Upper Leptaena) Limestone. — Dalarne: Osmundsberg. Chasmops Limestone. — Västergötland: Jonstorp, Ålleberg, Kinnekulle. — Skåne: Fågelsång. Östersjö Limestone. — In boulder from the North Baltic Area found at Assjö in Uppland.

Chasmops Limestone. — Norway.

?Lyckholm Formation. — Esthonia.

Upper Ordovician. — British Isles.

Platylichas sp. ind. b.

1925. *Platylichas* sp. ind. b, WARBURG, p. 289, Pl. 7, fig. 18.

Horizon and Locality. — Boda (Upper Leptaena) Limestone. — Dalarne: Lissberg (a fragmentary pygidium).

The *Platylichas lingua*-group.

Group Characters. — Cranidium with anterior portion — or with anterior portion of glabella — sub-triangular; anterior border of cranidium widening proximally and produced in front into a marginal extension, well defined from glabella; glabella flattened on top posteriorly; glabella along median line only slightly or hardly at all curved down in front, but with surface sloping downwards antero-laterally; fronto-median lobe with long (transversely), pointed antero-lateral extensions, neck narrowing posteriorly to roughly one-fourth anterior width of lobe, suddenly expanding at base to about half this width, without independent convexity, except sometimes expanded basal portion; bi-composite lobes with or without slight independent convexity, completely defined, oblique; basal lobes of moderate length, undefined distally; occipital lobes elongated sub-ovate. Rostral shield produced anteriorly forming ventral part of marginal extension; its posterior margin arched strongly forwards. Labrum with anterior portion sub-triangular and extending far in front of anterior wings. Pygidium (as far as known) with lateral margins of anterior pair of pleuræ nearly straight or gently rounded; rachis convex, much shorter than post-rachial piece, with three ring furrows, the third often incomplete; pleuræ elongate, with moderately long, broad-based, tapering, pointed, backwardly directed free terminations.

Remarks. — The species referable to this group, *Platyl. lingua* n. sp., *Platyl. planifrons* (ANG.), *Pl. Warburgi* THORSL., *Pl. nasutus* (WIG.), *Pl. validus* (LNRSN.), and *Pl. Wegelini* WARB., appear to be closely related, but differ from one another in some characters, especially in the character of the anterior marginal extension. All belong to the fauna of the Kullsberg (Lower Leptaena) Limestone of Dalarne, but they have not all been found on the same horizon. *Platyl. nasutus* occurs in the shaly bottom layers and in the lower part

of the true reef-limestone, whereas *Platyl. lingua*, *Platyl. validus*, and *Platyl. Warburgi* have been found in the upper part of the formation. From which part of the formation *Platyl. planifrons* and *Platyl. Wegelini* originate, I do not know.

Platylchas planifrons (ANGELIN, 1854).

Pl. 9, fig. 12.

1854 & 78. *Platymetopus planifrons*, ANGELIN, p. 73 (pars) Pl. 38, fig. 3 (non figs. 3a—3b).

Remarks. — In 1925 I referred to this species a form of which a great number of specimens have been found in the Kullberg Limestone of Dalarne, especially at Kullberg. I have now come to the conclusion that this form probably does not belong to ANGELIN'S species, but represents a distinct one, which I have called *Platyl. lingua* (cf. below).

The holotype of ANGELIN'S species consists of a very fragmentary pygidium (R.M. Ar. 6032; Pl. 9, fig. 12). As far as it is preserved, it resembles the pygidia that apparently belong to *Platyl. lingua* except in the ornament of the test, which is very finely and relatively evenly granulate, as shagreen. In *Platyl. lingua* the coarseness of the ornament varies very much and is different on different parts (cf. WARBURG, 1925, p. 269). Sometimes it is very fine, but even in such cases there occur, rather sparingly but regularly distributed among the closely placed minute granules, somewhat larger granules or small tubercles which appear to correspond to the sometimes fairly large tubercles found in other specimens.

It is quite possible that one of the other forms described from the Kullberg (Lower Leptaena) Limestone belongs to ANGELIN'S species. *Platyl. nasutus* WIGAND may perhaps belong there. In 1925 this species had been found, in Dalarne, only in the shaly layers of the Kullberg (Lower Leptaena) Limestone at Amtjärn, but recently a great number of specimens, which apparently belong to this species, have been collected in the lower part of the true reef limestone. In the pygidia the portions corresponding to those preserved in the holotype of *Platyl. planifrons* show the same characters and the ornament of the test appears to be similar, but the state of preservation being different, it is difficult to be sure of this. It is conceivable also that the fragmentary cranidium from Furudal (R.M. Ar. 6335) described and figured by me in 1925 (p. 273, Pl. 7, fig. 5) as *Platyl. Wegelini* HOLM in Mus. belongs to ANGELIN'S species. The test is worn and its ornament indistinct, but it seems as if it might have been finely granulate. I do not know from which part of the Lower Leptaena Limestone this specimen originates. *Platyl. nasutus* occurs, as just mentioned, in the lower part, both in the shaly layers and in the true reef limestone. It has not been found in the upper part of the Kullberg Limestone, and it does not appear to be represented there. *Platyl. lingua*, on the other hand, appears to occur only in that part. From which part the holotype of *Platyl. planifrons* originates, I do not know. That it is from the Kullberg Limestone is, however, practically certain, and it comes from the true reef limestone.

ANGELIN did not mention any locality, he merely stated that the specimen had been found in Dalarne in his Regio DE (the Leptaena Limestone). According to a pencil note on the Museum label, the correctness of which there does not seem to be any reason to doubt, it was collected at Arfvet¹. That Kullberg (Lower Leptaena) Limestone occurs at this locality has recently been ascertained, but it is as yet imperfectly investigated. It is not improbable that further investigation and new finds will make it possible to ascertain, not only from which part the specimen originates, but also the true characters of ANGELIN's species and whether any of the forms mentioned belong to it. At present, however, this is not possible. The only specimen representing a *Platylichas* that has been collected at Arfvet during recent years is a small labrum of the *Platyl. lingua*-type, now in the Uppsala Museum.

Horizon and Locality. — Kullberg (Lower Leptaena) Limestone. — Dalarne: Arfvet.

***Platylichas lingua* n. sp.**

Pl. 9, fig. 11, Pl. 13, figs. 10 a—b.

- | | | |
|-------|---------------------------------|---|
| 1884. | <i>Platylichas planifrons</i> , | TÖRNQUIST, p. 35, Pl. 1, fig. 34. |
| 1925. | » | » |
| | » | WARBURG, p. 263, Pl. 6, figs. 11, 12, 14—23, Pl. 7, fig. 9? |
| 1930. | » | » |
| | » | THORSLUND, Pl. 4, fig. 7 (copy after WARBURG). |
| 1936. | » | » |
| | » | THORSLUND, Pl. 1, fig. 8. |

Diagnosis. — Anterior marginal extension rather distinctly defined from narrow side portions of anterior border, long and wide, its length more than half, generally about three-fourths, that of glabella, generally increasing in width to about middle, sometimes nearly parallel-sided, anterior outline strongly rounded; surface flattened, sloping downwards posteriorly, the slope, at least sometimes, becoming steeper near the preglabellar furrow. Anterior outline of glabella sub-triangular, with side portions nearly straight or slightly concave outwards, and median portion arched rather strongly forwards. Glabella along median line hardly at all curved downwards in front, antero-lateral portions of fronto-median lobe narrow (longitudinally), sloping less steeply downwards towards the front than foremost portions of bi-composite lobes (and generally more gently towards the sides than adjacent proximal portions of lobe). Pygidium with antero-lateral angles very narrowly rounded and outer margins of pleurae nearly straight. Ornament of test fine to relatively coarse, tubercles of various sizes, on most parts rather sparingly distributed, and between the tubercles minute granules.

Remarks. — As already stated above (p. 126), this form, described and figured by me in 1925 as *Platyl. planifrons* ANG., appears to represent a new species, which I have called *Platyl. lingua*. The holotype is the cranidium from Kullberg illustrated in fig. 15 of Pl. 6 in my work of 1925.

¹ In my work of 1925 I did not mention this. At that time not being aware of the fact that the Kullberg (Lower Leptaena) Limestone was represented at Arfvet, I suspected that the specimen had been found elsewhere, and that this note was owing to some mistake.

In the material of this species collected during recent years and now in the Uppsala Museum is a fragmentary individual showing the number (eleven) of thoracic segments and one cranidium with the rostral shield in position. The rostral shield shows the characters that might have been expected. It consists of a large, broad, rounded anterior portion and narrow postero-lateral portions, and has the posterior margin arched strongly forwards.

Horizon and Localities. — Upper part of Kullberg (Lower Leptaena) Limestone. — Dalarne: Kullberg (holotype, cranidium, U.M.; original WARBURG, 1925, Pl. 6, fig. 15), Furudal, Amtjärn, Skälberget, Sinksjön?

Platyliehas Warburgi THORSLUND, 1930.

Pl. 13, fig. 11, fig. 12?

1925. *Platyliehas planifrons* var., WARBURG, p. 271 (pars), Pl. 7, fig. 6?

1930. » *Warburgi*, THORSLUND, p. 299, Pl. 4, figs. 3, 6.

Diagnosis. — Anterior marginal extension about half as long as glabella, broad at base, tapering anteriorly to narrow, rounded front end, surface very gently convex on median portion, the curvature becoming stronger at sides. Anterior outline of glabella arched forwards with side portions nearly straight and median portion broadly rounded. Cranidium otherwise closely similar to that of *Platyl. lingua*. Ornament of test fine (in the specimens so far recognized), small tubercles, on most parts rather sparingly distributed, and between the tubercles minute granules.

Remarks. — This species was founded by THORSLUND on two cranidia (both in the Uppsala Museum) from the Kullberg (Lower Leptaena) Limestone of Dalarne. The one, the holotype, he had collected at Skälberget. The other is a specimen from Kullberg, which was described by me in 1925 (p. 271) as possibly representing a new species, but provisionally placed with the form that I have now called *Platyl. lingua* (cf. above). In this the anterior outline of the glabella is somewhat more broadly rounded and the basal portion (the only part preserved) of the anterior extension tapers more slowly than in the holotype, and as a consequence of the more abrupt change in the direction of the margin, the extension is better defined from the narrow side-portions of the anterior border. In other respects the two specimens agree well in characters.

There is also another specimen among those provisionally placed with the form just mentioned in my work of 1925 that appears to belong to THORSLUND's species, viz the fragmentary cranidium from Furudal mentioned on p. 271 and illustrated in fig. 6 of Pl. 7. It agrees rather better with the holotype than with the specimen from Kullberg.

A pygidium in the Uppsala Museum found at the same locality as the holotype belongs possibly to this species. It differs from typical pygidia of *Platyl. lingua* in having the outer margins of the pleurae gently rounded and the basal pair of pleural furrows more curved. The tuberculation of the surface is fine as in the cranidium.

Horizon and Localities. — Kullberg (Lower Leptaena) Limestone. — Dalarne: Skälberget (holotype U.M.), Kullberg, Furudal?

Platylichas nasutus (WIGAND, 1888).

Pl. 13, figs. 1—8.

1888. *Platylichas nasuta*, WIGAND, p. 69, Pl. 8, figs. 7 a—b.
 1925. » » WARBURG, p. 274, Pl. 7, fig. 7—8.
 1930. » » THORSLUND, Pl. 4, fig. 5 (copy after WARBURG).
 1936. » » aff. *planifrons*, THORSLUND, Pl. 1, fig. 9.

Diagnosis. — Anterior border of cranidium narrow at sides, gradually increasing in width and curving upwards proximally and produced in middle into short, sub-triangular, obtusely pointed anterior extension, which is somewhat compressed from the sides and rounded longitudinally. Anterior outline of glabella arched forwards with side portions very gently curved outwards, and median portion broadly rounded or nearly transverse (apparently as result of pressure sometimes arched backwards). Glabella along median line gently curved downwards in front, antero-lateral extensions of fronto-median lobe of moderate width (longitudinally), generally sloping downwards with about the same degree of steepness as foremost portions of bi-composite lobes. Pygidium with outer margins of pleurae distinctly rounded. Surface finely granulate.

Remarks. — This species was originally founded by WIGAND on a cranidium found in Mecklenburg in a boulder of »Backstein»¹, and specimens found in the shaly layers of the Kullberg (Lower Leptaena) Limestone at Amtjärn in Dalarna were described and figured by me in 1925 (p. 274, Pl. 7, figs. 7—8). A great number of specimens (cranidia, pygidia and labra) that apparently belong to this species have since then been collected in the lower part of the true reef-limestone at Amtjärn and are now in the Uppsala Museum. In the unpressed cranidia from the limestone the marginal extension is shorter — although of somewhat varying length — more obtusely pointed in front, and more rounded longitudinally, and less compressed from the sides than in the pressed specimen from the shaly layers figured by me in 1925 and refigured here (Pl. 13, fig. 7). It appears probable, however, that in the latter the shape of the extension has been altered by the pressure. The pressure has apparently also caused a flattening of the foremost portion of the glabella and to some extent altered its anterior outline, which in its median part is arched backwards. In the cranidia from the reef-limestone the corresponding part of the glabellar outline is generally gently arched forwards or nearly transverse. In the cranidium from the shaly layers the granulation of the test appears somewhat coarser and more uneven than in testiferous specimens from the reef-limestone, but this is probably only, or chiefly, owing to the fact that the surface of the test is badly preserved, and most of the smaller granules more or less effaced and the remaining larger ones consequently relatively conspicuous.

I have not seen the holotype, but I suspect that this also is somewhat pressed. According to WIGAND'S (1888, p. 69, Pl. 8, figs. 7 a—b) description and figures the anterior outline of the glabella is distinctly arched backwards

¹ Another cranidium has, according to KUMMEROW (1927, p. 31), been found in a boulder of the same kind of rock at Brandenburg.

in the middle. The marginal extension seems to have about the same shape as in my old specimen, but to be somewhat shorter; to judge from the figures the length along the surface of the extension does not appear to be greater, in relation to the dimensions of other portions, than in some of our specimens from the reef-limestone, but the projected length is greater than in those. The ornament of the test seems to be as in the Swedish specimens («Die granulierung ist eine sehr feine», WIGAND, 1888, p. 70).

As already mentioned above, even among the cranidia from the reef-limestone, the anterior marginal extension varies somewhat in length, and in some specimens it is more strongly rounded longitudinally and more bluntly pointed than in others. Also in some other features the cranidia vary to some extent, e.g. in the degree of steepness of the lateral slopes, in the relative width of the antero-lateral extensions of the fronto-median lobe of the glabella, in the width of the bi-composite glabellar lobes, and in the directions of the antero-lateral margins of the cranidium and the glabella, which in some specimens converge less strongly anteriorly than in others.

In my work of 1925 (p. 276) I recorded as probably belonging to this species two fragmentary labra and a portion of a badly preserved pygidium which had been collected at Amtjärn in the same layers as the cranidium described. Another somewhat less fragmentary labrum (R.M. Ar. 6336) from the same kind of shaly layers and in all probability from the same locality is now available. These specimens agree well, as far as they are preserved and show the characters, with the labra and the pygidia from the reef-limestone. There does not seem to be any reason to doubt that these portions really belong to our species. The labrum is closely similar to that of *Platyl. lingua*. Judging from my old material, I believed that a distinctive character might be found in the direction of the middle furrows, but, to judge from the better preserved specimens now available, this does not appear to be the case. The pygidium also is very like that of *Platyl. lingua* but differs in having the outer margins of all the pleurae distinctly rounded.

The rostral shield and a portion of the right free cheek, with the eye, are preserved together with one of the cranidia. The cheek is in its right position. The marginal part of the anterior border and border-extension of the cranidium is broken off and together with the attached rostral shield pushed slightly out of position. The rostral shield has about the same transverse extension as the anterior border of the cranidium and has a similar shape, except that it narrows more gradually towards the sides and has the posterior margin arched more strongly forwards in the middle. Its surface is gently rounded longitudinally.

The test of the cranidium and the pygidium is finely and relatively evenly granulate. The granules are not all of the same size, but there are no especially conspicuous ones.

The fragmentary free cheek figured by me in 1925 (Pl. 6, fig. 13; p. 273) and provisionally with a mark of interrogation attributed to *Platyl. Wegelini* (cf. below, p. 132) agrees in the ornament of the test with the cranidia and

the pygidia belonging to *Platyl. nasutus*, and it is not improbable that it is referable to the latter species. Possibly further investigation will prove that the specimen which I called *Platyl. Wegelini* does not represent a distinct species but belongs to *Platyl. nasutus* (cf. below), and it is even possible that both *Platyl. Wegelini* and *Platyl. nasutus* really are identical with *Platyl. planifrons* (ANG.) (cf. above, p. 126).

Horizons and Localities. — Lower part of Kullberg (Lower Leptaena) Limestone (both in true reef-limestone and in shaly layers). — Dalarne: Amtjärn.

North Germany, in boulder(s) of »Bäckstein» (holotype, cranidium, WIGAND, 1888, Pl. 8, figs. 7 a—b).

Platylichas Wegelini WARBURG, 1925.

Pl. 13, fig. 9.

1925. *Platylichas Wegelini* HOLM in Mus., WARBURG, p. 273, Pl. 7, fig. 5, Pl. 6, fig. 13?

Remarks. — This species was founded by me in 1925 on an incomplete cranidium (R.M. Ar. 6335) from the Kullberg (Lower Leptaena) Limestone at Furudal in Dalarne, which had previously been named by HOLM on the museum-label. I think now that this specimen, on account of its fragmentary condition, should not have been made the holotype of a new species. At the time, of course, I fully believed that it represented a distinct form. I now suspect that it will ultimately prove necessary to place it in *Platyl. nasutus* [or possibly in *Platyl. planifrons* (ANG.) cf. above, p. 126], but since I am not at present able to settle this matter definitely, it seems safer to keep the forms apart rather than to assume a possibly non-existing specific identity.

In my work of 1925 (p. 277) I stated that *Platyl. Wegelini* differed from *Platyl. nasutus* in several characters. Of the latter I had, for comparison only the cranidium from the shaly layers of the Leptaena Limestone at Amtjärn described and figured in that work (refigured below, Pl. 13, fig. 7). This appears to have been somewhat more altered by pressure than what I then suspected, and the apparent difference in the ornament of the test is probably chiefly due to the different state of preservation (cf. above p. 129); in both specimens the surface of the test is badly preserved. Still, they differ decidedly in some feature of primary nature, e.g. the direction of the antero-lateral borders of the cranidium and the glabella, in the relative width of the antero-lateral extensions of the fronto-median glabellar lobe, and in the shape of the bi-composite lobes. The new material of *Platyl. nasutus* shows, however, that the cranidia vary in all these characters. In none of them, however, the bi-composite glabellar lobe is as wide as in *Platyl. Wegelini*, and generally the antero-lateral margins of the glabella converge more strongly, but in one specimen they have about the same direction as in that form. In the latter the foremost portion of the cranidium is not preserved. Indubitably an anterior marginal extension was present and its character was probably about the same as in *Platyl. nasutus*, although perhaps not quite the same, a

difference being indicated by the nature of the lateral portion of the anterior border, which increase more gradually in width than is generally the case in that species.

As stated above (p. 126) *Platyl. nasutus* seems to occur only in the lower part of the Kullberg Limestone. I do not know from which part of the formation the holotype of *Platyl. Wegelini* originates.

As already mentioned (p. 130) it is quite possible that the fragmentary free cheek, which I in 1925 (p. 273, Pl. 6, fig. 13) provisionally and with a mark of interrogation attributed to *Platyl. Wegelini* belongs to *Platyl. nasutus*. The specimen (which is associated with a labrum which probably belongs to the same species) has probably been found in the Kullberg Limestone at Sinksjön, but I do not know, in this case either, from which part of the formation it originates.

Horizon and Locality. — Kullberg (Lower Leptaena) Limestone. — Dalarne: Furudal (holotype, cranidium, R.M. Ar. 6335; below, Pl. 13, fig. 9), Sinksjön?

***Platylichas validus* (LINNARSSON, 1869).**

Pl. 14, figs. 2—8.

1869. *Platylichas validus*, LINNARSSON, p. 66, Pl. 1, figs. 19—20.

1901. " " GÜRICH, Pl. 20, fig. 1 (copy after LINNARSSON).

1925. " *planifrons* var., WARBURG, pp. 271, 72 (pars).

Diagnosis. — Anterior marginal extension (incompletely known) with posterior portion broad, tapering anteriorly, strongly convex from side to side. Central portion of cranidium (glabella, convex portions of fixed cheeks, and occipital ring) relatively long and narrow; flattened lateral areas of fixed cheeks relatively wide. Anterior outline of glabella arched strongly forwards, with side portions slightly curved outwards, and median portion sub-truncate or very broadly rounded. Antero-lateral extensions of fronto-median lobe wide (longitudinally), with steep, even lateral slopes, anterior slopes more gentle but about as steep as that of foremost portions of bi-composite lobes. Pygidium (incompletely known) with antero-lateral angles scarcely rounded and distal margins of — at least — anterior pair of pleurae nearly straight. Surface coarsely and thickly tuberculate, tubercles occurring on labrum as well as on other portions.

Remarks. — This species was founded by LINNARSSON on a cranidium and a fragmentary pygidium (cf. below, Pl. 14, figs. 7—8) from the upper Chasmops Limestone at Jonstorp on Mösseberg in Västergötland. The cranidium I have, naturally, selected as lectotype. In addition to these a few other specimens from the Chasmops Limestone of Mösseberg¹, which evidently belong to this species, are now available in Swedish collections, viz. four cranidia (R.M. Ar. 2198—2199, 6337—38), fragments of two pygidia (U.M., S.G.U.), and a pressed and distorted labrum (S.G.U.).

¹ Some of these specimens are labelled Jonstorp, Mösseberg, the others just Mösseberg, but it appears probable that the latter also have been collected at or near Jonstorp.

Apparently »the coarsely tuberculate form» from the Kullberg (Lower Leptaena) Limestone at Kullberg in Dalarna, described by me in 1925 (pp. 271—72), and provisionally referred to the species which I have now called *Platyl. lingua* (cf. above, p. 127), belongs to *Platyl. validus*, as I then suspected. The material from Kullberg (which belongs to the Uppsala Museum) consists of two incomplete cranidia, fragments of three other cranidia, two fragmentary pygidia, and three labra.

From the Norwegian Etage 4 b our species is represented in the Oslo Museum by an incomplete cranidium found on Nackholmen.

No entire pygidia of this species are known, nor any cranidia in which the anterior marginal extension is complete. The lateral portions of the anterior border, which increase in width and slope upwards proximally, are preserved in several specimens; in the lectotype among others, but LINNARSON'S (1869, Pl. 1, fig. 19) figure gives a false impression of their character. In one of the cranidia from Dalarna a fairly large portion of the extension itself is preserved. It is not distinctly marked off from the lateral portions of the anterior border and tapers anteriorly, more strongly so at first, then very gradually; probably the extension was long, and the strong convexity of the preserved posterior portion is notable. The cranidium differs also decidedly in some other features from the other species belonging to this group, as the diagnoses show. The anterior portion of the labrum is more extended than in any of these and its middle furrows are more oblique. The pygidium seems to have about the same characters as that of *Platyl. lingua* except as regards coarser tuberculation of the test.

Horizons and Localities. — Upper Chasmops Limestone — Västergötland: Jonstorp on Mösseberg (Lectotype, cranidium, S.G.U.; below Pl. 14, fig. 8). — Upper part of Kullberg (Lower Leptaena) Limestone. — Dalarna: Kullberg.

Etage 4 b. — Norway: Nackholmen.

Genus *Dicranopeltis* CORDA, 1847.

Genotype: *Dicranopeltis scabra* (BEYRICH, 1845).

Synonyms: *Lichas* BEYRICH 1845 pars, auctt. pars. — *Lichas (Trachylichas)*, GÜRICH 1901. — *Lichas (Dicranopeltis)* REED 1902, 1923. — *Dicranopeltis + Dicranopeltoides + Macromuktis* PHLEGGER 1936.

Diagnosis. — Cranidium with complete dorsal furrows; prolonged anterior lateral glabellar furrows not reaching occipital furrow, basal portion of median lobe defined at sides only by weak grooves or slight depressions; basal lateral glabellar furrows well defined; occipital lobes well defined. Pygidium with prolonged dorsal furrows dying out before reaching margin, or growing weak posteriorly and ending and nearly meeting at fork between free terminations of basal pair of pleurae; rachis with two ring furrows, rather indistinctly defined behind, continued by long post-rachial piece; pleural portions composed of three pairs of furrowed pleurae ending in free points.

Dicranopeltis polytomus (ANGELIN, 1854).

Pl. 11, figs. 4—6.

1854 & 78. *Lichas polytomus*, ANGELIN, p. 69, Pl. 36, fig. 3.1884. *Lichas elegans*, TÖRNQUIST, p. 29, Pl. 1, fig. 25.1925. *Dicranopeltis elegans*, WARBURG, p. 291, Pl. 7, figs. 27, 31, Pl. 8, figs. 9—10.

Diagnosis. — Cranidium strongly convex, but flattened on top. Glabella sub-pentagonal, rather wider than long, flattened posteriorly, very steeply curved downwards and slightly overhanging anteriorly; fronto-median lobe narrowing posteriorly to about one-third anterior width at inner extremities of basal lateral furrows, and occupying here about one-third entire width of glabella, then widening slightly to base and defined from basal lobes by only weak grooves: bi-composite lobes relatively large, irregularly sub-elliptical, oblique, convex; basal lobes quadrilateral, rather wider than long, very gently convex. Occipital lobes sub-triangular, extending beyond base of glabella. Pygidium sub-semielliptical; rachis extending less than half the length and anteriorly occupying less than one-third width of entire pygidium, strongly convex with terminal piece bulbous in middle; post-rachial piece long, tapering, bounded to its pointed extremity by the prolonged dorsal furrows; pleural portions flattened; pleural furrows long; anterior two pairs of pleurae of moderate width, with moderately long, backwardly directed, pointed free ends; basal pair broader, with shorter, more broad-based free points, separated by acutely angulated narrow emargination. Surface covered by low tubercles of different sizes.

Remarks. — When TÖRNQUIST introduced the name *Lichas elegans* for this species, which he founded on two cranidia from the Boda (Upper Leptaena) Limestone of Dalarna, he evidently did not suspect that his »new» species was identical with ANGELIN's *Lichas polytomus*. Neither did I myself when in 1925, I gave a new description of the species founded on the material from Dalarna then available, which, in addition to TÖRNQUIST's specimens, included a third cranidium and a pygidium. It is indeed hardly possible to recognize the form only from the figure (of a fragmentary cranidium) and the short — partly incorrect — diagnosis given by ANGELIN.

ANGELIN stated that the species occurred in his regio DE (the Dalmanites Shales), at Alleberg in Västergötland, and it is represented from there in our State Museum of Natural History by three fragmentary cranidia (Ar. 6024—26) which apparently were there already in ANGELIN's time, by six others (Ar. 2197, 6027—30), which seem to have been collected later, and by the impression of a part of a pygidium (Ar. 6031), and further by one cranidium in the Museum of the Geological Survey. The specimens are compressed, mostly badly crushed or only fragmentary. Except for such features as depend on the state of preservation they agree well with the specimens from Dalarna. ANGELIN's figure gives a wrong impression of the characters of the cranidium. The prolonged anterior glabellar furrows do not reach the occipital furrow as indicated both in that figure and in his diagnosis; they are only — as in the

specimens from Dalarna — connected with it by slight, ill-defined grooves, or, it is perhaps more correct to say, by the depressions formed between the slightly independently convex basal lateral glabellar lobes and the likewise slightly convex base of the fronto-median lobe. These depressions are placed a little further towards the sides than are the posterior portions of the furrows in the figure. The other misconceptions of the characters illustrated in the figure are easily understood by an examination of the incomplete and badly preserved specimens from which it apparently was drawn. The specimens Ar. 6024 and Ar. 6025 seem both to have been used. As lectotype I have chosen specimen Ar. 6025.

In addition to the material already mentioned there is now available a cranidium from Östbjörka, collected by Dr. O. ISBERG and in his possession.

Horizons and Localities. — Dalmanites Shales — Västergötland: Ålleberg (lectotype R. M. Ar. 6025; below, Pl. 11, fig. 6). Boda (Upper Leptaena) Limestone. — Dalarna: Osmundsberg, Lissberg in Gulleråsen, Östbjörka.

Genus *Leiolichas* FR. SCHMIDT, 1885.

Genotype: *Leiolichas illaenoides* (NIESZKOWSKI, 1857).

Synonyms: *Platymetopus* NIESZKOWSKI 1857. — *Lichas* auctt. pars. — *Lichas* (*Leiolichas*) SCHMIDT 1885, POMPECKI 1890, GÜRICH 1901, REED 1902, 1923.

Diagnosis. — Cranidium and pygidium (the only parts known) utuberculated, the furrows weak or not at all marked on surface of test; dorsal furrows complete; prolonged anterior lateral glabellar furrows (as shown on casts) rather deeply impressed to some distance in front of occipital furrow, and connected with it by weaker grooves; middle and basal pair obsolete, sometimes represented by traces on casts; occipital lobes present. Pygidium with lateral and posterior margins forming a continuous curve; on casts: dorsal furrows of moderate length not reaching posterior margin, rachis with one ring-furrow, pleural portions with five pairs of furrows not reaching margin.

Leiolichas illaenoides (NIESZKOWSKI, 1857).

Pl. 3, figs. 7—10.

1857. *Platymetopus illaenoides*, NIESZKOWSKI, 622, Pl. 3, figs. 3—5.

1874. *Lichas convexa* (?), STEINHARDT, p. 34, Pl. 3, figs. 7 a—b.

1885. » *illaenoides*, SCHMIDT, p. 46, Pl. 3, figs. 27—31.

1890. » » POMPECKI, p. 43, Pl. 5, figs. 12—13.

1901. *Leiolichas illaenoides*, GÜRICH, Pl. 20, fig. 18 (copy after SCHMIDT).

1902. *Lichas illaenoides*, REED, p. 80, text-figs. 16 a—b (copies after SCHMIDT).

1920. *Leiolichas illaenoides*, FOERSTE, Pl. 4, figs. 6 a—b (copies after SCHMIDT).

Diagnosis. — Glabella somewhat wider than long, relatively broadly rounded in front, rather gently convex in both directions posteriorly and in middle, rather steeply curved downwards in front; fronto-median lobe (as shown on casts) narrowing posteriorly to a little behind middle, then increasing in width to base, width across narrowest portion less than one-fourth of width

in front, about two-fifths of width at base, less than one-fourth of width of entire glabella; tri-composite lobes somewhat luniform in outline, elongate; prolonged anterior lateral furrows scarcely discernible, dorsal furrows very narrow and shallow on surface of test; on casts, both kinds well marked, but not deep and rather narrow. Occipital furrow narrow and shallow on surface of test; on casts, stronger than other furrows on cranidium. Occipital lobes sub-elliptical, extending considerably beyond base of glabella, but not so far outwards as main portion of occipital ring. Pygidium with anterior margin gently arched forwards, posterior and lateral margins forming a broad sub-semielliptical curve, rather strongly convex with a flattening on top, with weak approximate fulcra and indistinctly defined sub-triangular facets on anterior edge; rachis anteriorly occupying more than one-third width of pygidium, and extending about two-thirds its length, on surface of test only defined in front; pleural and interpleural furrows (as shown on casts) nearly straight, dying out a good distance from margin; anterior pair of furrows directed slightly backwards, following ones successively more and more strongly backwards, or last pair sub-parallel to the preceding, or directed slightly more outwards.

Description. — Width of cranidium between middle of palpebral lobes exceeding length. Glabella rather gently convex in both directions posteriorly and in middle, rather steeply curved downwards in front, somewhat wider than long, its greatest width in front of middle, rather broadly rounded in front, narrowing posteriorly, but with its hindmost portion nearly parallel-sided. Glabellar lobes without independent convexities. Fronto-median glabellar lobe widest in front, narrowing posteriorly to a little behind middle of glabella, then increasing in width to occipital furrow; width across narrowest portion less than one-fourth frontal width, about two-fifths basal width, and less than one-fourth entire width of glabella. Tri-composite lobes somewhat luniform in outline, about twice as long as wide. Prolonged anterior lateral glabellar furrows scarcely discernible on the surface of the test, but well marked on interior casts though rather narrow and not deep, converging posteriorly at first rather strongly, then gently to a little behind middle of glabella, then diverging to a little in front of occipital furrow, and — in casts — connected with this by weak grooves continuing in about the same directions. Middle and basal lateral glabellar furrows nearly or entirely obsolete. [On one of the casts examined the inner walls of the tri-composite lobes were slightly indented a little in front of the posterior extremities of the prolonged anterior glabellar furrows, the indentations apparently representing the inner ends of the basal furrows; according to SCHMIDT (1885) there are, on casts, slight indications of a pair of furrows curving from these points obliquely forwards to the dorsal furrows, as well as indications of another pair crossing the tri-composite lobes farther forward, beginning in slight indentations in the inner walls and running obliquely backwards to the dorsal furrows]. Dorsal furrows very narrow and shallow on surface of test, on casts about as strong as the prolonged anterior glabellar furrows, forming curves with slight outwards convexity outside anterior portions of tri-composite lobes, then gently concave

curves to anterior side-branches of occipital furrow, meeting them nearly at right angles and beyond them bending rather strongly outwards.

Occipital furrow narrow and shallow on surface of test, on casts stronger than other furrows on cranium, transverse in middle, dividing at sides, anterior side-branches not much more than half as long as posterior branches, directed slightly forwards. Occipital ring of moderate width, extending laterally rather far beyond base of glabella; its main portion rather gently arched transversely, flattened longitudinally; occipital lobes transversely elongate, sub-elliptical with pointed extremities, on casts gently convex with a flattening on top, on surface of test flattened; their surfaces sloping slightly downwards posteriorly, more strongly laterally. [Anterior border of cranium — not observable in the specimens examined — according to SCHMIDT (1885, p. 47) very narrow and, like the border furrow, scarcely discernible on surface of test].

Fixed cheeks sloping from above eye-lobes rather steeply both anteriorly and posteriorly to posterior borders, lateral slopes to palpebral lobes gentle and gently convex, behind these flatter and rather steep; their anterior portions of moderate length rather narrow, flattened, band-like; their posterior portions of moderate size. [Palpebral lobes, according to SCHMIDT, narrow and not projecting much]. Palpebral furrows well marked on casts, their anterior and posterior parts meeting at obtuse angles inside middle of palpebral lobes. Posterior borders of fixed cheeks narrow near the dorsal furrows, rapidly widening laterally, flattened on surface of test; posterior border furrows not impressed on surface of test. Anterior branches of facial sutures running from eye lobes at first nearly straight forwards and downwards [bending rather strongly inwards anteriorly; posterior branches running from eye lobes at first but very slightly backwards, but before reaching the middle of their course bending strongly backwards]. [Rostral shield, labrum and thorax not recognized].

Pygidium with anterior margin arched gently, but distinctly forwards and posterior and lateral margins forming a continuous, broadly sub-elliptical curve, about one-and-a-half times as broad as long or rather more, rather strongly convex but with a flattening of the convexity on top, with weak approximate fulcrum on anterior edges of pleural portions, and beyond the fulcrum sub-triangular facets, which are bent obliquely downwards and indistinctly defined behind — the edges being rounded, not sharp — and apparently without terraced lines. Furrows faintly or not at all marked on surface of test. (The following description of the characters of the furrows refers to internal casts). Rachis in front more than one-third as wide as entire pygidium, extending about two-thirds its length (less when the measures are taken along the convex surface), gently tapering posteriorly, indistinctly defined behind from narrow post-rachial piece, gently convex, though without true independent convexity; anteriorly with one narrow (longitudinally), gently rounded rachial ring marked off by comparatively deep and broad furrow, which grows weak at sides, and is gently arched forwards. Dorsal furrows of moderate width,

rather shallow, converging posteriorly, bent slightly inwards at end of rachis and continued a short distance behind it by rather weak sub-parallel furrows or grooves.

Pleural portions of pygidium with five pairs of nearly straight furrows, all weakening externally and dying out a good distance from margin. Anterior pair of pleural furrows directed rather slightly backwards; the following pairs, up to and including second pair of interpleural furrows, successively directed more and more strongly backwards; third pair of pleural furrows (in the specimens examined) sub-parallel to second pair of interpleural furrows or directed somewhat more outwards (in SCHMIDT's figures they are directed more backwards). Anterior and second pair of pleural furrows relatively strong internally, beginning in dorsal furrows near anterior margins of their respective pleuræ, of which the anterior pair are somewhat narrower (longitudinally) than the second. Third pair of pleural furrows with their inner extremities a little in front of posterior end of rachis and at a distance from the inner extremities of the second interpleural furrows somewhat greater than the distance from the latter to the inner extremities of the anterior interpleural furrows. Doublure of pygidium wide.

Test of cranium and pygidium very thick, on dorsal surface smooth or almost smooth (under a high magnifying power it appears rather rough). Doublure of pygidium with faint traces of impressed lines on upper (inner) surface of test. (According to SCHMIDT there are distinct terraced lines on the doublure, but probably this statement refers to the under surface of the test).

Dimensions. — In a somewhat crushed incomplete cranium (Pl. 3, fig. 8) the sagittal distance between the margins seems to have been about 25 mm, and the width between the palpebral lobes about 27 mm, and in an incomplete pygidium the sagittal distance from the anterior to the posterior margin to have been between 23 and 24 mm, and the greatest width about 37 mm.

Remarks. — Of this characteristic species one incomplete, somewhat crushed cranium and two incomplete pygidia found in boulders of Macrourus Limestone at Eriksöre in Öland are in the Museum of the Geological Survey. In the State Museum of Natural History there is another fragmentary cranium (Ar. 2188) preserved in a similar limestone, which is probably also from Öland, but its locality is not noted. The above description is chiefly based on this material. The statements between brackets, which refer to portions not preserved in these specimens, are based on SCHMIDT's (1885) description and figures.

Affinities. — The only other species that has been referred to *Leiolichas* is *Leiol. Gageli* POMPECKI (1890, p. 44, Pl. 2, figs. 33—33 a), of which only the pygidium has been recognized, and which was placed here by its author apparently with considerable hesitation. As POMPECKI pointed out the pygidium shows several characters resembling those of *Leiol. illænoides*, and indicating a closer relationship to that than to any other hitherto described

species, but differs markedly in several other characters. It appears impossible, as long as the characters of the cranidium are unknown, to decide whether the species should be referred to *Leiolichas* or not, though the probability is that it belongs to that genus.

The small cranidium described and figured by WIGAND (1888, p. 57, Pl. 7, fig. 8) as *Lichas* aff. *illanoides* NIEZSK. may represent a distinct species or a variety. According to WIGAND it differs in the course of the posterior portions of the prolonged anterior lateral glabellar furrows, which are said not to diverge, and in the greater width of the portions of the fixed cheeks lying inside of the palpebral furrows. The figure, however, does not show the characters of those portions quite clearly.

Horizons and Localities. — Macrourus Limestone. — Öland: Eriksöre (in boulders).

Jewe Formation (D₁). — Esthonia.

Kegel Formation (D₂). — Esthonia. (Lectotype, cranidium, Wesenberg, NIEZSKOWSKI, 1857, Pl. 3, figs. 3, 5, SCHMIDT, 1885, Pl. 3, fig. 28).

North Germany, in boulders.

Genus *Amphilichas* RAYMOND, 1905.

Genotype: *Amphilichas lineatus* (ANGELIN, 1854).

Synonyms: *Lichas* auctt. pars; — *Platymetopus* + *Lichas* pars ANGELIN 1854; — *Lichas* (*Platymetopus*) SCHMIDT 1885 pars; GÜRICH 1901 pars; — *Lichas* (subg. *Paralichas* pars + *Metalichas* pars) REED 1902; — *Amphilichas* RAYMOND 1905 pars; — *Acrolichas* + *Amphilichas* pars FOERSTE 1919, 1920; — *Lichas* (subg. *Acrolichas* + *Amphilichas* pars + *Metalichas* pars) REED 1923. — *Amphilichas* + *Acrolichas* + *Tetralichas* + *Kerakephalichas* + *Probolichas* PHLEGER 1936.

Diagnosis. — Cranidium with complete dorsal furrows; prolonged anterior lateral glabellar furrows in genotype not reaching occipital furrow, in most other species extended to it; basal lateral glabellar furrows obsolete; occipital lobes absent or possibly coalesced with compound (tri-composite) lateral lobes of glabella. Pygidium with prolonged dorsal furrows reaching and nearly meeting at notch between free terminations of basal pair of pleurae; rachis with two ring-furrows, sometimes with traces of a third, continued by short, sub-triangular post-rachial piece ending in acute point; pleural portions consisting of three pairs of completely defined pleurae, all with free terminations, two anterior pairs with, generally short, pleural furrows, basal pair without pleural furrows.

Remarks. — ANGELIN's species *Platymetopus lineatus* is the genotype, not EICHWALD's *Lichas laevis*. RAYMOND (1905, p. 378) introduced the name *Amphilichas* as a substitute for *Platymetopus* ANGELIN (non *Platymetopus* DEJEAN 1829) as well as for *Paralichas* REED 1902 (non *Paralichas* WHITE 1859) and ANGELIN had based his genus *Platymetopus* on *Pl. lineatus*. His diagnosis of the genus shows this clearly and moreover *Pl. lineatus* was the only species which ANGELIN (1854, p. 68) when giving the diagnosis, unreservedly placed in it. SCHMIDT in his paper of 1907 (p. 26) expressed the opinion that EICH-

WALD's *Lichas laevis* was identical with ANGELIN's *Platymetopus lineatus*, but there appears to be strong reason to doubt the correctness of this (cf. below) and, anyhow, ANGELIN's name is the older.

That the pygidium which SCHMIDT originally (1885) ascribed to *Amph. laevis* and later (1907) to *Amph. lineatus* evidently does not belong to either of them or to any other species of *Amphilichas*, and that *Acrolichas* FOERSTE apparently is identical with *Amphilichas* RAYMOND, has previously been pointed out by me (cf. WARBURG, 1925, p. 256; above p. 13).

***Amphilichas lineatus* (ANGELIN, 1854).**

- 1854 & 78. *Platymetopus lineatus*, ANGELIN, p. 75, Pl. 38, figs. 12—12 a (non fig. 13).
 1884. *Lichas lineatus*, TÖRNQUIST, p. 36.
 1884. » *brevilobatus*, TÖRNQUIST, p. 34, Pl. 1, figs. 32—33.
 1885. » *laevis*, SCHMIDT, p. 49 (pars), Pl. 6, fig. 5—7, 9 (non fig. 10; non fig. 8?).
 1920. *Amphilichas lineatus*, FOERSTE, Pl. 4, fig. 12 a—b (copies, ANGELIN 1854).
 1920. » *laevis*, FOERSTE, Pl. 4, fig. 11 a (copy, SCHMIDT 1885).
 1925. » *lineatus*, WARBURG, p. 326. Pl. 8, figs. 39—40.

Diagnosis. — Glabella sub-pentagonal, with anterior margin rather broadly rounded, wider than long, sagittal distance between margins about equal to greatest width, posteriorly flattened-convex but with postero-lateral portions curved rather steeply downwards, curved strongly downwards anteriorly and overhanging; its lobes without independent convexity; prolonged anterior lateral glabellar furrows not reaching occipital furrow, always (apparently) ending at level of posterior ends of palpebral lobes, narrow and rather deeply impressed in front, but soon growing very shallow and still narrower, posteriorly on surface of test only forming fine, scarcely impressed lines (probably owing to state of preservation not discernible in all specimens), stronger on casts; fronto-median glabellar lobe clavate, with pointed antero-lateral extensions, its width across latter exceeding that of entire glabella at base, narrowing posteriorly to a little in front of extremities of prolonged anterior furrows, here occupying rather less than one-fourth entire width of glabella, then becoming nearly parallel-sided before entirely coalescing with tri-composite lobes; tri-composite lobes extending about four-fifths length of glabella, and only very slightly beyond base of median lobe. Surface of cranium with low tubercles or punctate; large specimens without tubercles but punctate on surface of test — on the cast indistinct tubercles on posterior parts — or tubercles on hindmost portions only; in smaller specimens the tuberculation reaching farther forward, the tubercles decreasing in height anteriorly and finally disappearing, and punctae occurring instead.

Remarks. — Apparently some of the cranidia which SCHMIDT in 1885 attributed to EICHWALD's species *Lichas laevis* (EICHWALD, 1860 (61), p. 1387, Pl. 54, figs. 16 a—b) belong to *Amphilichas lineatus* (ANG.), but there appears to be strong reason to doubt the correctness of the opinion later (1907, p. 26) expressed by SCHMIDT that EICHWALD's species is identical with ANGELIN's (cf. WARBURG, 1925, p. 328).

That the pygidia which SCHMIDT (1885, 1907) attributed to *Amph. lineatus* or *laevis* evidently do not belong to any species of *Amphilichas* but to a member of *Conolichas* DAMES (incl. *Homolichas* SCHMIDT) and probably to *Conol. angustus* (BEYR.) has previously been pointed out by me (1925, p. 256; cf. also above pp. 13, 73).

Two cranidia in the Oslo Museum from Etage 5 a of Ringerike belong to our species.

Horizons and Localities. — Boda (Upper Leptaena) Limestone. — Dalarna: Kallholn, Boda, Osmundsberg, Lissberg, Unskarsheden, Torsmo, Östbjörka. (Holotype, R.M. Ar. 6040, Dal.: locality unknown, ANGELIN, 1854, Pl. 38, figs. 12—12 a).

Lyckholm Formation (F₁). — Esthonia.

Etage 5 a. — Norway: Stavnæstangen in Ringerike.

***Amphilichas dalecarlicus* (ANGELIN, 1854).**

1854 & 78. *Lichas Dalecarlicus*, ANGELIN, p. 74, Pl. 38, figs. 9—9 a, ?fig. 9 b.

?1854 & 78. *Platymetopus planifrons?* ANGELIN, p. 73, Pl. 38, fig. 3 b (non figs. 3, 3 a).

1885. *Lichas dalecarlica*, SCHMIDT, p. 53, Pl. 6, figs. 11—13.

1901. *Platymetopus dalecarlicus*, GÜRICH, p. 524, Pl. 20, fig. 19 (copy after SCHMIDT).

1902. *Lichas dalecarlicus*, REED, p. 80, text-fig. 17 (copy after SCHMIDT).

1925. *Amphilichas dalecarlicus*, WARBURG, p. 309, Pl. 7, 21—22, 24—25, ?figs. 20, 23, 26; ?Pl. 8, fig. 44; text-fig. 21.

Diagnosis. — Glabella sub-pentagonal with anterior margin arched strongly forwards, slightly longer than wide, sagittal distance between anterior and posterior margin about equal to greatest width, convex longitudinally with distinct flattening of curvature from a little in front of base to about middle, bent downwards in front, slope of hindmost portion to occipital furrow rather steep in middle, laterally very steep; its posterior half in middle very slightly convex transversely, the slope becoming stronger at sides; prolonged anterior lateral furrows strongly defined as far as occipital furrow; fronto-median lobe clavate, with pointed antero-lateral extremities, its width across latter about equal to that of entire glabella at base, narrowing to opposite middle of palpebral lobes, here occupying somewhat less than one-third entire width of glabella, slightly but distinctly increasing in width posteriorly, strongly convex anteriorly, posteriorly without independent convexity; tri-composite lobes very gently convex transversely, extending about three-fourths length of glabella, with postero-lateral extremities abruptly curved downwards and reaching only slightly beyond median lobe. Test tuberculate.

Horizons and localities. Boda (Upper Leptaena) Limestone. — Dalarna; Arvet (holotype R.M. Ar. 6033; ANGELIN, 1854, Pl. 38, figs. 9—9 a; WARBURG, 1925, Pl. 7, figs. 21—22), Kallholn, Östbjörka, Born, Boda? (labra only).

Lyckholm Formation (F₁). — Esthonia.

Etage 5 a. — Norway: Stavnæstangen in Ringerike (cranidium in Oslo Museum).

Amphilichas Wahlenbergi WARBURG, 1925.

- ? 1901. *Platymetopus planifrons*, LINDSTRÖM, p. 6, Pl. 4, figs. 50—51 (labrum).
 1925. *Amphilichas Wahlenbergi*, WARBURG, p. 315, Pl. 8, figs. 27—31, 33—34, ?figs. 26, 32, 35, 41.
 1936. *Amphilichas Wahlenbergi*, THORSLUND, Pl. 2, fig. 6.

Diagnosis. — Glabella sub-pentagonal with anterior margin rather strongly and rather evenly arched forwards, wider than long, sagittal distance between anterior and posterior margin about eight-ninths greatest width, strongly convex longitudinally, curved downwards anteriorly and overhanging, posterior slope gentle, moderately convex from side to side posteriorly; prolonged anterior lateral furrows strongly defined as far as occipital furrow; fronto-median lobe clavate, with pointed antero-lateral extremities, width across latter about equal to that of entire glabella at base, tapering posteriorly to occipital furrow or its hindmost portion nearly parallel-sided, at level of eye-lobes wider than tri-composite lobes, at base generally occupying about two-fifths entire width of glabella, strongly convex anteriorly, posteriorly without independent convexity; tri-composite lobes with slight independent convexity, extending about three-fourths length of glabella, with postero-lateral extremities produced beyond base of median lobe. Test tuberculate.

Remarks. — With a mark of interrogation WEBER (1928, pp. 234, 255, Pl. 22, figs. 30—31), referred to this species a fragment of a glabella from the Kuznetsk Basin and some labra from the Kirghiz Steppe, which specimens had been found at localities where other forms belonging to the fauna of the Boda (Upper Leptaena) Limestone of Dalarne occur. It is impossible to judge from the figure (30) whether the fragmentary glabella might belong to this species, but it does not seem so. The frontal lobe appears to extend farther in front of the tri-composite lobe and the latter to be more convex than in our species. The labrum, as figured (fig. 31), resembles that which appears to belong to this species rather closely, but is no less like the labra of some other species of *Amphilichas*; WEBER (op. cit., p. 255) compared it to several.

Horizon and Localities. — Boda (Upper Leptaena) Limestone. — Dalarne: Kallholn (lectotype, cranidium, U.M., WARBURG, 1925, Pl. 8, figs. 33—34) Gulleråsen (probably from the hill Lissberg), Osmundsberg, Arfvet, (Boda?).

Amphilichas latifrons WARBURG, 1925.

- ? 1854 & 78. *Lichas planifrons?* ANGELIN, Pl. 38, fig. 3 a (labrum).
 1925. *Amphilichas latifrons*, WARBURG, p. 320, Pl. 8, figs. 36—38, ?figs. 24—25. 43.

Diagnosis. — Glabella sub-pentagonal with anterior margin arched forwards with strongest bend at the sides and the middlemost portion broadly rounded, considerably wider than long, sagittal distance between anterior and posterior margin about four-fifths greatest width, strongly convex longitudinally, curved downwards anteriorly and overhanging, posterior slope moderate; its posterior half in middle slightly convex transversely, the slope becoming stronger at sides; prolonged anterior lateral furrows strongly defined as far

as occipital furrow; fronto-median lobe clavate, with pointed antero-lateral extremities, its width across latter about equal to that of entire glabella at base, narrowing to opposite middle of palpebral lobes, here occupying somewhat less than one-third entire width of glabella, slightly increasing in width posteriorly or hindmost portion nearly parallel-sided, strongly convex anteriorly, with gentle independent convexity across middle, generally becoming flatter posteriorly; tricomposite lobes with gentle independent convexity, extending about three-fourths length of glabella, postero-lateral extremities produced beyond base of median lobe. Test tuberculate.

Horizon and Localities. — Boda (Upper Leptaena) Limestone. — Dalarna: Kallholn (holotype, cranidium, U.M., WARBURG, 1925, Pl. 8, figs. 36—38), Östbjörka (?Osmundsberg, Dalby, Torsmo; labra).

***Amphilichas atavus* WARBURG, 1925.**

Pl. 7, figs. 3—6.

1925. *Amphilichas atavus*, WARBURG, p. 323, Pl. 7, figs. 37—38.

Diagnosis. — Glabella sub-pentagonal, with anterior margin broadly rounded, considerably wider than long, sagittal distance between anterior and posterior margin about three-fourths greatest width, flattened on top posteriorly, anterior slope strongly convex and overhanging, lateral slopes gently convex, postero-lateral portions curving steeply downwards; prolonged anterior lateral furrows strongly defined up to a little in front of occipital furrow, then suddenly becoming weak; fronto-median lobe clavate, with pointed antero-lateral extensions, its width across latter about equal to width of entire glabella at base, hinder half nearly parallel-sided or gently tapering posteriorly for some distance and then increasing slightly in width, at level of palpebral lobes slightly narrower than tri-composite lobes, strongly convex anteriorly, with marked independent convexity in middle, becoming flatter posteriorly; tri-composite lobes with slight independent convexity, extending about four-fifths length of glabella, postero-lateral extremities produced beyond median lobe. Test tuberculate.

Remarks. — This species was founded on a very small glabella, the only specimen known at the time, which had been found in the Kullsberg (Lower Leptaena) Limestone at Amtjärn in Dalarna. At the same locality several larger cranidia, several labra, and one incomplete pygidium, which evidently belong to this species, have since been collected and are now (like the holotype) in the Uppsala Museum. All those specimens were found in the lower part of the formation. It appears probable that the holotype also came from this lower part, which evidently contains species of Lichidae other than those that have been found in the upper part of the Kullsberg Limestone (cf. above, pp. 125—126).

To judge from the material now available, the species seems to have been rather small. In one of the largest cranidia the sagittal distance between the anterior and the posterior margin of the glabella is about 11.5 mm. In a

large labrum the sagittal length is 11 mm. The length of the pygidium is 11 mm., and its estimated greatest width about 22 mm.

The cranidia agree closely in characters with the holotype, except that in these larger specimens the tuberculation is, on the whole, somewhat coarser, and there are more relatively large tubercles. Some of the better preserved and higher tubercles have an oblique cone-shape, but most of them appear flattened or rounded. The course of the dorsal furrows differs slightly in different specimens (cf. diagnosis), but the variation is not greater than in most species of Lichidae. In some of the specimens the tri-composite lobes are notched on their inner sides at the points where the prolonged anterior furrows weaken, the notches apparently representing the inner ends of the basal lateral glabellar furrows.

The labra and the pygidium are of the usual *Amphilichas* type and show the following characters:

Labrum broadly sub-oval, wider than long, not constricted behind anterior wings, with relatively long, moderately deep posterior excavation. Central body very gently convex, more than one-and-a-half times as broad as long, tapering posteriorly, broadly rounded in front, truncate behind, postero-lateral angles obtuse; middle furrows strongly defined, relatively long, and nearly straight. Borders and anterior wings of usual type. Posterior wings long, with broadly rounded, or sub-truncate, ends, directed obliquely forwards, outwards, and upwards.

Pygidium about twice as wide as long. Rachis rather strongly raised, compressed from the sides, with obtuse apex, anteriorly occupying about two-fifths entire width of pygidium, tapering rather rapidly posteriorly, width across middle about equal to length, rounded and indistinctly marked off behind from small, depressed, sub-triangular post-rachial piece, which slopes relatively steeply downwards posteriorly; two rachial rings of usual type; both ring-furrows weak in middle, especially the second, growing stronger at sides, the second not quite reaching dorsal furrows. Dorsal furrows, distinctly impressed, weakening behind rachis. Pleural portion anteriorly next the dorsal furrow with horizontally extended, flattened, sub-triangular, posteriorly tapering area, beyond this area sloping downwards relatively steeply for the genus, lateral slope steeper than posterior one. First and second pleurae increasing in width to bases of relatively long, backwardly directed free ends; the latter tapering, at first very gradually, then rapidly, to acutely pointed extremities, with distal margins curved, proximal margin of first and, as far as preserved, that of second nearly straight. Second pleural furrow very weak and short; the first longer as usual and apparently stronger (surface damaged, only end of furrow discernible). Interpleural furrows narrow, distinctly impressed; the first straight and directed only slightly backwards for about half its length, laterally bending more strongly backwards; the second nearly straight and for the greater part of its length directed at about 45° to sagittal line, curving backwards near margin. Basal pleurae with longer axes sub-parallel to posterior parts of dorsal furrows, narrowing proximally, produced into small, rather

obtuse points, which are situated somewhat more than one-third anterior width of rachis apart; inner margins of free portions of lobes diverging very slightly for some distance, then curving strongly outwards to extremities, lateral margins and angles rounded, postero-lateral margins nearly straight. Surface closely set with oblique tubercles of different sizes.

Horizon and Locality. — Kullberg (Lower Leptaena) Limestone; lower part. — Dalarne: Amtjärn (Holotype, U.M., WARBURG, 1925, Pl. 7, fig. 37).

***Amphilichas parvulus* WARBURG, 1925.**

1925. *Amphilichas parvulus*, WARBURG, p. 324, Pl. 7, figs. 34—36.

Diagnosis. — Glabella much wider than long, widest in front of middle, slightly narrowing posteriorly, anterior outline broadly rounded with frontal lobe only slightly projecting in front of tri-composite lobes, strongly convex longitudinally, curved downwards and slightly overhanging in front, more gently convex transversely; prolonged anterior lateral furrows strongly defined except near the occipital furrow, there suddenly weakening; fronto-median lobe with small, pointed antero-lateral extensions, its width across latter about two-thirds that of entire glabella at base, narrowing to a little in front of occipital furrow, here occupying scarcely more than one-third entire width of glabella, then widening at base, curved downwards for anterior half, throughout with independent convexity; tri-composite lobes very strongly convex longitudinally, gently convex transversely, about as long as fronto-median lobe, with postero-lateral parts produced beyond latter. Test tuberculate.

Horizon and Locality. — Boda (Upper Leptaena) Limestone. — Dalarne: Kallholn (4 crania U.M., lectotype, WARBURG, 1925, Pl. 7, figs. 34—35; 1 cranidium R.M. Ar. 6076).

***Amphilichas periformis* WARBURG, 1925.**

1925. *Amphilichas periformis*, WARBURG, p. 329, Pl. 7, figs. 32—33.

Diagnosis. — Glabella somewhat wider than long, widest a little behind middle, tapering slightly anteriorly and posteriorly, with slight expansion near base, rather narrowly rounded in front; prolonged anterior furrows strongly defined as far as occipital furrow; fronto-median lobe sub-pyriform in shape with anterior margin very strongly arched forwards, without distinct antero-lateral extensions, its width in front exceeding width of entire glabella at base, narrowing posteriorly until at about four-fifths the distance from anterior end to base occupying about one-third width of entire glabella, then widening slightly posteriorly; hindmost portion gently convex transversely; anterior portion strongly convex in both directions, with gentle posterior slope and steep anterior and lateral slopes; tri-composite lobes strongly convex longitudinally, gently convex transversely, sub-crescentic, more than twice as long as wide, reaching only a little in front of middle of fronto-median lobe, produced

posteriorly a short distance beyond latter. Dorsal furrows weak in middle. Test tuberculate.

Horizon and Locality. — Boda (Upper Leptaena) Limestone. — Dalarna: Kallholn (3 cranidia, U.M., holotype, WARBURG, 1925, Pl. 7, figs. 32—33).

Genus *Trochurus* BEYRICH, 1845.

Genotype: *Trochurus speciosus* BEYRICH, 1845 pars [= *Lichas palmata* BARRANDE, 1846 = *Cordyocephalus flabellatus* CORDA, 1847].

Synonyms: *Lichas* auctt. pars. — *Arges* auctt. pars. — *Cordyocephalus* Corda 1847, WELLER 1907, auctt. pars. — *Lichas (Arges)* SCHMIDT 1885 pars. — *Lichas (Plusiarges)* GÜRICH 1901. — *Lichas (Cordyocephalus)* REED 1902 pars, REED 1923.

Diagnosis. — Cranidium with complete dorsal furrows; prolonged anterior lateral glabellar furrows not reaching occipital furrow; hindmost portion of median lobe of glabella depressed and fairly well defined from convex basal lateral lobes, although not by furrows; basal lateral glabellar furrows well developed; occipital lobes well defined. Pygidium with rachis well defined postero-laterally and continued by narrow post-rachial ridge; two distinct rachial rings present; pleural portions consisting of three pairs of pleurae with corresponding free points on margin; marginal portion between bases of free points raised into narrow border; two anterior pairs of pleurae with flattened anterior and raised, rib-like posterior bands, the free points forming direct continuations of the latter; basal pair of pleurae undivided, flattened (inside border), separated by post-rachial ridge, with approximate free points.

Remarks. — REED'S (1923, p. 455) definition of this genus — regarded by him as a subgenus of *Lichas* and called by CORDA'S name *Cordyocephalus* — is not quite correct. The part concerning the chief characters of the cranidium is as follows: »bi-composite, fourth» (= basal) »lateral, occipital and central» (= fronto-median) »lobes of the glabella well developed and completely separated and circumscribed by furrows.» It appears as if REED had not seen any specimens of the genotype and had misunderstood BARRANDE'S figures. The reproduction in outline in his paper of 1902 (p. 71) of one of BARRANDE'S (1852, Pl. 28, fig. 7) figures of the cephalon shows the characters mentioned in the definition. The basal lateral lobes of the glabella are, however, not separated by furrows from the median lobe, but, since they are strongly convex and raised above the depressed posterior portion of the latter, they are fairly well defined from it.

It does not appear improbable that the known species of this genus originated from forms in which the prolonged anterior lateral glabellar furrows really extended to the occipital furrow and separated the portions in question, and that only when the posterior portion of the median lobe became depressed, were the hindmost portions of the furrows effaced. Possibly new finds will prove that there are forms that must be referred to this genus and that have the characters ascribed to the genus by REED, but those are not the characters of the genotype.

Trochurus Törnquisti (GÜRICH 1901).

1884. *Lichas palmatus*, TÖRNQUIST, p. 30, Pl. 1, figs. 26—27.

1901. » (*Plusiargēs*) *Törnquisti*, GÜRICH, p. 526.

1925. *Trochurus Törnquisti*, WARBURG, p. 257, Pl. 7, figs. 1—2.

Diagnosis. — Dorsal furrows shallow outside basal lateral glabellar lobes. Glabella gibbous, overhanging anterior margin of cranium, widest across basal lateral lobes, its anterior outline from about middle of bi-composite lobes rounded-sub-triangular; prolonged anterior lateral furrows deep to points of junction with basal pair; behind those points the joint furrows continue a short way inwards and backwards as rather broad, shallow, smooth grooves, which may be connected across median lobe by narrow, weak impression; fronto-median lobe widest at anterior margin, its width here about equal to five-eighths that of entire glabella across middle, rapidly narrowing to about four-fifths the anterior width, parallel-sided for the greater part of its length, tapering slightly posteriorly, forming the median third of glabella at junction of prolonged anterior furrows with basal lateral furrows; its main portion very strongly and evenly convex and raised high above lateral lobes, hindmost portion depressed, very gently convex in both directions; bi-composite lobes large, rather strongly convex, in dorsal aspect sub-triangular with rounded distal sides, sub-ovate or pear-shaped when viewed from the side or obliquely, acutely angular behind, the longer axes slightly oblique to sagittal line; basal lateral lobes strongly convex, narrowly sub-elliptical to sub-ovate, with the longer axes nearly at right angles to sagittal line. Occipital lobes sub-triangular to sub-ovate, rather strongly raised.

Horizon and Localities. — Boda (Upper Leptaena), Limestone. — Dalarna: Boda (Holotype, Lund Museum, TÖRNQUIST, 1884, Pl. 1, figs. 26—27; WARBURG, 1925, Pl. 7, figs. 1—2), Kallholn, Osmundsberg.

Kildare Limestone. — Ireland: Chair of Kildare.

Genus *Dicranogmus* CORDA, 1847.

Genotype: *Dicranogmus simplex* (BARRANDE, 1846) (= *Dicr. pustulatus* CORDA, 1847).

Synonyms: *Lichas?* BARRANDE 1846. — *Lichas* BARRANDE 1852 pars, TÖRNQUIST 1884 pars. — *Lichas (Dicranogmus)* HALL 1888, REED 1923. — *Lichas (Iipargēs)* GÜRICH 1901. — *Lichas (Cordyocephalus)* REED 1902 pars.

Remarks. — REED in 1923 (p. 257) defines *Dicranogmus* CORDA as follows. »Cranidium with first lateral furrows obsolete, the bicomposite lobes being undefined anteriorly and fused with first lateral lobes» (= antero-lateral portions of fronto-median lobe) »and central lobe of glabella; fourth» (= basal glabellar) »lateral lobes fused with cheeks; central lobe parallel-sided, well defined behind; occipital lobes present. Axial furrows incomplete posteriorly. Pygidium undescribed».

In 1884 (p. 33) TÖRNQUIST stated that his new species *Lichas aequalis* showed close affinities with *L. simplex* BARRANDE (1852, p. 608, Pl. 28, figs. 14, 15), the genotype of *Dicranogmus*, but differed in the absence of distinct furrows

between the basal lateral lobes and the median lobe of the glabella, and in having the prolonged anterior glabellar furrows marked in front, although growing weak at the level where in *Dicr. simplex* those furrows become obsolete. In 1925 (p. 260, Pl. 7, figs. 3—4) I placed TÖRNQUIST'S species in *Dicranogmus*.

As regards the character first mentioned, there does not appear to be any difference. To judge from BARRANDE'S figures of the genotype, the prolonged anterior furrows do not seem to reach the occipital furrow, but only to be continued inside the basal glabellar lobes by weak grooves or depressions. The character of the anterior portions of these furrows, whether they are very weak or entirely obsolete, does not seem to be of generic importance. Possibly the absence of traces of the furrows in the cranidia of the Bohemian form is only owing to the state of preservation.

***Dicranogmus aequalis* (TÖRNQUIST, 1884).**

1884. *Lichas aequalis*, TÖRNQUIST, p. 32, Pl. 1, figs. 29—30.

1901. " (*Euarges*) *aequalis*, GÜRICH, p. 527.

1925. *Dicranogmus aequalis*, WARBURG, p. 260, Pl. 7, figs. 3—4.

Diagnosis. — Glabella wider than long, narrowing anteriorly, truncate in front, moderately convex, slightly overhanging in front, anterior margin slightly arched upwards in middle, the lobes anteriorly without independent convexity; prolonged anterior lateral furrows anteriorly for a little less than half their length very narrow and shallow, then distinctly impressed and somewhat wider to basal lateral furrows, and then continued backwards to occipital furrow by very shallow grooves; basal pair of moderate strength throughout, meeting prolonged anterior pair at angles of about 70°; from point of junction on each side a weak groove curves obliquely inwards and backwards dying out before meeting its fellow or occipital furrow; fronto-median lobe of glabella about twice as long as wide at base, slightly narrower at front margin than across middle, narrowest a little above front margin, its anterior portion without independent convexity, posterior portion gradually becoming more and more distinctly raised above bi-composite lobes, behind them decreasing in height, postero-lateral parts slightly depressed; bi-composite lobes, sub-ovate, narrowing anteriorly, greatest width about equal to that of fronto-median lobe across middle; basal lobes slightly raised, incompletely defined. Occipital lobes sub-ovate, with gently rounded surfaces.

Horizon and Locality. — Boda (Upper Leptaena) Limestone; Dalarna: Lissberg. (Holotype, S.G.U.: TÖRNQUIST 1884, Pl. 1, figs. 29—30; WARBURG, 1925, Pl. 7, figs. 3—4).

List of Species described showing their stratigraphical Distribution in Sweden.

± indicates that the specimens have been found in boulders	Asaphus Lmst.	Gigas Lmst.	Chiron Lmst.	Chiron or Lower Chas- mops Lmst.	Chasmops Lmst.	Lower Chasmops Lmst.	Macrourus Lmst.	Kullberg Lmst.	Gray Trinucleus Shales	Red Trinucleus Shales	Östersjö Lmst.	Borkholm Lmst.	Boda Lmst.	Dalmanites Shales	
	<i>Lichas laciniatus</i> (WAHLENERRG)	-	-	-	-	-	-	-	-	-	-	-	-	-	+
<i>Lichas affinis</i> ANGELIN	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
<i>Lichas verrucosus</i> (EICHWALD)	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Lichas celorhin</i> ANGELIN	+	?	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Lichas Erici</i> n. sp.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Lichas pachyrhinus</i> (DALMAN)	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Lichas platyrhinus</i> FR. SCHMIDT	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Conolichas deflexus</i> (ANGELIN)	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
<i>Conolichas Sjögreni</i> n. sp.	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
<i>Conolichas Eichvaldi</i> (NIESZKOWSKI)	-	-	-	-	-	-	+	-	-	-	+	-	-	-	-
<i>Conolichas Peri</i> n. sp.	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
<i>Conolichas angustus</i> (BEYRICH)?	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
<i>Conolichas? oelandicus</i> (ANGELIN)	+	-	-	-	-	-	-	-	-	-	-	+	-	-	-
<i>Hoplolichas dissidens</i> (BEYRICH)	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
<i>Hoplolichas proboscideus</i> DAMES	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
<i>Hoplolichas proboscideus</i> DAMES v. <i>elongatus</i> n. var.	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
<i>Hoplolichas conicotuberculatus</i> (NIESZKOWSKI)	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
<i>Hoplolichas curvifrons</i> n. sp.	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
<i>Platylichas bottniensis</i> (WIMAN)	-	-	-	-	+	-	-	+	-	-	-	-	-	-	-
<i>Platylichas robustus</i> WARBURG	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-
<i>Platylichas latus</i> (TÖRNQUIST)	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-
<i>Platylichas Dalmani</i> n. sp.	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-
<i>Platylichas cicatriosus</i> (LOVÉN)	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
<i>Platylichas angulatus</i> WARBURG	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
<i>Platylichas? mastocephalus</i> (ÖPIK)	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
<i>Platylichas laxatus</i> (MC COY)	-	-	-	-	+	-	-	+	+	+	+	-	?	-	-
<i>Platylichas planifrons</i> (ANGELIN)	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
<i>Platylichas lingua</i> n. sp.	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
<i>Platylichas Warburgi</i> THORSLUND	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
<i>Platylichas nasutus</i> (WIGAND)	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
<i>Platylichas Wegelini</i> WARBURG	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
<i>Platylichas validus</i> (LINNARSSON)	-	-	-	-	+	-	-	+	-	-	-	-	-	-	-
<i>Dicranopeltis polytomus</i> (ANGELIN)	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-
<i>Leiolichas illaenoides</i> (NIESZKOWSKI)	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
<i>Amphilichas lineatus</i> (ANGELIN)	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
<i>Amphilichas dalecarlicus</i> (ANGELIN)	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
<i>Amphilichas Wahlenbergi</i> WARBURG	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
<i>Amphilichas latifrons</i> WARBURG	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
<i>Amphilichas atavus</i> WARBURG	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
<i>Amphilichas parvulus</i> WARBURG	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
<i>Amphilichas periformis</i> WARBURG	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
<i>Trochurus Törnquisti</i> (GÜRICH)	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
<i>Dicranogmus aequalis</i> (TÖRNQUIST)	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-

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Explanation of Plates.

I have used the following abbreviations:

<p>R.M. = State Museum of Natural History, Stockholm.</p> <p>U.M. = Museum of the Palaeontological In- stitution of Uppsala.</p> <p>S.G.U. = Museum of the Geological Survey of Sweden.</p> <p>St.H. = Geological Museum of the University of Stockholm.</p> <p>L.M. = Museum of the Geological Institution of Lund.</p>	<p>O.M. = Palaeontological Museum of Oslo.</p> <p>Dal. = Dalarne.</p> <p>V.g. = Västergötland.</p> <p>Ö.g. = Östergötland.</p> <p>Öl. = Öland.</p> <p>Smål. = Småland.</p> <p>Sk. = Skåne.</p> <p>Uppl. = Uppland.</p> <p>Södm. = Södermanland.</p> <p>Gotl. = Gotland.</p>
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Plate 1.

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3 a—c. Dorsal frontal and lateral views of cranium × 1. Asaphus Limestone. Smål. Humlenäs. R.M. Ar. 2249 a. Partly restored with plaster-cast from impression of same cranium, Ar. 2249 b.	
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Plate 2.

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3. Labrum × 1. Original to ANGELIN, 1854, Pl. 35, fig. 1 b. Asaphus Limestone. Smål. Humlenäs. R.M. Ar. 2236.	
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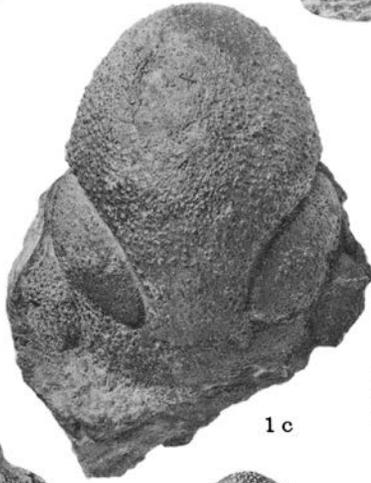
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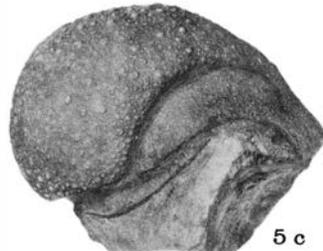
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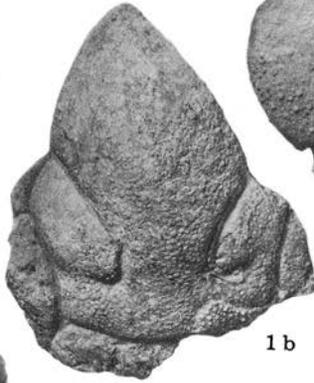
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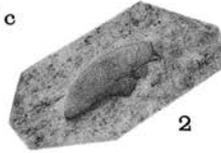
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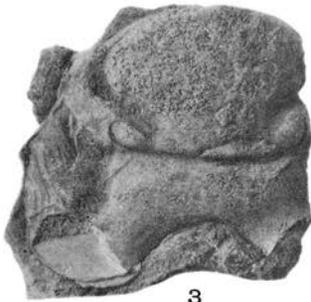
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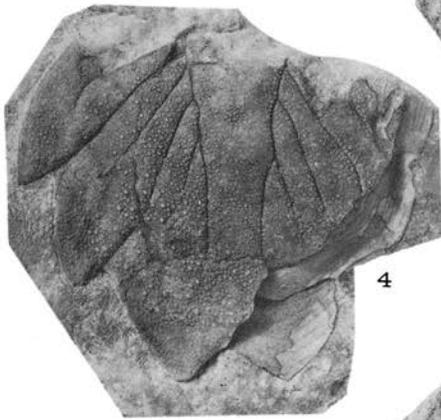
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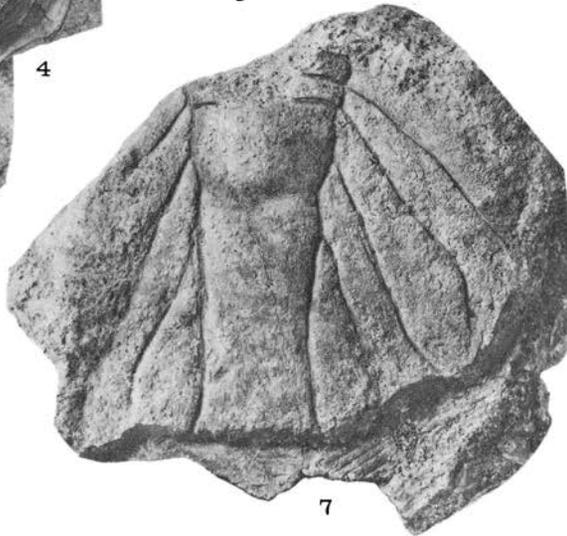
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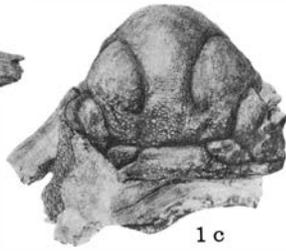
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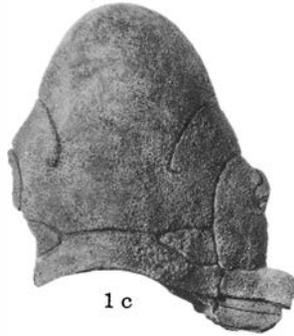
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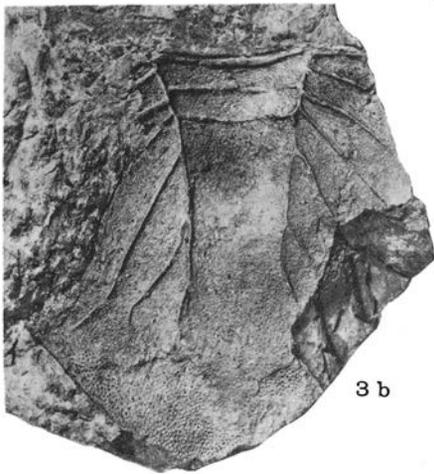
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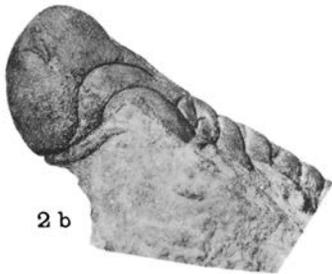
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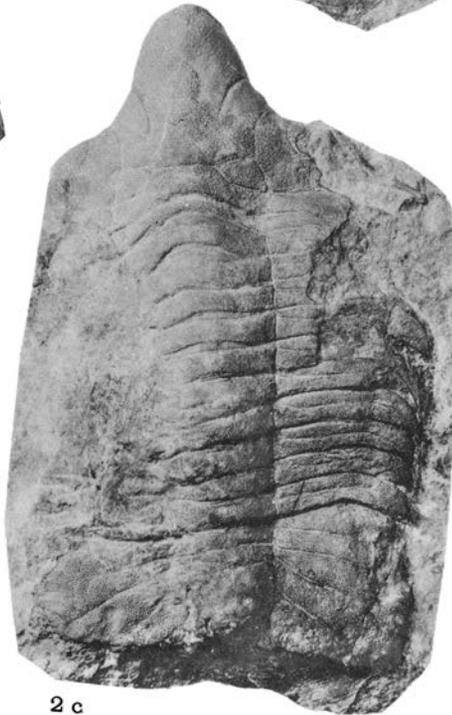
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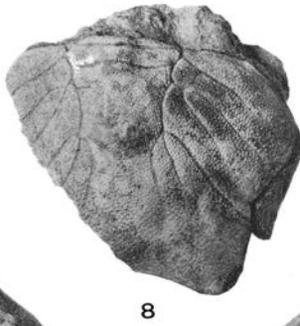
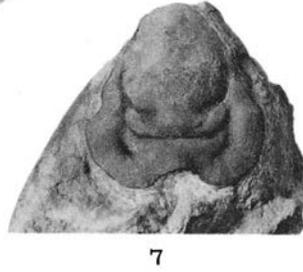
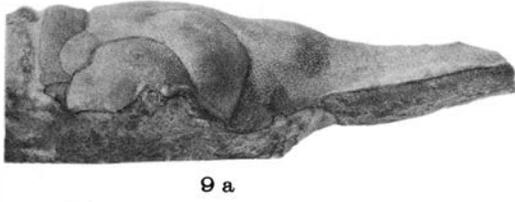
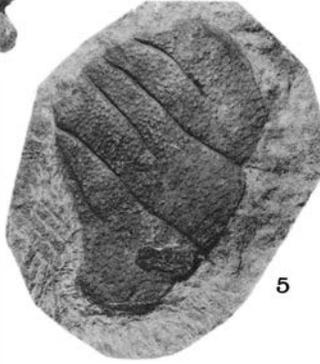
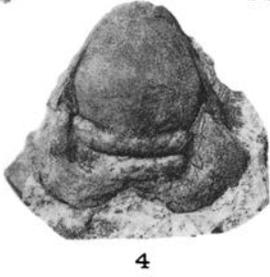
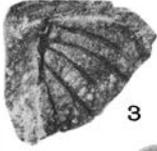
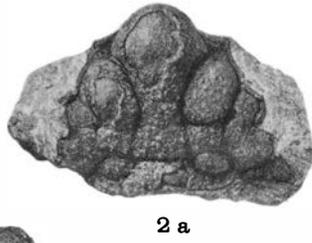
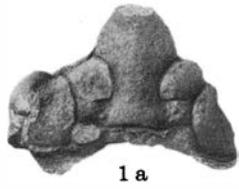
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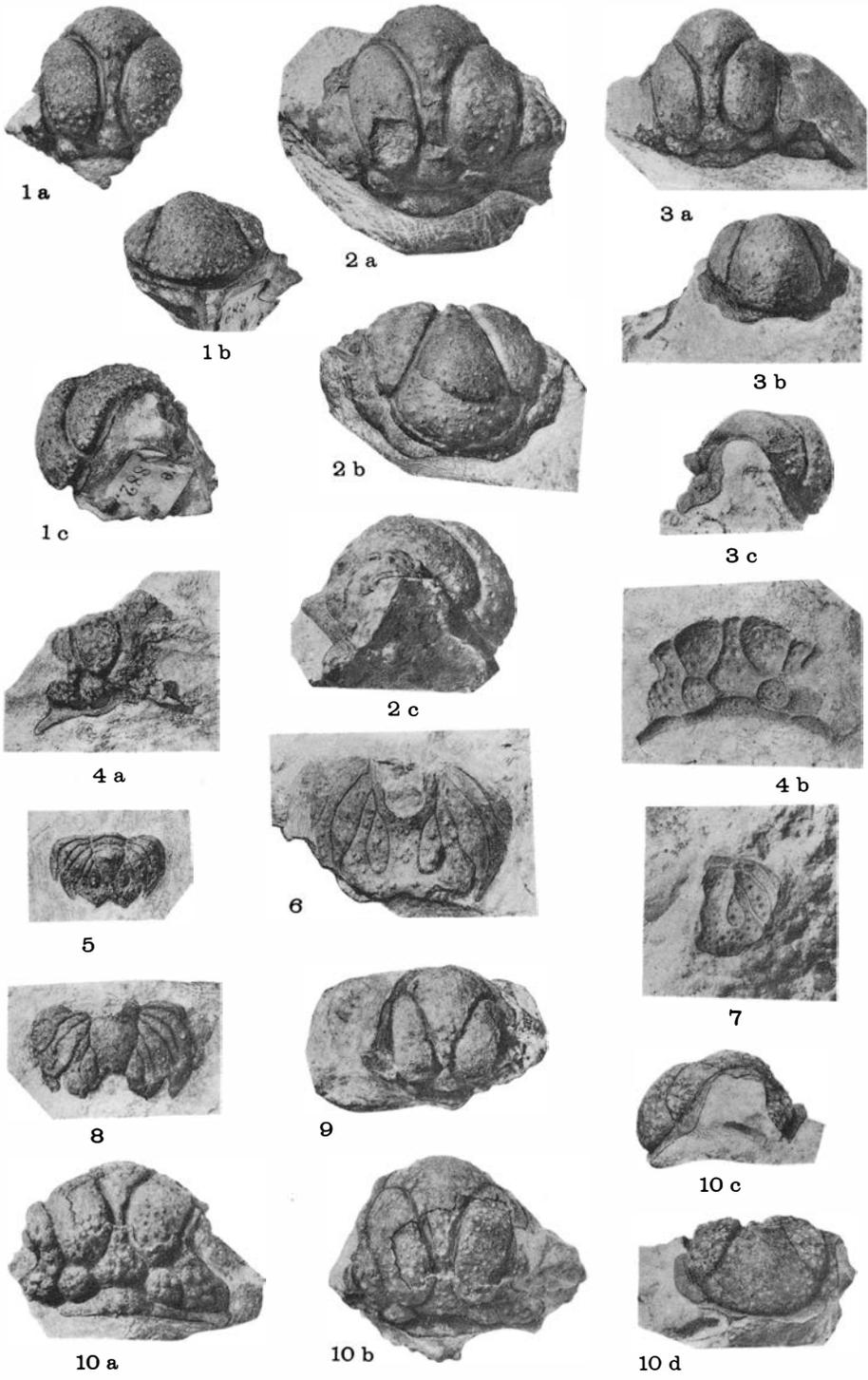


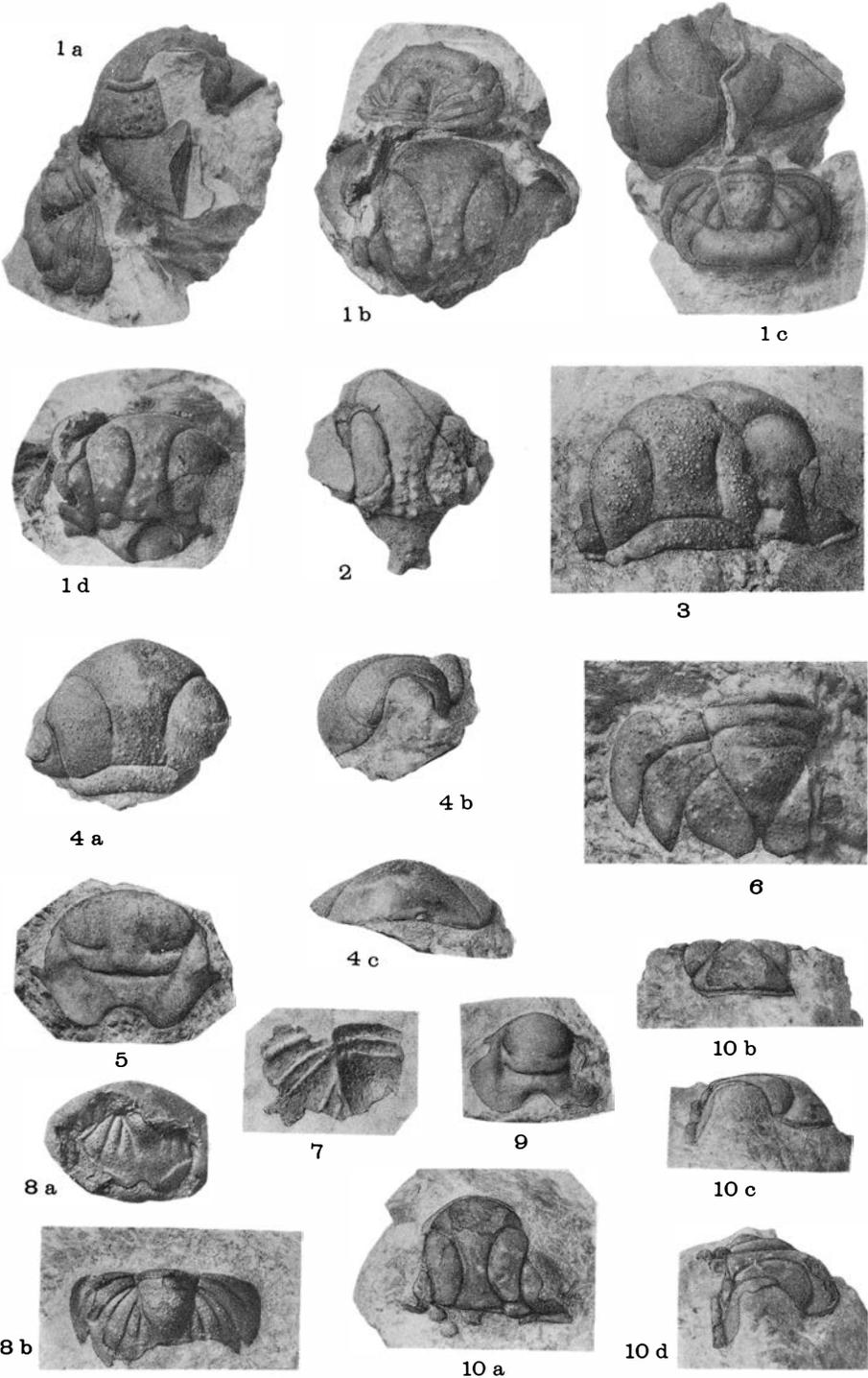
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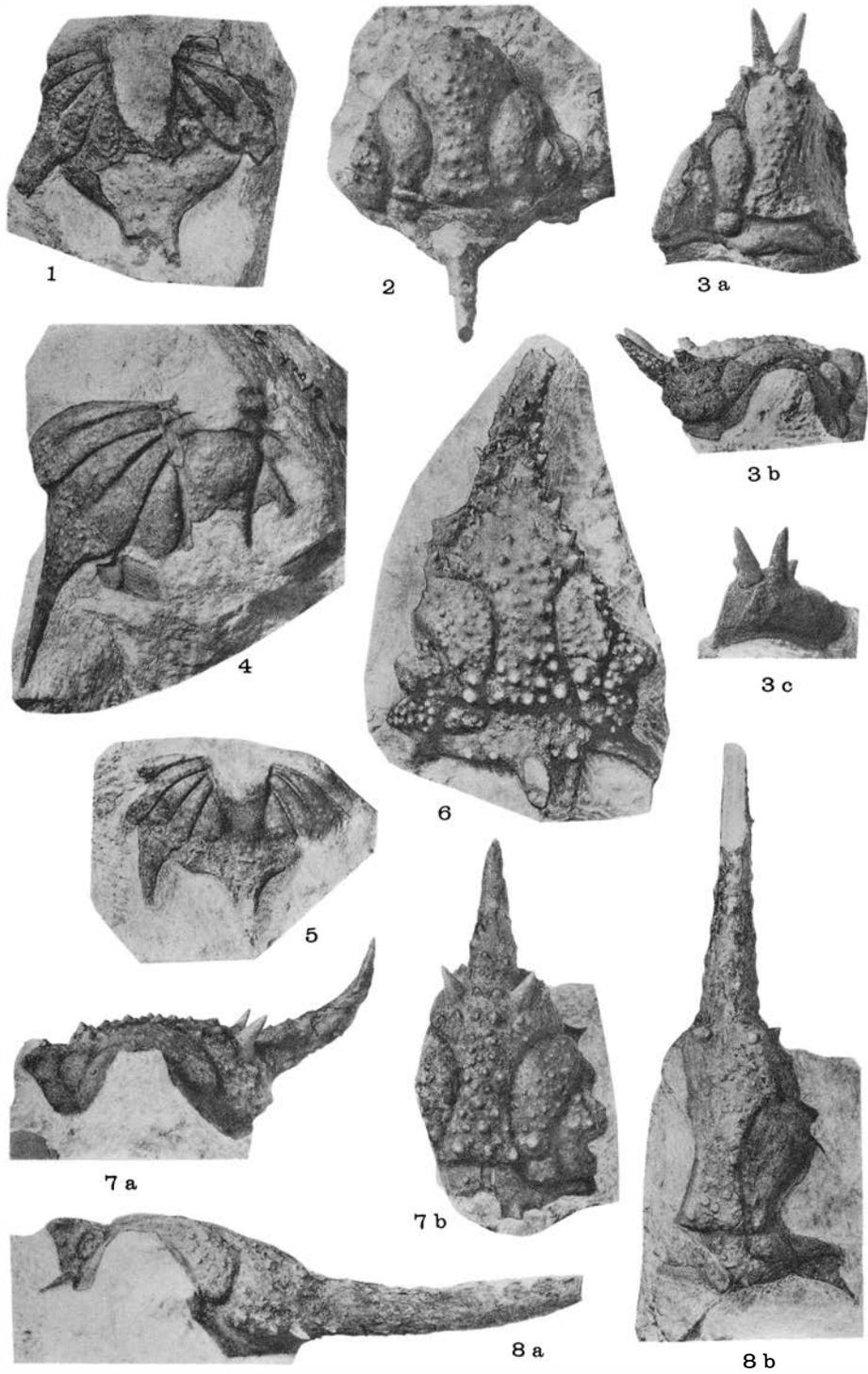


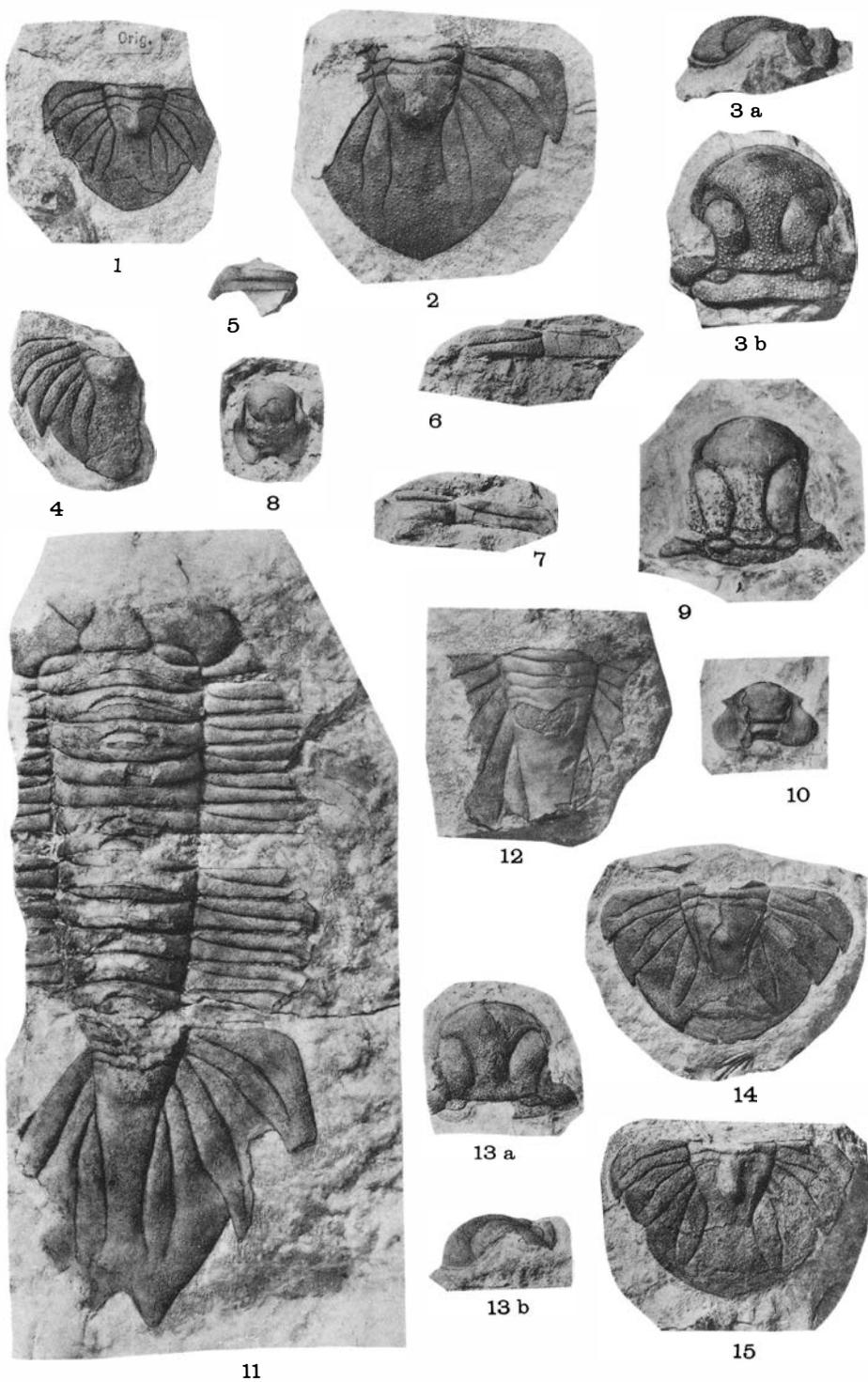
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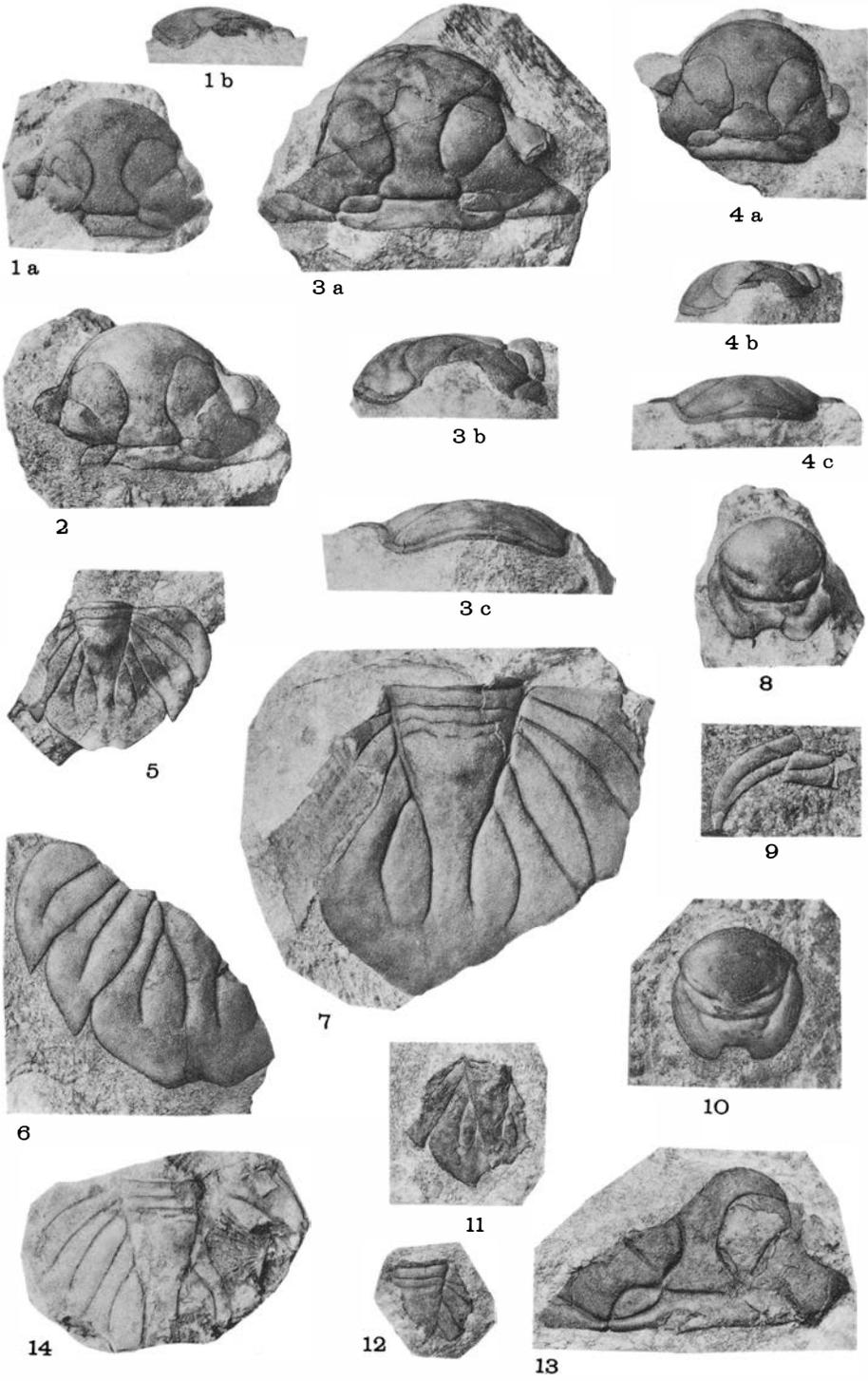














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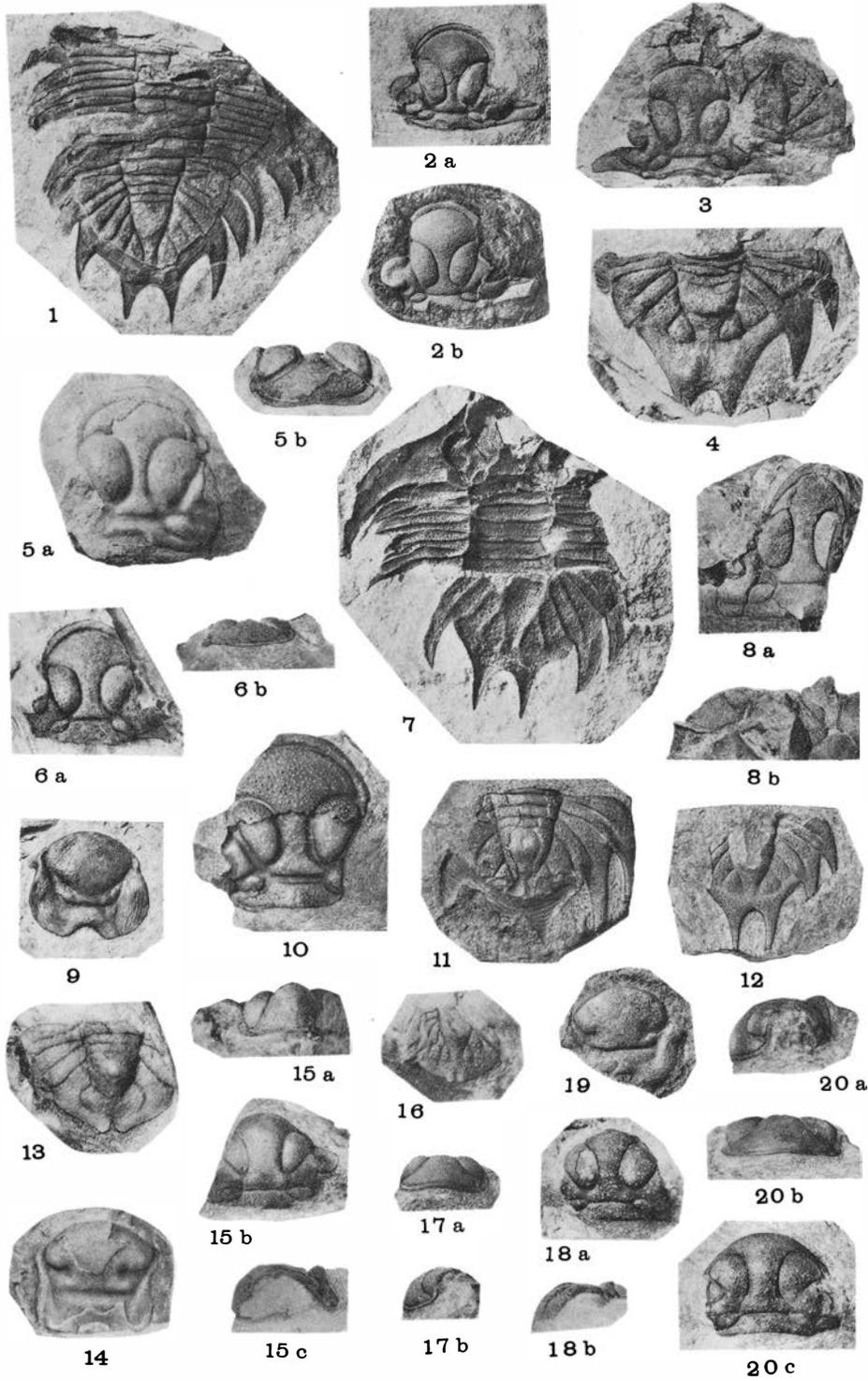
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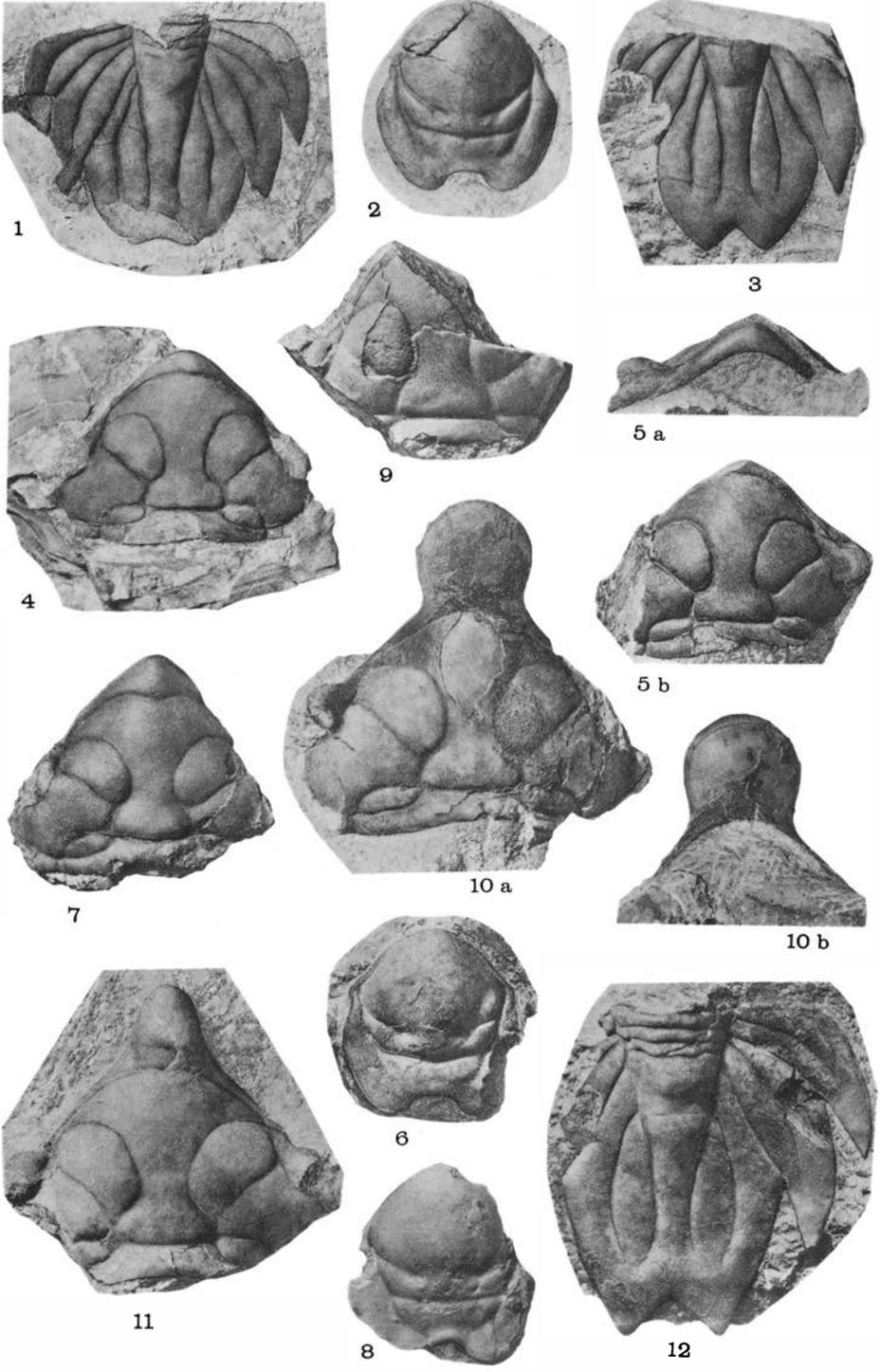


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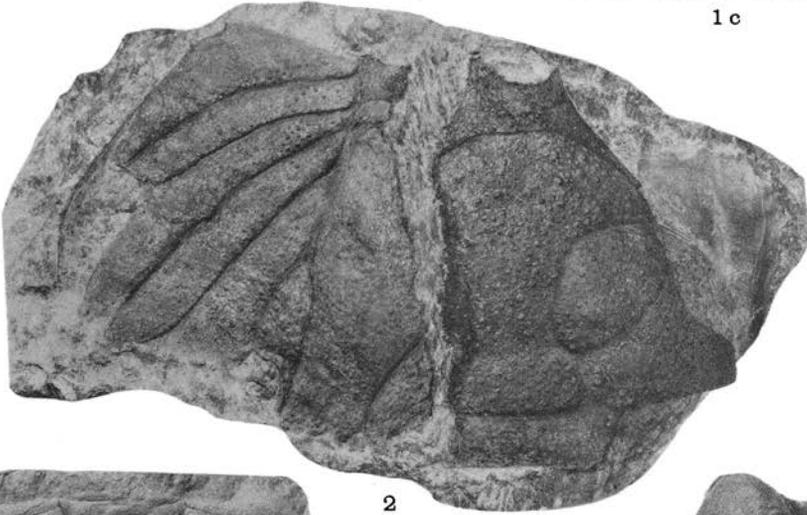
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6 a



4



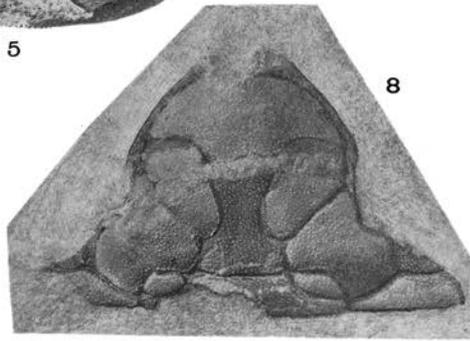
5



6 b



7



8