The Trilobites of the Leptæna Limestone in Dalarne.

With a Discussion of the zoological Position and the Classification of the Trilobita.

By

Elsa Warburg.

(With Plates I—XI.)

Contents.

Preface.

The material on which this monograph is based, consists partly of fossils collected by the author and now preserved in the Palæontological Museum of Upsala; the other collections in this museum have also been at my disposal. Further, by the courtesy of the authorities of the State Museum of Natural History, the Museum of the Geological Institution of Lund, the Museum of the Geological Survey, and the Museum of the University of Stockholm, I have had the advantage of using the collections in these institutions, for which I tender my most respectful thanks. I am also indebted to Mr. O. Isberg of Lund, who in the most obliging manner has allowed me to use his private collection; for this kindness I am very grateful to him.

In the summer of 1921 I had the opportunity of studying the trilobites of the Keisley and the Kildare Limestones in addition to certain other trilobites of interest for comparison with those of the Leptæna Limestone, in the following museums—the Sedgwick Museum, Cambridge; the British Museum of Natural History, and the Museum of Practical Geology, London; the Museum at Carlisle; the Natural Museum, and the Museum of the Geological Survey of Ireland, Dublin. I had also the opportunity of visiting Keisley and Kildare and of making small collections of fossils in these places. To the authorities and officials of the above-mentioned museums I tender my most sincere thanks for their courteous help. I wish particularly to thank Dr. F. A. BATHER, of the British Museum, and Professor J. E. MARR, of Cambridge, for valuable advice and personal kindness shown to me.

It is a pleasant duty to express my respectful and most sincere thanks to the late Professor H. SJÖGREN and to his widow, Mrs. ANNA SJÖGREN, for the previlege of printing my work in this Bulletin.

Most of the originals of the figures in this volume were drawn by my friend, Mrs. AINA STENSIÖ, who has also assisted me in preparing the bibliography. For the great interest and patience she has lavished upon this work I wish to thank her most cordially. My sincere thanks are due also to Miss SIGRID OHLSSON and Mrs. TH. EKBLOM, who have done the remainder of the drawings. — It is a pleasure to me to acknowledge my debt of gratitude to Professor E. STENSIÖ, who has taken most

of the photographs reproduced in this volume. During the years of our friendship I have enjoyed the privilege of discussing with him many interesting scientific questions.

To Professor A. G. HÖGBOM, who has been my teacher of geology, I offer my thanks for his valuable teaching and the interest he has shown me during my work.

Finally, I am glad to have this opportunity of expressing my most hearty thanks to Professor C. WIMAN, who has been my teacher and friend for several years. It is to his stimulating teaching that I owe my special interest in palæontology, and it was he who first drew my attention to the scientifically valuable fauna of the Leptæna Limestone. Throughout my work he has shown me much interest and great personal kindness, and I shall always owe him a debt of gratitude.

Terminology.

As the terminology of the parts of the trilobites in many cases is rather confused, several terms being used with a different signification by different authors, it may be suitable to give a brief account of the meaning of the terms adopted in this paper (text-fig. 1). I have tried to use the terms most commonly known, at least when they have not received a different signification from the one in which they were first used, or are not in any way misleading as to the morphology of the trilobites.

The anterior portion of the dorsal shield, or carapace, is called the head shield or cephalon, the middle portion the thorax, and the posterior portion the pygidium.

The cephalon is divided by the facial sutures into the cranidium, or middle shield, and the free cheeks. The middle part of the cephalon, which is generally more or less swollen, is called the glabella. This term was first introduced by DALMAN (1827), who defined it as the »destinct elevation which is to be seen in the middle of the head». It is not quite clear whether DALMAN meant the occipital ring to be included in the glabella, BARRANDE anyhow did not, whereas SALTER gave that meaning to the term, and several later authors define the glabella in the same way as the last-mentioned author, but in the descriptions of the different species they use the name in the same sense as BARRANDE, in which sense it is used also in this paper. Only in such cases, as for instance in *Illænus*, where there is no marked occipital furrow, it must cover both the real glabella and the part which corresponds to the occipital ring. Generally the whole of the glabella belongs to the cranidium, but in some forms, e. g. some species of *Phacops* and *Encrinurus*, its antero-lateral parts are formed by the free cheeks.

The glabella is generally divided by the glabellar furrows into several lobes. When the furrows, as most often is the case, do not reach across the glabella, they are called lateral glabellar furrows and the lobes bounded by them and by the lateral parts of the occipital furrow lateral glabellar lobes. The term frontal or anterior lobe is, according to the custom, used for the part of the glabella which lies in front of the anterior pair of furrows, but as it is generally not sepa-

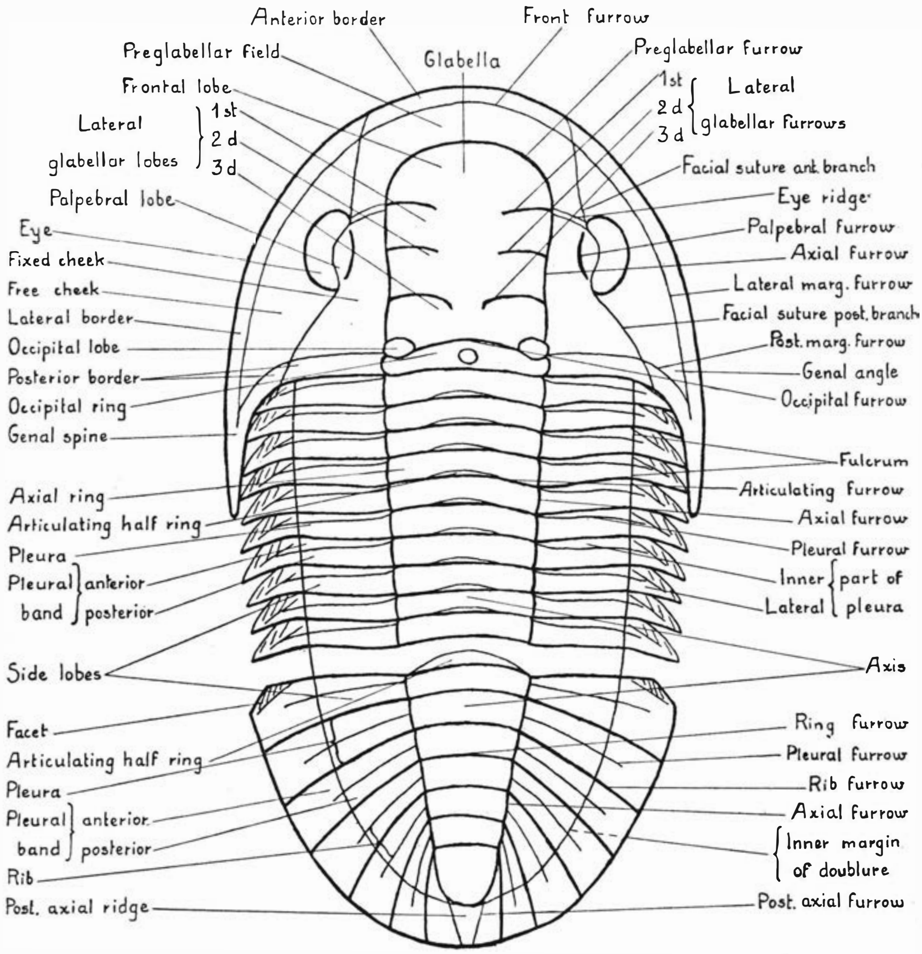


Fig. 1. Diagram of trilobite to show the parts.

rated from the middle part lying behind it, it is necessary to have a term which includes both parts, and for this the term central or median lobe is employed. The lateral parts of the frontal lobe are called the lateral wings. In most of the trilobites described in this paper there are not more than 3 pairs of lateral glabellar furrows and lobes, and I have numbered them by pairs from the anterior backwards, calling them 1st or anterior, 2d, 3d or basal furrows and lobes, as those are the terms most commonly used. To call the frontal lobe or its lateral parts 1st lobe or lobes and the following 2d, 3d and 4th does not seem practical, as it may cause confusion to use the terms in a meaning different from the one generally adopted. To name the lobes after their corresponding appendages as done by JAEKEL (1901) and BEECHER (1897) may be suitable, when the morphology of the trilobite head is made quite clear, but as yet it seems better to use a terminology which is more independent of the morphology. In some trilobites there are, as is well known, 4 pairs of lateral glabellar furrows, and it seems likely that this was the original number and that all of them represent boundaries of segments, and thus it would be more adequate, when, which is generally the case, only the three posterior ones are developed, to name those 2d, 3d and 4th, but then the disagreement with the prevailing terminology would be the same as the one just pointed out. In his papers on the Devonian *Proetidæ* (1912, 1913) R. RICHTER has counted the furrows from back to front calling them: *letzte, zweitletzte, drittletzte* and *viertletzte,* but a corresponding terminology would, in most languages, sound very heavy and informal. As mentioned above, most trilobites whose glabella is lobated have 3 pairs of lateral furrows, or, at least when there are fewer, it is generally easy to recognize to which they correspond in other trilobites, and therefore I think it most practical, for the present at least, to use the common terminology, and in such cases where there are 4 pairs, call the anterior pair of furrows frontal and the lobes separated by them 1st and 2d frontal lobes, or else to number the furrows and lobes independently in each case.

The posterior part of the glabella is separated by the occipital or neck furrow from the occipital or neck ring, which latter often bears an occipital tubercle or one or two occipital spines and the antero-lateral parts of which sometimes form separate lobes, the occipital lobes. The glabella and the occipital ring are bounded laterally by the dorsal or axial furrows. The furrow just in front of the glabella is called the preglabellar furrow and the part in front of it the preglabellar field or band. The side parts of the cranidium form the fixed cheeks. To these belong the palpebral lobes, which are often separated from the inner parts of the cheeks by the palpebral furrows. The palpebral lobe and the eye, situated on the fixed cheek, constitute together the eye lobe. Between the eye lobe and the anterior part of the glabella there is often a narrow, elevated ridge, the eye or ocular ridge. Because of its probable origin from a part of the palpebral lobe (an account of which will be given further on in this paper) it would be more adequate to call it palpebral ridge, but as this name might cause it to be confused with the palpebral lobe it is best to keep the old name, which is better than the term facial ridge used by some authors, which term was proposed by LINDSTRÖM (1901) because of his misconception of the origin of the ridge (see below). Below the outer part of the eye there is often a small raised border, the palpebra inferior or lower eyelid, which also belongs to the eye lobe and is separated from the outer part of the cheek by the lower lid furrow. The part of the facial suture lying in front of the eye is called the anterior, the part behind it the posterior branch of the facial suture.

The margin of the cephalon is generally raised into a border, separated from the inner parts by furrows. The different parts of these are called anterior or front, lateral and posterior borders and border furrows. At the genal angle the border is often produced into a genal spine. The posterior borders and furrows are separated from each other by the occipital ring and furrow, and by some authors the posterior borders, or in forms where the facial sutures cut these, the parts lying within the sutures are referred to the occipital ring or called the pleural parts of the occipital segment. I have not used this terminology because the posterior borders (or the parts of them within the sutures) do not, at least not always, seem to correspond to these pleuræ. In *Holmia Kjerulfi* LINRS. (text-fig. 2) the small ridges prolonged into short intergenal spines are formed by the pleural parts of the last glabellar segment (see below), and it appears as if the anterior parts of the pleuræ of the occipital segment did not partake in the building of the borders, the inner parts of which seem to correspond to the posterior bands of the thoracic pleuræ and the parts of the border furrows in front of them to the pleural furrows. Moreover the obliterated posterior branches of the facial sutures run outside the afore-said ridges, which indicates that also the segment in front of the occipital one may partially be included in the parts of the borders here in question.

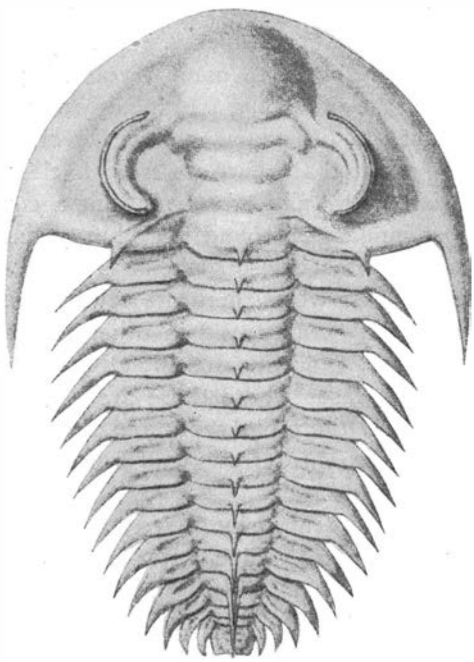


Fig. 2. *Holmia Kjerulfi* LINRS. Reconstruction (after KJER).

The test of all parts of the trilobite body is continued beyond and beneath the margin, forming a wider or narrower reflexed border or doublure. The anterior part of this is sometimes transected by the continuations of the facial sutures, the connective sutures, and the part of the doublure lying between these is called the rostrum (text-fig. 12). The term epistoma, used by several authors, does not seem appropriate, as in the works of some scientists it indicates other parts of the trilobite. The rostrum is generally separated from the anterior part of the cranidium by the rostral furrow (which in some forms has disappeared). When the rostrum is entirely reduced the anterior branches of the facial sutures meet in front, and there is no rostral suture and only one median (connective) suture, or none at all.

Behind the rostrum, on the ventral side of the body, and generally separated from it by the hypostomal suture, lies the hypostoma (text-fig. 3). Its swollen middle body is generally separated from the anterior, lateral and posterior borders by more or less strongly marked furrows of corresponding names, and divided hy the middle furrow in an anterior and a posterior lobe. At the front margin of the posterior lobe or in the middle furrow there is sometimes a pair of maculæ. At the sides of the hypostoma the border is generally produced into a pair of anterior and a pair of posterior wings.

The central portion of the thorax and the pygidium is called the axis or rachis and is separated from the side lobes by the axial or dorsal furrows.

The thorax is composed of a variable number of movable segments, the axial parts of which are called the axial rings, the lateral parts the pleuræ. The anterior part of each ring, the articulating half-ring, is separated from the posterior part by the articulating furrow and is overlapped by the preceding outer ring. Each pleura is generally divided by a pleural furrow into an anterior and a posterior pleural band. The inner parts of the pleuræ, which are generally directed straight outwards, reach from the axial furrow to the knee or fulcrum, from where the lateral parts are more or less strongly bent down and generally directed more backwards. They are sometimes prolonged into pleural spines, or else their anterior lateral parts are obliquely bevelled, forming the facets.

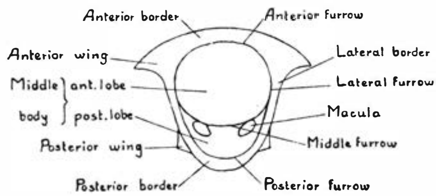


Fig. 3. Diagram of hypostoma.

BARRANDE (1852, p. 167, Pls. IV—VI) distinguished two types of pleuræ, furrowed pleuræ *(plèvre à sillon)* and ridged pleuræ *(plèvre à bourrelet)*, which latter, instead of the pleural furrow, had a median ridge, in front and behind generally bounded by flattened borders. He considered the two types to be of different origin and of great value for the classification, and believed the flattened borders, sometimes found in the pleuræ of the first type, to be of a different nature *(bourrelets accessoires)* than those of the second, and vice versa with regard to the furrows. This does not, however, seem to be the case. It is easy to conceive how a ridged pleura developed from a normal furrowed one in such a manner that it grew more swollen, but if the whole of the pleura had taken part in this swelling, the mobility of the thoracic segments must have been lessened. Therefore, it was necessary, in order to make it possible for the animal to enroll itself, that a small border part remained flat, or was developed either both in front and behind the swollen ridge or in one of these places. When both the anterior and posterior pleural bands partake in the building of the ridge, it seems natural that the pleural furrow has become more or less effaced, which is generally the case, when not as in some Cheiruridæ, the ridge is much shortened (from side to side), its anterior and posterior parts forming separated lobes. In some species of *Acidaspis* the furrow is very broad (e. g. *Acidaspis mira* BARR.), but here it is only the posterior pleural band, which forms the real ridge, the anterior one being much less swollen and without a flat border in front of it. In *Acidaspis Hoernesi* BARR. the anterior band is quite flattened out and forms the anterior border. This difference in the anterior and posterior pleural bands is also seen in some of the pleuræ of the pygidium of *Acidaspis,* and also in some of the Lichadidæ, where the thoracic pleuræ are of a type intermediate between the furrowed and the ridged ones. BARRANDE (1852, p. 170) mentions *Corydocephalus palmata* BARR. as exemplifying such trilobites which have furrowed pleuræ with *bourrelets accessoires.*

The pygidium consists, as a rule, of a number of anchylosed segments. The axis is generally divided by the ring furrows into several rings or annulations, the anterior one is like the thoracic axial rings furnished with an articulating half-ring and an articulating furrow. Behind the axis there is sometimes a postaxial ridge, separated from the posterior parts of the side lobes by the postaxial furrows, which form the continuation of the axial furrows. The pleuræ of the pygidium have either free ends, sometimes prolonged into spines, or the margin is entire; in some forms its median part is prolonged into a caudal spine. The side lobes are generally traversed by two kinds of furrows, of which the pleural furrows often are most distinct but generally do not reach the margin. The interpleural or rib furrows mark the boundaries between the fused pleuræ, and form the continuations of the ring furrows on the axis. They generally continue to the margin of the pygidium or to the inner parts of the spines. The parts of the side lobes lying between two pleural furrows often form raised ribs, and the part in front of the anterior pleural furrow a separate articulating half-rib. This is often furnished with a facet like those on the thoracic pleuræ. In some species the outer part of the pygidium forms a concave border, sometimes separated from the inner parts by a border furrow. In some cases both the interpleural and the pleural furrows are effaced, and sometimes the latter only are discernible, or at least the former are very slightly marked. This has caused some confusion, as several authors have regarded the ribs as corresponding to segments, not counting the articulating half-rib. EMMERICH (1839, p. 8) and BARRANDE (1852, p. 216—217) had a right apprehension of the nature of the ribs (costæ, côtes), and GRÖNWALL (1902, p. 132) and R. RICHTER (1912, p. 250) have already pointed out the misconception of later authors. In such forms, e. g. *Bronteus,* where there are no pleural furrows, the ridges on the pygidium evidently do not correspond to the ribs in other forms but to the pleuræ, the anterior pair of ridges being of the same nature as the following ones.

Systematic Account of the Trilobita.

Zoological Position.

Most scientists which have treated the question of the systematic position of the trilobites, have considered them to be primitive crustaceans and generally regarded them as most closely related to the phyllopods. A great number of authors, however, have believed the trilobites to be more nearly related to the merostomes, especially to *Limulus,* and in that case included the merostomes also in the class Crustacea, or referred them and the trilobites to a separate group, Gigantostraca or Palæocarida, or else brought both together with the Arachnoidea. That the Merostomata and the Arachnoidea are rather intimately related to each other seems, according to the researches of several scientists, brought beyond all doubt, but on the other hand several investigators have pointed out that the merostomes in so many characters show a likeness to the crustaceans that both the crustaceans, the arachnoids, the merostomes and the trilobites ought to be brought together, and the probable relationship of the trilobites on one hand to the merostomes, on the other to the crustaceans seems to point in that direction (Cfr. KASSIANOW, 1914, p. 224). The question whether the trilobites are more closely related to the crustaceans or to the merostomes is, however, very difficult to settle, as the construction of nearly all of their inner parts is unknown and the appendages known only in a few cases. But as far as these latter are known, they seem to indicate that the affinities of the trilobites are with the crustaceans.

It has generally been considered that the trilobites had 5 pairs of cephalic appendages, which have been regarded as homologous to those of the crustaceans, and this correspondence has been considered as one of the strongest proofs of the relationship between the two groups. What is known of the ventral sides of the trilobites seems to have proved the presence of 5 pairs of cephalic appendages, but does not prove that there might not have been more. JAEKEL (1901) is of the opinion that the anterior pair of appendages found in the trilobites corresponds to the 2d pair of antennæ in the crustaceans, and believes that in front of those there was a pair of antennules, which either are not yet observed or else were reduced. This conclusion he has drawn from the fact that in several trilobites there are 4 pairs of lateral glabellar furrows and lobes, which seems to indicate, that at least 6 originally appendage-bearing segments were included in their cephalon.

HOLMGREN (1916) also has another conception than the general one regarding the number of appendages in the trilobite head, which he believes was constituted homologous to that of *Limulus.* Beacause of the construction of the brain he considers *Limulus* to have descended from ancestors in which the antennules were developed and which may have had the following segments in the cephalothorax.

1.	Eye + Antennulary	segment	with	appendages		Antennules.
2.	Cheliceral		»	»	»	Cheliceræ.
3.	Pedipalpal		»	»	»	Pedipalpi.
4—7.	Walking leg	segments	»		»	Walking legs.

The segments (3—) 4—7 in *Limulus* are, on the dorsal side of the cephalothorax, indicated by elevations, which signify the points of attachment of the big muscles of the legs. Here then the 2(—3) anterior segments are not indicated on the dorsal side, though the appendages belonging to the 2d and 3d, the cheliceræ and the pedipalpi, are not reduced. Concerning the corresponding conditions in the trilobites HOLMGREN says (p. 87): »Auf der Dorsalseite des Kopfes sind nun gleich wie bei *Limulus* die Muskelursprünge markierende Erhebungen in segmentaler Anordnung vorhanden. Die Zahl dieser Erhebungen wechselt. Gewöhnlich sind jedoch (mit Ausnahme der Nackenring) 3 Paar vorhanden, aber bisweilen können vier Paar unterschieden werden. Es müssen deshalb *ex analogia* wenigstens 4 Paar wohlentwickelte Extremitäten vorhanden gewesen sein. Über die weniger gut entwickelten Extremitäten, welche dem Trilobitenkopf zukommen dürften, geben uns diese Erhebungen keine Auskunft. Die im übrigen grosse Übereinstimmung zwischen Trilobiten und *Limulus* (-Larve) berechtigt uns, für die Trilobiten anzunehmen, dass es vor den dorsal markierten Segmenten von Cephalothorax noch andere Segmenten gibt, und zwar wie bei *Limulus* noch 2.» HOLMGREN seems to assume that the trilobites were more closely related to *Limulus* than to other forms, but since this is doubtful, the passage just quoted does not prove anything else but that there might have been a greater number of appendages in the heads of the trilobites than what is indicated by the lobes on the dorsal side. Moreover, it is to be observed that though there are not more than 3 or 4 pairs of lateral glabellar lobes, the lateral wings of the frontal lobe seem to be of the same nature as those, and therefore JAEKEL's assumption that the trilobites have or originally had 6 pairs of cephalic appendages seems to be well grounded.

Whether there were more, is as yet impossible to express a definite opinion about. It is, of course, possible that the number of cephalic appendages was not the same in all trilobites. If this were so, one would expect to find a greater number of these in forms which had a greater number of glabellar furrows. In *Triarthrus Becki* GREEN there are 4 pairs of furrows, but BEECHER has assumed that there were only 3 pairs of appendages, except the antennules and the pair belonging to the occipital segment. However, this assumption does not appear to be grounded on direct observations, and a study of the figures published by him does hardly confirm it. If comparing Pl. IV, fig. 1, with Pl. V, figs. 8—10 (BEECHER, 1895a) one observes that the coxopodites (protopodites WALCOTT, 1918) of the posterior pair of cephalic appendages are very different. Those figured on Pl. IV are long and slender, very like those of the thoracic limbs, while those on Pl. V are shorter and broader, more like the coxopodites of the anterior appendages. One will further find that they are differently situated, the former having their bases clearly situated beneath the occipital ring, the latter in front of it. In front of these latter there are on Pl. V, figs. 9—10, 3 pairs of coxopodites. On the left side of the specimen figured on Pl. IV there are in front of the 1st endopodite clearly belonging to the thorax, 5 jointed pieces of appendages which seem to be endopodites. This suggests that there might have been 5 pairs of biramous cephalic appendages and that the posterior pair belonging to the occipital segment is wanting on the specimens figured on Pl. V. Of course this does not necessarily prove anything, as the differences just pointed out may be due to the bad preservation of the specimens. According to WALCOTT (1918) the coxopodites (protopodites) were deep and narrow, and perhaps the posterior pair of those found beneath the cephalon are seen from different sides on the different specimens, and therefore seem to be of different shape. It is also possible that the figures are not quite correct (those on Pl. V seem to be somewhat schematic). But even if it should be proved that no trilobite had more than 5 pairs of cephalic appendages, it appears probable that they had descended from ancestors which originally had at least 6 pairs since the occurrence of 4 pairs of glabellar furrows is otherwise difficult to understand, as will be further discussed below. If one pair was reduced, it seems most probable that it was the 2d pair. That it was one of the anterior pairs is indicated by the fact that in trilobites with only 3 pairs of furrows it is the frontal one that is not developed, or in some cases developed in the larva and not discernible in the adult e. g. *Holmia Rowei* WALC. (WALCOTT, 1910, Pl. XXIX). Since the anterior pair of appendages found in the trilobite head seems to be constructed similarly to the antennules of the crustaceans, it is natural to presume that it also corresponds to those. If the 2d pair really was reduced in some or all trilobites, this would be a point of agreement with the Apodidæ, where those appendages are very degenerate.

If one assumes that the trilobites originally had 6 pairs of cephalic appendages, of which the 2d pair perhaps was afterwards reduced, and that the 1st pair corresponds to the antennules of the crustaceans, the appendages of the occipital segment would correspond to the maxillipedes of these latter and to the 3d pair of walking legs in *Limulus.* The trilobite cephalon would thus have been composed of one segment more than the cephalon of the crustaceans and of one segment less than the cephalothorax of the merostomes. Since the cephalon of the arthropods, as generally considered, is formed by the fusion of the anterior segments of an annelid-like ancestor, a fusion which seems to have begun already in the higher annelids, it appears reasonable to presume that in the common ancestors of the trilobites and crustaceans proper 4 postoral segments were fused with the preoral part of the head, and that in the trilobites, later on, yet another segment coalesced with this original cephalon. There seems to be much that speaks in favour of the occipital segment being incorporated at a considerably later stage than the anterior segments, since it shows a much greater likeness to the thoracic segments than to the other segments of the cephalon and since also the appendages belonging to it are very like those of the thorax (Cfr. JAEKEL, 1901, p. 135). This is also indicated in the ontogeny, since in the earliest protaspis stage at least of *Elliptocephala* (see below p. 21) and probably also of *Liostracus* (p. 26) and other genera the occipital segment is not developed, or at least not separated from the pygidium. The development of the intergenal spines on the posterior glabellar segment in the larvæ of several trilobites, e. g. *Elliptocephala asaphoides* EMM. and *Pædeumias transitans* WALC. (WALCOTT, 1910, Pls. XXV, XXXII and text-figs. 4, 5 of this paper) might also be considered to point in the same direction. To have the genal angles produced into spines seems to have been a primitive character among the trilobites, and, as shown by the ontogeny of the genera concerned, it was originally the intergenal spines that were developed as »genal spines». That those were not formed by the occipital segment but by the segment in advance of it[1] might be due to the fact that they were already fully developed before the former segment was incorporated. That in some groups the intergenal spines were replaced later on by spines belonging to the ocular segment might have depended on the increasing of the free cheeks, and does not seem to be of any consequence in this connection. As is well known, also among the crustaceans proper, one or more or all of the thoracic segments may unite with the head forming a more or less complete cephalothorax. In for instance *Koonunga* SAYCE (SAYCE, 1908), a primitive crustacean referred to the Malacostracan order Anaspidacea, the anterior thoracic segment is fixed to the head, the posterior ones being free.

BERNARD (1894) has already pointed out that the ontogenetic development of *Elliptocephala*, which he considered to have had 5 cephalic segments, indicates that this trilobite must have arisen from a form, which

[1] RAYMOND (1917, p. 207) is of the opinion that the intergenal spines, as a rule, are formed by the 2d cephalic segment, but this is not confirmed by the figures and descriptions published, as will be further discussed below.

had only 4, since the cephalon of the youngest larva was composed of one segment less than that of the adult. He was of the opinion that the number of head segments varied among the trilobites and that within this group new ones had been added to the posterior margin of the cephalon. Except by the circumstance just referred to he considered this confirmed by the close resemblance of the occipital segment to those belonging to the thorax, and further by the fact that the number of segments indicated by the glabellar furrows varied. As SWINNERTON (1919, p. 104) has pointed out, this last consideration »is fallacious, for glabellar furrows are often reduced or smoothed out, so that» if for instance »indications of four segments are left, it is not safe to say that there are *not more* than four segments in the head, but it is safe to say that there are *at least* four».

»With regard to the resemblance of the occipital segment to the trunk segments» the last-named author remarks that »it may be observed that this is merely an illustration of the principle that in segmented animals specialization of the posterior lags behind that of the anterior segments.» This may be true to a certain extent, but it does not prove that the occipital segment could not have been incorparated with the head at a considerably later stage than the anterior ones. That »the cephalic segments became marked off as a cephalic *en bloc*» and »that the posterior limits of the head-shield became defined and the number of its segments fixed at a very early stage in the evolution» of the trilobites is indicated, according to SWINNERTON's opinion (1919, p. 105), by the fact that in »so primitive a form as *Marrella*» (WALCOTT, 1912a, p. 192, Pls. XXV, XXVI), which he considers a trilobite, as well as in the widely separated genus *Triarthrus,* »five pairs of cephalic appendages occur and that the last pair in each case resembles those in front more than it does the trunk appendages». As I have tried to show above it is not impossible that *Triarthrus* might have had more than 5 pairs of cephalic appendages, and it appears as if the pair belonging to the occipital segment was very like those of the thorax. With regard to *Marrella* it does not seem to have been a trilobite, as will be further discussed below, and moreover the cephalic appendages described in this form evidently do not correspond to those in *Triarthrus.* It is true that WALCOTT (1912a) defined *Marrella* as having 5 pairs of cephalic appendages, but according to his descriptions and plates only 4 of these can be regarded as true appendages since »the strong, backward-curving spine» »at each antero-lateral angle» of the cephalic carapace, which he calls the »antennule?», hardly can be an appendage and certainly has not any resemblance to the antennule or to any other of the limbs of the trilobites. Consequently this line of reasoning cannot be accepted. On the other hand one must agree with SWINNERTON that, since »in all trilobites, young or old, which possess eye-lines or eye-lobes as well as a clearly segmented glabella, the line or lobe is related to the palpebral segment that is the fifth from the posterior margin» this fact indicates that »these five segments are homologous in all typical trilobites». Probably he is also right in assuming »that no new segment has been added to the cephalon since definitive trilobites came into existence». Thus BERNARD's opinion that the number of head segments varied among the trilobites evidently was not correct, but from this does not follow that they could not have originated from ancestors in which, as in the primitive crustaceans, only 4 postoral segments were included in the cephalon, and in which the occipital one still belonged to the thorax, this segment later on, but before they became definitive trilobites, being fused with the head. Whether the segments of this original cephalon were marked off »*en bloc*», is of course impossible to form a definite opinion about, but it is not inconceivable that such was the case.

It is likewise difficult to tell whether the merostomes and arachnoids also arose from ancestors with only 4 postoral fused segments, but it seems rather probable, at least if the arthropods had a monophyletic origin. About this there are different opinions among the scientists; however, most modern investigators appear inclined to think that such was the case, and it is difficult to understand the close correspondence in several important characters especially among the more primitive forms of the different groups of arthropods, if they had had a polyphyletic origin.

Among the remarkable fossils found by WALCOTT in the Middle Cambrian strata of British Columbia, there are several arthropods, which, though considered by this author to belong to different groups, Branchiopoda, Malacostraca, Trilobita and Merostomata, in some respects show great similarities (WALCOTT, 1911, 1912a, 1918). Some of the forms found he evidently, at least in his earlier papers, regards as transition forms. »In *Marrella* (pls. 25 and 26)» he says (1912a, p. 163) »the trilobite is foreshadowed and *Nathorstia* (pl. 28, fig. 2) is a generalized trilobite as the trilobite appears to be a specialized branchiopod, adapted largely for creeping on the bottom. The trilobite gives some conception of a possible form between the Branchiopoda and the Aglaspidæ of the Merostomata.» Both these forms he refers to the trilobites, and in a diagram (1912a, p. 161) all other trilobites are derived from *Marrella*, *Nathorstia* representing an early offshoot on this line of descent.

As pointed out above the cephalic appendages of *Marrella*, as described, do not seem to correspond to those of the trilobites. It seems to have been a form rather highly specialized for a planktonic life. From the figures and descriptions, which unfortunately are rather indistinct and incomplete, it is difficult to form an opinion about how it was constructed, but they do hardly give the impression that it was a trilobite or was especially closely related to the forms from which the trilobites originated. In his last paper published (1918) the afore-said author does not appear to regard it as representing the ancestor of these, since he emphasizes (p. 170) that in some respects it indicates less primitive characters than they, though it agrees with them in serveral others, and there are some features that point »to it as a primitive form possibly ranking in development between *Apus* and the trilobite». This statement seems to indicate that he, like the present writer, considers it to represent a separate offshoot of the same ancestral stock from which the trilobites and the crustaceans proper arose. *Nathorstia* on the other hand probably was a trilobite.

In another diagram in his paper of 1912 (p. 164) WALCOTT makes »the attempt» »to show the relations of Cambrian crustaceans», including the trilobites and the merostomes, »to a theoretical ancestral stock which for convenience is correlated with the Apodidæ. From this stock it is assumed that the Branchiopoda came, and from the Branchiopoda stock three distinct branches were developed prior to or during Cambrian time.» In one of these lines »of descent it is assumed that the Trilobita are directly descendent from the Branchiopoda and forms grouped under the order Aglaspina derived from the Trilobita. The order Limulava is considered as being intermediate between Aglaspina and the Eurypterida, and that the two orders Limulava and Aglaspina serve to connect the Trilobita and the Eurypterida.» From the Eurypterida he derives the Xiphosura, while the Phyllocarida and Ostracoda are derived from the Branchiopoda on different lines of descent than the Trilobita.

Later researches, however, seem to have made him modify this view, as in his last paper (1918, p. 168) he says: »The Trilobita disappeared at the close of Paleozoic time without leaving direct descendants. The Branchiopoda, including the Ostracoda, Copepoda and Cirripedia developed steadily during Paleozoic and subsequent geologic time, until to-day their descendants form the subclasses Branchiopoda and Malacostraca, each of which is equivalent to the subclass Trilobita of Paleozoic time. Springing from a common crustacean base the three groups have many features in common, and in details of structure of the limbs many striking resemblances occur. It does not impress me that trilobites were true Branchiopodans or Malacostracans; they have certain characteristics in common, but these are not necessarily the result of lineal descent one from the other, but are the result of descent from a common ancestral crustacean type of pre-Cambrian time.» And after comparing the trilobite limbs with those of *Apus* and of some of the forms referred to the Malacostraca he concludes: »that the trilobite is a primitive crustacean far back on the line of descent from the original crustacean type which existed in pre-Cambrian or Lipalian time» (p. 174). He seems to be of the opinion that BEECHER was right in considering that the Trilobita ought to be regarded as a special subclass of the Crustacea equivalent to the subclasses Entomostraca and Malacostraca and that »its affinities are with both the other subclasses, especially their lower orders, but its position is not intermediate» (BEECHER, 1897, p. 93).

In his paper »Zur vergleichenden Anatomie des Gehirns von Polychæten etc. (1916)» HOLMGREN comes to the conclusion that the arthropods have had a monophyletic origin and that they are descendants from a polychæt-like ancestor. From this ancestor he believes that the trilobites were developed, and from the trilobites he derives on one line of descent the Xiphosura and Arachnoidea and on another the Phyllopoda (and higher Crustacea) and the Myriapoda—Insecta. The higher trilobites, of which he believes the xiphosures to have been direct descendants, he considers to have had 7 pairs of cephalic appendages, as mentioned above (p. 9), and since the crustaceans have only 5, he does not think that they could have originated from these trilobites but that the number of cephalic appendages varied among the trilobites and that »bei den niederen Trilobiten dürfte die Zahl der Kopfextremitäten geringer gewesen sein als bei den höheren. Von solchen niederen Formen könnten die Phyllopoden sehr wohl abgeleitet werden (oder sind sie sogar solche niedere Trilobiten?)» (p. 277). It is rather difficult to understand what he means by saying that the phyllopods perhaps were such lower trilobites, since he presumes that the higher trilobites, the direct ancestors of the xiphosures, originated from the lower ones and since, as he has pointed out, the construction of the brain of the xiphosures and of the lower crustaceans (Apodidæ), though exhibiting such great similarities that the two groups must be considered as near relations, shows that neither of them could have descended from the other. This, however, is of less importance and does not, of course, contradict the result of his researches that the arthropods have had a monophyletic origin or that the xiphosures and phyllopods are closely allied, but he has not proved that the trilobites were the ancestors of either of these two groups, though on account of their many resemblances to both of them it seems probable that they came from the same stock.

His researches appear to speak against the line of descent which WALCOTT has given in his diagram, mentioned above. Since, however, they only comprise recent arthropods and since the brain of the Cambrian ones very likely was more primitive, this only seems so. On the contrary, if HOLMGREN when saying that the phyllopods perhaps were lower trilobites, had the Cambrian or other extinct forms in mind, his view would be about the same as the one expressed in WALCOTT's diagram, where the phyllopods though not considered to be trilobites yet are regarded as closely related to these and where, as mentioned above, the merostomes are derived from the trilobites.

WALCOTT's researches seem to have proved that the trilobites were closely related to the crustaceans and that they have many points of resemblance as well with some of the more primitive recent ones as especially with the Cambrian branchiopods. But there are also many dissimilarities, and since the representatives of both groups seem to be already at their first appearance in the fossiliferous strata so specialized in different directions, it does not seem probable that any of them had originated from the other, but one has a right to assume that they are descendants from the same stock. If it be so, it appears natural that among the Cambrian branchiopods there are several more which are similar to the trilobites than among the recent ones, since evidently among the oldest known fossils one must expect to find the most primitive forms, which have many characters in common with each other and with the pre-Cambrian ancestors. It is also only natural that among these there are forms that seem to be transition forms, as it is probable that from the ancestral stock several groups originated which eventually only survived a short time. Conceivably these were in some primitive features like the trilobites, in others like the branchiopods or other groups of the same stock, and they could also have developed characters homologous to one or another of these groups, since the hereditary tendencies might have been the same. But some similarities, which seemingly were of a homologous nature, might have been due only to an analogous evolution, as one must assume that forms which came from the same primitive ancestors in some respects must, independently of each other, have evolved the same characters, since Nature has not the choice of an unlimited number of ways to enter upon.

Marrella for instance might have been such a form, and perhaps also some of the Cambrian »branchiopods», the relation of which to the recent branchiopods does not seem to be clear. Also the »trilobites» *Mollisonia* WALC. (WALCOTT, 1912a, p. 196, Pl. XXIV) and *Tontoia* WALC. (Ibid., p. 198, Pl. XXIV) possibly belonged to this group. At all events it is probable that such forms will be discovered.

Some of the Cambrian »merostomes» perhaps also belonged here. Their likeness to the trilobites and branchiopods is indisputable. Some of their characters indicate a close relationship, e. g the development of the appendages and perhaps the construction of the test. Possibly such forms as *Aglaspis* HALL (RAYMOND in ZITTEL's Text-book 1913, fig. 1501) and *Molaria* WALC. (WALCOTT, 1912a, p. 200, Pl. XXIX) might have been trilobites, but if the latter really had 5 pairs of cephalic appendages, of which the 2 anterior pairs were antennæ, this appears rather to be a dissimilarity than a similarity.

If the presumption is right that the 2d pair of antennæ was reduced in the trilobites and that the occipital segment did not originally belong to the cephalon, the Cambrian merostomes might be considered to represent forms which in these respects, viz. that the occipital segment was not incorporated in the head, and that the 2d pair of antennæ were developed, were more like the crustaceans proper than the trilobites.

As to the relationship between the Cambrian merostomes and the eurypterids and xiphosures, the likeness between these latter and the forms referred to the Aglaspina is very slight, whereas the Limulava have more points of agreement with them. The general form of the body is the same in *Sidneyia* WALC. (WALCOTT, 1911, 1912a) as in the eurypterids and also the number of segments in the abdomen, though in the former

9 of them are branchial-bearing, in the latter only 6. On the other hand the dissimilarities between the two groups are so many that it seems possible that the points of agreement only are of an analogous nature. One of the most important characters in which *Sidneyia,* as described, differs from the higher merostomes is that it has only 5 pairs of cephalic appendages, of which the 1st pair is not chelicerae but simple antennæ. If those really correspond to the cephalic appendages of the crustaceans, as WALCOTT seems to think is the case, the Limulava would have had a less number of body segments than the eurypterids and xiphosures, the number of abdominal segments being the same, and if it be so, it does not seem probable that the latter descended from them. CLARKE and RUEDEMANN (1913, p. 403) think it probable that *Sidneyia* had cheliceræ, but that these are not yet discovered, and that the antennæ correspond to the 2d pair of appendages of the eurypterids, which pair in *Slimonia* PAGE is also tactile. If *Sidneyia* really is a merostome, this assumption seems probable, or conceivably the cheliceræ were reduced, but in either of these cases one of WALCOTT's chief reasons for deriving the Limulava from the crustaceans via the trilobites would fall, and in the latter case the higher merostomes can hardly have originated from a *Sidneyia*-like ancestor. As far as the construction of the Limulava is yet known, it seems most probable that they came from the same stock as the eurypterids and xiphosures, but that they are not the ancestors of these but form a separate branch.

The connection between the Limulava and the Aglaspina appears to be rather undecided; from WALCOTT's figures and descriptions one hardly gets the impression that they were very closely related, and, at least with regard to the former, I cannot see that they really have any more points of resemblance to the trilobites than to the lower crustaceans proper. As to the special similarities generally quoted between other merostomes and the trilobites, they seem to be rather of an analogous than of a homologous nature. Interesting is the reported occurrence of a facial suture in some lower xiphosures and the indication of such a one in *Limulus.* One does not know, however, if this is a structure of the same nature as the facial suture in the trilobites. It does not seem probable that the merostomes derived their origin from the trilobites but that they belonged to the same stock as these and the crustaceans proper.

With our present knowledge it is not possible to decide the closer relationship between the lower arthropods, as I have tried to show above, but one seems to be entitled to assume that they all came from the same ancestral stock (of which it seems as if no representative were known). Probably the forms found in the older fossiliferous strata represent a great number of different branches of this stock, of which some died out already during Cambrian time, some developed offshoots, which soon became extinct and others survived for a longer or shorter period, some up to the present time.

The trilobites seem to be more closely related to the crustceans than to the merostomes, and one might be justified in regarding them as a subclass of the Crustacea.

Classification of the Trilobita.

Among the several attempts made by different authors to construct a general classification of the Trilobita none can be said to be successful.[1] The families defined by BARRANDE and SALTER seem on the whole to be rather natural, and have largely been adopted by later authors. But the phylogenetic relation between the families is as yet only very unsatisfactorily established.

The error in the classifications of most of the older authors is that they are based on one or a few progressive characters generally of minor importance from a phylogenetic point of view, so that families which in most respects differ very much from each other are grouped together. This is also, as SWINNERTON (1915) has pointed out, applicable to the classification proposed by GÜRICH (1907).

It does not seem possible to find any special character on which to base a classification of the Trilobita. Conceivably the construction of their appendages would be serviceable for this purpose, as is the case among other arthropods, but as they are as yet known only in so very few trilobites, this is for the present of no practical significance. It seems more probable that the question will be sooner solved along the line upon which the scientists of the last twenty years have started, viz. by the study of larval and transition forms, when a somewhat greater number of these will be found than is the case at present.

BEECHER's Outline of a Natural Classification of the Trilobites (1907) is, as is well known, based upon such a principle, since by studying the larval forms he tries to interpret by means of ontogenetic facts the phylogeny of the animals concerned. However, he does not take enough into consideration, either that several characters, which may seem to be very primitive, often are due to secondary reduction, or the circumstance that some of the stages of evolution that the species has had to pass are eliminated in the development of the individual, or the fact that some characters might have been adapted in different groups independently of each other because of similar conditions of life. Another error is that in too high a degree he has, from the characters of the larva of one group of trilobites, drawn conclusions as to the phylogeny of other groups. This he had to do partly because only a proportionally very

[1] For an account of the different classifications applied to trilobites reference may be made to the works of BARRANDE (1852), ZITTEL (1885), BEECHER (1897), RAYMOND (in ZITTEL-EASTMAN's Text-book 1913) and SWINNERTON (1915).

small number of larval forms are known, partly because the larva at the earliest phylembryonic stage, the protaspis, of the higher and geologically younger genera is more developed than that belonging to the more primitive Cambrian forms. Another difficulty was that apparently he had not seen the original specimens of all the larval forms he dealt with, but had to draw his conclusions only from the figures and descriptions made by other authors. This was evidently the case regarding *Sao*, the ontogeny of which played such an important part in the building up of his theory, and it seems as if he had in some respects misunderstood BARRANDE's figures (which will be further illustrated below).

It may be presumed that BEECHER's classification is too well known to require that a more particular account of it should be given here, since it is adopted by most English and American authors, e. g. by RAYMOND in ZITTEL-EASTMAN's Text-book of Paleontology 1913. It may, however, deserve mentioning that BEECHER's classification as well as SALTER's (1864) is founded on the development of the eyes and the facial sutures, and does not on the whole differ much from the one given by the last author, being only a modification of his system, in some respects, as it seems, inferior to it. In his order Hypoparia he brings together SALTER's groups Agnostini and Ampycini; also the family Harpedidæ is referred to this order. His order Opisthoparia comprises the same families as SALTER's group Asaphini with the exception of Harpedidæ and Calymenidæ and lastly the order Proparia is equivalent to SALTER's Phacopini with the addition of the Calymenidæ. Inside the orders BEECHER regards those families which show the greatest resemblances to the larvæ as the most primitive, and if it can be said that his grouping of the families within the orders, or at least within his largest order Opisthoparia, is more natural than SALTER's, one must say that SALTER's general classification was better without BEECHER's modification, though SALTER never claimed that his was entirely natural.

This has already been pointed out, e. g. by WOODS (1909), and several authors have attacked BEECHER's classification on several points and especially his order Hypoparia (LAKE, 1907, JAEKEL, 1909, RICHTER, 1915 etc.). In the Geological Magazine for 1915 H. H. SWINNERTON has given a Revised Classification of Trilobites, and in the American Journal of Science, Vol. XLIII, 1917, P. E. RAYMOND has tried to show that BEECHER's classification was largely correct. But before entering upon a closer examination of these papers it might be appropriate at first to discuss to some extent the larval development of the trilobites, the origin and course of the facial suture within different groups, and some other questions connected with these.

As is well known, BEECHER considered the earliest larval form of trilobites, the protaspis, to have had the following characters: »Dorsal shield minute, not more than ·4 to 1 mm. in length; circular or ovate in form; axis distinct, more or less strongly annulated, limited by longitudinal grooves; head portion predominating; axis of cranidium with five annulations; abdominal portion usually less than one-third the length of the shield; axis with from one to several annulations; pleural portion smooth or grooved; eyes, when present, anterior, marginal, or submarginal; free cheeks, when visible, narrow and marginal.» (BEECHER, 1897, p. 99).

Most of these features, excepting of course the smallness and the absence of thoracic segments, he evidently considered to have been characteristics of the primitive trilobites. He also presumed that the larval development ascertained for the single types corresponded to the phylogenetic evolution. The fact that in the earliest protaspis stages, the anaprotaspis, of such comparatively primitive forms as *Liostracus, Solenopleura* and *Ptychoparia* one has not discerned any eyes or free cheeks on the dorsal side of the cephalon and that these organs are marginal in the later larval stages of these genera and in the anaprotaspis of higher trilobites, led him to suppose that both in the ontogenetically and phylogenetically earliest stages they were situated on the ventral side and later on migrated »first forward to the margin and then backward over the cephalon to their adult position» (BEECHER, 1895b, p. 177). The younger larva of the aforesaid Cambrian genera should still have had the eyes and the free cheeks ventrally situated, while in the higher genera it was so far developed that they had travelled to or over the margin of the cephalon. The order Hypoparia, BEECHER considered to correspond in this respect to the anaprotaspis of the primitive type, but it does not seem as if this order was maintainable, since the forms referred to it, as has been shown by different authors, probably had descended from ancestors with ordinary eyes and facial sutures.[1] When the former were reduced, the latter grew together *(Harpes, Trinucleus)* or moved towards the margin *(Ampyx,* probably *Agnostus),* and no trilobites with the eyes situated on the ventral side are known, and there is no reason to believe that such forms ever existed, since apparently the eyes were not so situated in the larva either.

In the earliest known larvæ of such primitive species as *Elliptocephala asaphoides* EMMONS (FORD, 1877, WALCOTT, 1886, 1890, 1910, and text-fig. 4 of this paper after WALCOTT) and *Holmia Kjerulfi* LNRS. (KIER, 1916, text-fig. 11, Pl. VI) the eyes, or those parts of the cephalon where the eyes later on were developed, are situated on the dorsal side and well within the border of the head shield. BEECHER considered that the larvæ of the former species illustrated by FORD (1877), and WALCOTT (1886, 1890) »present a number of features considerably in advance of a typical protaspis» (BEECHER 1895b, p. 176). One of these features would just be »the adult position of the eyes», another »the distinct and separate pygidium». BEECHER evidently presumed that the protaspis illustrated by WALCOTT, 1886, Pl. XVII, fig. 5 (copied by BEECHER 1895b, in text-fig. 8; the text-fig. 4a of this paper is copied from WALCOTT,

[1] This is contrary to RAYMOND's opinion, but this question will be more fully discussed below.

1910, Pl. XXV, fig. 9, which figure is drawn from the same specimen as the one mentioned above illustrated in his paper of 1886) only represents the cephalon and that the pygidium is not preserved on the specimen, but this does not seem to be the case. Probably the posterior annulation is the pygidium, from which the occipital segment is not separated. The annulation in question is too long to be only the occipital segment, and moreover somewhat rounded posteriorly. In the evidently much later stage, illustrated by text-fig. 4 c, the pygidium and occipital ring are as yet not separated, and in the youngest larvæ of other forms the conditions seem to be the same, as will be further illustrated below. The larva concerned would thus, contrary to BEECHER's presumption, represent a more primitive stage than any of those illustrated by him. That it is a very early stage is also shown by the circumstance that the frontal lobe of the glabella is not separated from the larval ridge (see below). SWINNERTON (1915, p. 492) has also pointed out that it is so primitive that »it shows the pleural elements of the fixed cheek region quite distinctly». This must undeniably be considered a primitive feature,

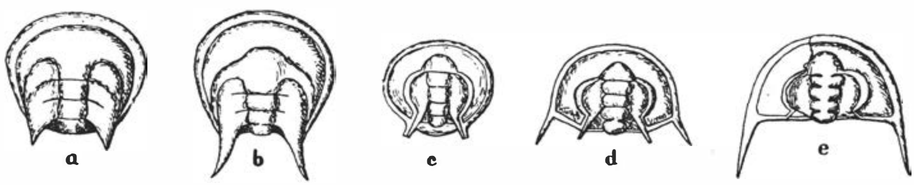


Fig. 4. *Elliptocephala asaphoides* EMMONS. a—c, Successive stages of the protaspis much enlarged. d, Cephalon of nepionic individual much enlarged. e, Cephalon fully developed slightly enlarged (after WALCOTT).

but need not prove that the larva represents the earliest protaspis stage, since the same feature is also clearly shown in later larval stages both of this species (text-fig. 4 b) and others, e. g. *Pædeumias transitans* WALC. (WALCOTT, 1910, Pl. XXV) and *Liostracus Linnarssoni* BRÖGG. (text-fig. 6 e) and also in the protaspis of *Triarthrus Becki* (WALCOTT, 1918, Pl. XXX, fig. 16).

In the above-mentioned earliest protaspis of *Elliptocephala asaphoides,* as illustrated and described by WALCOTT (text-fig. 4 a), the frontal lobe of the glabella is not separated from the adjacent parts of the cephalon. Inside the flat antero-lateral border, which surrounds the head shield, there is a swollen, posteriorly tapering ridge, which may be called the l a r v a l r i d g e. The median portion of this ridge partly corresponds to the frontal lobe, and is continuous with the 1st glabellar lobe, whereas the lateral portions of the ridge arch round the pleural parts of this lobe and of the following ones, but are separated from them by clearly marked furrows. The posterior parts of the dorsal furrows are distinctly marked, likewise the 2d and 3d glabellar furrows, also the segmentation of the cheeks is clearly indicated by furrows as mentioned above. The pleural parts of the 3d glabellar segment are prolonged into short intergenal spines. Between the spines lies the narrow pygidium, which is not separated from the occipital segment and on which the axis is only indistinctly marked.

WALCOTT (1910, p. 236) describes the intergenal spines as formed by the 2d and 3d glabellar segment and judging only from the specimen illustrated on text-fig. 4 a, where the furrows separating the pleural parts of these segments are very short, one might believe this to have been the case, but not when comparing it with the larva on the 2d stage (text-fig. 4 b) or with the protaspis of *Holmia Kjerulfi* figured by KIER (1916, text-fig. 11 a and Pl. VI, fig. 1).

In the 2d larval stage of *Elliptocephala* illustrated (text-fig. 4 b) the anterior and lateral portions of the ridge have flattened out, and constitute the preglabellar field and the parts of the cheeks lying between the borders and the postero-interior portions of the ridge, which form the palpebral ridges and eye lobes, the middle posterior portion constituting the frontal lobe of the glabella. The intergenal spines have grown considerably. In *Holmia Kjerulfi*, where there is no preglabellar field, evidently only the antero-lateral portions of the ridge flatten out, and the frontal lobe is formed by the whole of the middle portion, which in the protaspis figured is shorter than in *Elliptocephala* and separated by the 1st glabellar furrow from the ring behind.

In the third larval stage of *Elliptocephala* here represented (text-fig. 4 c) this furrow is also clearly marked as well as the axis of the pygidium. The pleural parts of the pygidium, but not the axis, are separated from the corresponding parts of the occipital segment. The furrows on the cheeks are obliterated with the exception of the palpebral furrow. The posterior portions of the eye lobes are situated closer to the glabella, the posterior parts of the free cheeks have grown a little broader, and there are genal spines lying close to the intergenal ones, which latter are considerably reduced in size.[1]

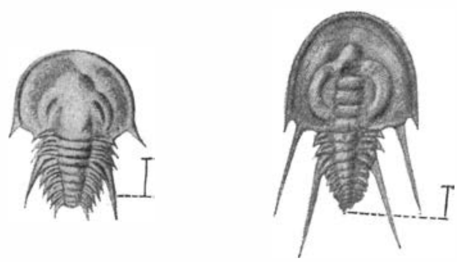
During the progressive development of the cephalon (text-fig. 4 d, e, text-fig. 5 a) the genal and intergenal spines gradually separate, and the latter finally disappear. The posterior parts of the free cheeks[2] and the lateral part of the occipital segment increase in size; the posterior margin straightens out. The posterior part of the eye lobe moves nearer

[1] RAYMOND (1917, p. 207) evidently does not regard the intergenal spines in the larva of this stage as homologous to the spines described in the earlier stages, but considers them to be formed by the 2d (palpebral) segment of the cephalon. But to judge from the figures published of the larval and later stages of this and other species of the Mesonacidæ, this assumption is not correct.

[2] As there are no facial sutures found in this species, there are no free and fixed cheeks in the ordinary sense, but their relative positions are partly marked by the eye lobes, and one has moreover a right to presume that the free and fixed cheeks have fused along a line which had about the same course as in other genera of the same family in which traces of the obliterated sutures remain (see below).

to the glabella, so that the surface of the eye finally is turned straight outwards.

From the earlier nepionic stages of the species concerned only the cephala are known, but judging by the position of the intergenal spines and by later stages where the thoracic segments are preserved (text-fig. 5 a), it is evident that the cephalon increased in width more rapidly than the thorax. This feature is still more prominent in the development of *Pædeumias transitans*, of which species several nepionic larvæ on different stages are known (WALCOTT, 1910, Pl. XXXII and text-fig. 5 b of this paper). Here the posterior parts of the fixed cheek region inside the intergenal spines increase much more rapidly than the thoracic segments do, whereas it seems as if the growth of these parts were more simultaneous in *Elliptocephala*. In the former the intergenal spines are still very long at a comparatively late stage and never very far separated from the genal ones, which are not developed until relatively late.



a b

Fig. 5. Nepionic individuals. a, *Elliptocephala asaphoides* EMMONS. b, *Pædeumias transitans* WALCOTT. The lines at the side of each figure show the actual size of each specimen. (After WALCOTT.)

As the eye lobes of the Mesonacidæ nearly reach the frontal lobe of the glabella, the eye ridges, when present, are very small. In some forms they are united with the postero-lateral parts of this lobe, in others they are separated from them by a narrow furrow. This latter is for instance the case in the adult *Elliptocephala* (WALCOTT, 1910, p. 272), whilst in the young the ridges are continuous with the frontal lobe. In such genera as *Holmia Kjerulfi*, where the palpebral lobe is longitudinally divided by a furrow, the eye ridge forms the continuation of the inner part of the lobe. The presence of this furrow is considered by LINDSTRÖM (1901, p. 15) to indicate the pleural nature of the lobe; the furrow would then correspond to the pleural furrows on the thorax and the pygidium, which does not seem improbable.

In other forms outside this family where there is an eye ridge, this is separated from the glabella. Since the presence of the eye ridge is chiefly characteristic of cambrian trilobites, and since the ridge is sometimes developed in the larva, but not retained in the adult, it has been considered a primitive feature. BEECHER, however, did not believe that it was developed in the youngest larva of some primitive trilobites, *Ptychoparia, Solenopleura* and *Liostracus,* but first at a later stage. Nevertheless he considered the presence of an eye ridge to be »a very archaic feature» (1897, p. 102). He presumes that it »first develops in the later larval stages of certain genera (*Ptychoparia* etc.); next in the early larval stages (*Sao*); then disappears from the adult stages (*Triarthrus*); and finally is pushed out of the ontogeny (*Dalmanites*)».

LINDSTRÖM (1901) also presumes that the eye (facial) ridge in the primitive genera in question was developed at a comparatively late stage, but that this also was the case in *Sao* and other Olenidæ (s. lat.) and related families. In the larvæ of *Sao* illustrated by BARRANDE (1852, Pl. VII) he does not recognize an eye-ridge in the earliest stages, but first in that represented by the figs. 4 c, d (text-fig. 7 d of this paper). It is true that in the earliest stages, as represented by the figures, the eye ridge does not seem to be developed as such, but forms part of the larval ridge, but since this is also the case with regard to the specimen on fig. 4 and since LINDSTRÖM does not otherwise make any distinction[1] between the eye ridge and the lateral parts of the larval ridge, he has evidently overlooked that the ridge is clearly indicated already in BARRANDE's fig. 1 b (text-fig. 7 b). He further considers that the development of the trilobites in question was quite different from that of the Mesonacidæ (Olenellidæ), since in the larvæ of the latter the pleural part of the cephalon is segmented, whereas in »the later Cambrian and older Silurian forms» the protaspis »have a rachis but no pleura proper, as the single facial ridge has a quite different signification and appears at a comparatively much later stage than the facial ridge of the Olenellidæ, which is present from the earliest stages known» (1901, ps. 21, 22) and the pleural nature of which is indicated by the longitudinal furrow occurring for instance in the adult of *Holmia Kjerulfi* (Ibid. p. 15). This as well as BEECHER's assumption that some trilobites in which the ridge is developed in the later stages would have been without it in the earliest larval stages, does not seem to be correct.

In the Paradoxides shales (*Tessini* Zone) at Ödegården and Öltorp in Wästergötland there is found, together with cranidia, pygidia and free cheeks of adult *Liostracus Linnarssoni,* a series of larvæ and young individuals of the same species. Larval forms of *Liostracus* (*Ptychoparia*) *Linnarssoni* are already described by MATTHEW (1888), and also the larvæ figured by BRÖGGER (1875, the figs. reprinted and described by LINDSTRÖM 1901) seem to belong to this species.

All of the protaspis larvæ of the species concerned, found at Ödegården and Oltorp (text-fig. 6 a—f), have a distinctly marked larval ridge,

[1] This distinction is not made by BEECHER either, which, however, is of no consequence in this connection.

the lateral parts of which do not, however, reach as far back as in *Elliptocephala* and *Holmia*. The ridge is also comparatively narrower than in those and obviously its middle part does not include the whole of the frontal lobe, the posterior part of which is laterally bounded by the dorsal furrows, which from having a nearly parallel course here take a slightly outward turn, so that the posterior part of the frontal lobe, as in most other early protaspis larvæ of related genera, as far as they are known, gets a triangular form. Forwards this triangular part of the lobe is continuous with the middle part of the larval ridge. The lateral parts of the ridge, just where they meet the dorsal furrows, reach a little further back than the middle part, so that their posterior inner portions become separated from the frontal lobe by the utmost ends of these fur-

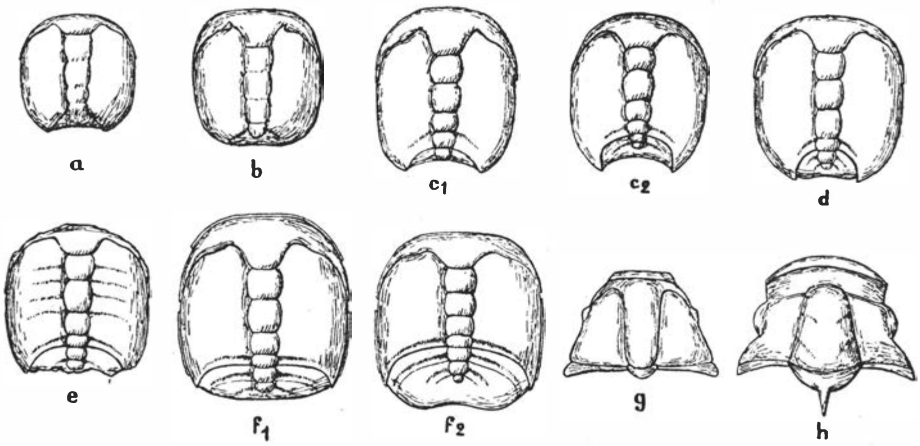


Fig. 6. *Liostracus Linnarssoni* BRÖGG. a—f, Successive stages of the protaspis, × 33. g, Cephalon of nepionic individual, × 24. h, Cephalon of adult, × 3. a, c_2, f_2 somewhat from behind.

rows (see text-fig. 6 b and c_1). These portions seem to be a little more swollen than the antero-lateral parts of the ridge, and in some specimens it looks as if, at least near the glabella, there were indistinct furrows in front of them.

The larvæ at the earliest stages are very strongly arched both from side to side and from back to front, and when viewed from above the ridge as well as the pygidium is partly hidden. Often the lower parts of the specimens are concealed in the rock and very difficult to extricate. This might explain why the ridge in larvæ of this and related genera at the same early stage, where the conditions probably were similar, so often has been overlooked, which led BEECHER to suppose that it was not developed. In later protaspis stages the convexity is somewhat less and the ridge easier to discern.

The ridge is very swollen and slightly overhanging, and this makes it very difficult to find the border in front and to the sides of it. In one specimen (text-fig. 6 f), representing a rather late protaspis stage, nearly the whole of it is preserved. It is very narrow, and continues behind the ridge along the margin of the cheek. Also in a few other specimens part of this lateral portion of the border is to be seen, and since some of them represent such an early stage that there is no line of demarcation between the occipital ring and the axis of the pygidium (Cf. below), it is evident that the border was developed already in the youngest larvæ.

In the earliest protaspis (text-fig. 6 a, b) the glabellar furrows are very faint, the 1st generally more strongly marked than the others. These latter are, however, all indicated in most specimens as well as the one posterior to the glabella. Just behind this last furrow it looks as if the dorsal furrows took an outward direction (text-fig. 6 a, the same is to be seen in the larva of *Sao hirsuta* BARR., illustrated on text-fig. 7 a), but apparently these bent-out parts do not belong to the dorsal furrows but indicate the line of division between the cephalon and the pygidium. There is nothing which indicates a boundary between the occipital ring and the pygidium, and probably the occipital segment was not developed at this stage. The pygidium is very narrow and nearly vertically bent down, the axis is indistinctly marked, and behind it there is a short flattened border part, the posterior margin of which is concave and generally does not reach as far back as the more swollen prolonged posterior parts of the cheeks. The larva at this stage is in several respects very similar to the earliest larva figured of *Elliptocephala* (text-fig. 4 a).

During the progressive development of the protaspis (text-fig. 7 c—f), the annulation of the glabella becomes stronger, the occipital segment separates from the pygidium, in which the axis by this time has become clearly marked, the posterior border furrows grow distinct, new segments are introduced in the pygidium, which increases in width, the inner parts of the posterior margins of the cheeks straighten out, and the whole animal gets less strongly arched.

In one specimen (text-fig. 7 e) the segmentation of the cheeks is clearly marked. Nearly straight out from the 2d and 3d glabellar furrows two pairs of narrow but distinct furrows run across the inner comparatively flat parts of the cheeks; whether they continue on the more strongly arched lateral parts I have not been able to discern. Between these and in front of the foremost pair there are two other furrows on each side, which seem to correspond to the pleural furrows on the thorax and the pygidium. The specimen in question represents a rather late protaspis stage, as seen from the figure, but also in some other specimens, at earlier as well as later stages, traces of these furrows may be seen.

In the oldest specimens of which complete dorsal shields are found (text-fig. 7 f), there are 2 furrows on the axis of the pygidium, the anterior pleural and rib furrows on the side lobes are marked, a 2d pair of each kind being more indistinctly discernible; the posterior margin is still slightly concave. In no larva at the protaspis stage the facial sutures have been observed.

From later larval stages only the cranidia are known. The youngest of these, which evidently represent an early nepionic stage, are only slightly convex, the glabellar furrows are still clearly marked, and the larval ridge is shorter, but has otherwise about the same appearance as in the later protaspis larvæ, and reaches to the anterior border. In later stages the glabellar furrows grow less distinct, and are in the adult only faintly marked near the dorsal furrows, or all but obliterated. The posterior portions of the lateral parts of the ridge become separated by shallow transverse furrows, or impressions,[1] from the anterior portions, which still are continuous with the middle part of the ridge. At a still later stage the antero-lateral parts of the ridge flatten out, and constitute the preglabellar field and the anterior parts of the fixed cheeks. The middle of the posterior part of the ridge becomes rounded in front and constitutes the anterior part af the frontal lobe; the postero-lateral parts, which are separated from the glabella by the dorsal furrows, form the narrow eye ridges and the palpebral lobes. The specimen figured in text-fig. 6 g represents a stage in which the flattening out of the anterior portion of the ridge has just begun. In it the furrows in front of the postero-lateral parts of the ridge are not discernible.

During the following development the eye ridges straighten out, and the palpebral lobes are directed more straight backwards, which implies that the eyes get their normal position, viz. that their axis becomes parallel with the axis of the body; the fixed cheeks grow narrower, the glabella broader, and the preglabellar field and the parts of the cheeks in front of the eye ridges increase in length (see text-fig. 6 h).

Of the *Liostracus* larvæ figured by BRÖGGER (1875, Pl. XXV and LINDSTRÖM 1901, p. 21) the earliest one (fig. I) is probably somewhat younger than any of those found in Wästergötland, since it seems to be so strongly arched that nothing of the larval ridge is seen from above and since there are no furrows on the axis. In fig. II the occipital segment is apparently not yet separated from the pygidium, the 1st glabellar furrow is clearly marked, the posterior ones more faintly, and the larval ridge is indicated. In fig. III it is to be seen distinctly, though LINDSTRÖM evidently has not noticed this, and it is likewise indicated in fig. IV. Fig. V represents, with regard to the development of the cephalon, a more advanced stage than any of the protaspis from Wästergötland, inasmuch as the frontal lobe of the glabella is clearly defined. In fig. VI the segmentation of the cheeks is indicated by one transverse furrow.

Also in MATTHEW's (1888, Pl. II, figs. 1 f, 1 g) figures of the protaspis, supposed to belong to *Liostracus Linnarssoni*, traces of the

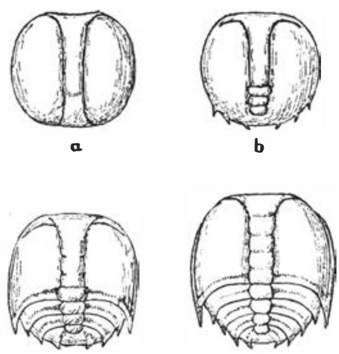
[1] As mentioned above it appeared to me that the beginning of these furrows was discernible already in some larvæ at the protaspis stage.

ridge are to be seen, but, as the figures are very indistinct, BEECHER obviously has overlooked this, and in his copies (1895 b, Pl. VIII, figs. 3, 4) the ridge is not laid down.

If one compares the larval development of *Liostracus* with that of *Elliptocephala* one will find that they agree largely with one another, even if the larvæ of the latter, the geologically older form, as is only natural, in some respects show more primitive characters. As such primitive characters the development of the intergenal spines may probably be considered, likewise the greater length of the larval ridge and the comparative narrowness of the fixed cheeks [which latter characters are connected with the length and situation of the eye lobe in the adult (see below)] and also the narrowness of the thoracic segments in the nepionic larvæ. Though of *Liostracus* no larvæ with these latter preserved are known, it is possible to conclude from the width of the anterior part of the pygidium in the older protaspis that they were nearly as wide as the cephalon already in the earliest nepionic stages, as is the case in other related and higher trilobites of which complete specimens at such stages are known. In one respect the development of *Elliptocephala* seems to have been more rapid than that of *Liostracus*, viz. with regard to the differentiating of the larval ridge.

Since the lateral border, or part of it, behind the eye has been observed in its normal place already in the earlier protaspis of *Liostracus* (p. 26) as well as in those of *Elliptocephala* (text-fig. 4 a) and *Holmia* (KJER 1916, text-fig. 11 a and Pl. VI, fig. 1) it is evident that the eyes, or the germs of the eyes, and the free cheeks were situated at this stage on the dorsal side of the head shield, though the latter were very narrow. That the conditions in this respect were the same also in the youngest larvæ of other trilobites is likely, and there does not seem to be anything in the larval development of the trilobites which indicates that they were originally situated on the ventral side, as presumed by BEECHER.

When comparing the larvæ of *Liostracus* with other larvæ of related genera, one will find that the development has been very similar in all of them. If first taking into consideration that of *Sao hirsuta*, which is the one best known through the complete series of larvæ described and illustrated by BARRANDE (1852, p. 387, Pl. VII), the earliest larva figured (text-fig. 7 a) seems to be at a stage between those represented by BRÖGGER's fig. 1 (1875, Pl. XXV) and by the youngest larvæ from Wästergötland (text-fig. 6 a, b). It is apparently very strongly arched, and only very little of the larval ridge is seen from above. Only one furrow on the axis and the division between the lateral parts of the cephalon and the pygidium are slightly indicated. In the next stage illustrated (text-fig. 7 b) the axis of the pygidium is divided by a furrow, the occipital ring is distinct, and here as in the following stages the larval ridge is clearly to be seen, though it seems narrower and shorter than in the corresponding stages of *Liostracus*. The anterior pair of points apparently are the genal spines, and that the lateral borders are not observed in this and in the preceding stage, is probably due to the convexity of the larvæ which caused them to be hidden by the overhanging inner parts of the cheeks, or else made them impossible to extricate. In the description of the larvæ at the next stage BARRANDE (1852, p. 388) has mentioned these borders, and they are also marked in the figures (text-fig. 8 c). BEECHER has taken their inner boundaries, the lateral border furrows, for the facial sutures, but since in the original figures they do not cross the lateral borders, as the aforesaid author has let them do in his copy (1895b, Pl. VIII, fig. 9, the same alteration is made in fig. 10 which is drawn from BARRANDE's fig. 3 b, copied in text-fig. 7 d of this paper), such a presumption does not seem to be justified, even if the sutures probably, if developed, ran close to the border, the free cheeks evidently being very narrow. BARRANDE apparently observed the sutures first in the larvæ of considerably later stages.



a b c d

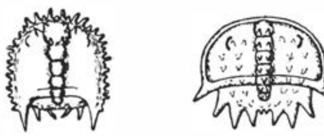
Fig. 7. *Sao hirsuta* BARR. Successive larval stages much enlarged. (After BARRANDE.)

In the figures of the anaprotaspis of *Liostracus ouangondianus* HARTT and *Solenopleura Robbi* HARTT given by MATTHEW (1888, Pl. I, fig. 4 l and Pl. II, fig. 3 g) it is not possible to see if there is a ridge or not because of the indistinctness of the figures, but at the right side of the glabella of the latter there is something which might be interpreted as the lateral part of it. MATTHEW, however, does not seem to have observed any ridge in the larvæ concerned, and as they probably were strongly bent down anteriorly and the specimens badly preserved, it is likely that it was difficult to discern, though presumably developed. The same might be applicable to the youngest larvæ of *Ptychoparia Kingi* MEEK figured by BEECHER (1895 b, Pl. VIII, fig. 5). That the ridge was not seen in this specimen was probably due to the fact that it is a cast in which the characters of the anterior part of the cephalon are on the whole very »obscurely defined» (BEECHER Ibid., explanation of the fig.). The utmost ends of the dorsal furrows obviously indicate the limit between the ridge and the part of the glabella behind it, which presumption is confirmed by a comparison with the metaprotaspis of the same species (Fig. 6 on the same Pl.), where the differentiating of the parts of the ridge evidently has gone rather far. As in the earlier protaspis of *Liostracus* the posterior margin of the pygidium of the anaprotaspis of the species in question is not rounded, but has a straight outline.

In the earlier larval stages of the species treated above (and probably also of other related forms, the development of which is not known) as in those of *Elliptocephala asaphoides* and *Holmia Kjerulfi* (and presumably of all other Mesonacidæ) the anterior part of the glabella was apparently not defined, but formed together with its lateral continuations the larval ridge, which reached to the border of the cephalon. The lateral parts of the ridge partly remain in the adult as eye ridges and eye lobes. In the former they become separated from the glabella, whereas in some of the latter they remain in connection with it.

The earliest larvæ of higher trilobites seem to have been so far developed that they had no true larval ridge, since such a one has never been found in the protaspis of these forms. Also with regard to the more distinct separation between the cephalon and the pygidium and the rounded posterior margin of the latter, they show a higher degree of development than the larvæ of more primitive forms at the corresponding stage.

The earliest known larva of *Triarthrus Becki* (BEECHER, 1895b, Pl. VIII, fig. 12) has the frontal lobe of the glabella distinctly defined, rounded in front and separated from the eye ridges by the dorsal furrows, thus corresponding in these respects to the nepionic larvæ of *Liostracus* and *Sao* though in the development of other characters showing that it is still at a rather early protaspis stage, there being only one furrow on the axis of the pygidium, the side lobes being unfurrowed, the posterior border furrow of the cephalon not marked and the fixed cheeks still very wide in comparison with the glabella. In the adults the fixed cheeks within the eyes are very narrow and the eye ridges have disappeared.



a b

Fig. 8. Protaspis larvæ.
a, *Acidaspis tuberculata* CONRAD much enlarged.
b, *Corydocephalus consanguineus* CLARKE much enlarged. (After BEECHER.)

With regard to the development of the ridge *Paradoxides* seems to represent the same phylogenetic stage as *Triarthrus*. In the earliest known larvæ, of which at least the one illustrated by RAYMOND (1914, Pl. fig. 8) must be considered an early protaspis, there is no larval ridge, but the eye ridge which has disappeared in the adult, is developed.

A still higher phylogenetic stage is represented by the larva of *Acidaspis tuberculata* CONRAD (text fig. 8 a) and that of *Corydocephalus consanguineus* CLARKE (text-fig. 8 b), of which the former seems to be at an early, the latter at a later protaspis stage. In these there are no traces to be seen of the eye ridges, the small eye lobes are situated well within the lateral margin, but much farther from the glabella and from the posterior margin of the cephalon than in the adult. It is of special interest that there is no marked eye ridge in the larva of *Acidaspis tuberculata,* of which according to BEECHER (1895b, p. 172) several specimens are found, since in most species of this genus there is a ridge which runs from the eye lobe to the anterior part of the glabella. This indicates that the ridge in *Acidaspis* is not homologous to the eye ridge in more primitive forms. Also the fact that the ridge in some species e. g.

Acidaspis Verneuili BARR. and *Acidaspis vesiculosus* BEYR. (BARRANDE, 1852, Pl. XXXVIII), is continued behind the eye, points in the same direction. The development of this ridge may be due to the general tendency shown in the Acidaspidæ (Odontopleuridæ) towards the swelling up of ridges and lobes in different parts of the dorsal shield.

Neither in the protaspis of *Dalmanites socialis* BARR., as illustrated by BARRANDE (1852, Pl. XXVI, some of the figures are copied in this paper, text-fig. 9) is a larval or eye ridge to be seen. The eye lobes are somewhat elongate and situated at the anterior margin of the cephalon very near to the glabella, distinctly separated from it. In the earliest larvæ of *Dalmanites eucentrus* ANG. found by TROEDSSON, which seem to represent the same stage as the youngest specimen figured of *Dalm. socialis* (text-fig. 9 a), the eye lobes are still more elongate and, as far as it is possible to see on the rather badly preserved specimens, which are inner casts, they seem to be situated close to the glabella without being continuous with it (See TROEDSSON, 1918, p. 59, Pl. I, fig. 24).

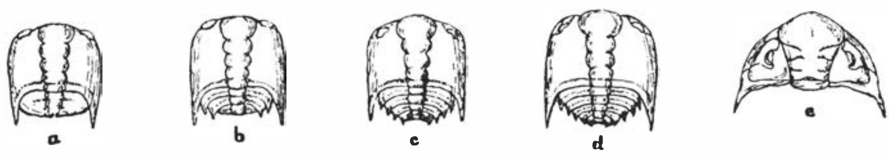


Fig. 9. *Dalmanites socialis* BARR. a—d, Successive larval stages much enlarged. (After BARRANDE). e, cephalon of adult reduced (from BEECHER, after BARRANDE).

With regard to the form and situation of the eye lobes the protaspis referred to *Proëtus parviusculus* HALL (BEECHER, 1895b, Pl. IX, figs. 5, 6) and *Calymene senaria* CONRAD (RUEDEMANN 1913, Pl. IX, fig. 7, text-fig. 10 of this paper) are very similar to the earlier *Dalmanites* larvæ. The two former are very like each other, and RUEDEMANN says (Ibid., p. 120) that the protaspis described by him »is practically identical with that referred to *Proëtus parviusculus* by BEECHER», but since it »is fairly well connected with the adult *Calymmene* by the neanic stages» from the same beds and since »*Proëtus parviusculus* has not been found associated with it», he feels »certain of its ontogenetic connection with the common *Calymmene senaria*» of the same formation. It is possible that it belongs to this species, though the similarities between it and the later larvæ figured in the same paper (Pl. IX, figs. 8, 9) are not very great, and though it seems rather remarkable that in such a case the eye lobes should be situated so much closer to the glabella in the earlier than in the later stages. It is also possible that the larvæ concerned, figured by BEECHER, belong to a species of *Calymene*, but they and RUEDEMANN's specimen are not so completely like each other. In the latter the lobes of the glabella are all very short, especially the frontal lobe, the 2d glabellar lobe is larger than the others, and the eye lobes are situated close to the glabella. Possibly the inner parts of these represent the eye ridges, which as yet are not entirely differentiated from the anterior portions of the lateral parts of the larval ridge, which in that case must be presumed to have been developed in the earlier larvæ (the specimen in question represents a late protaspis stage). In some species of *Calymene* the eye ridge is found also in the adult, e. g. in *Calymene Leptænarum* TGT. (Pl. IV, figs. 5, 6 of this paper), in the nepionic larva of which it is also marked (Pl. IV, fig. 9). In BEECHER's specimens the lobes of the glabella are more elongate, the frontal lobe is the longest, and also the 1st glabellar lobe larger than the 2d. As far as one can see there is nothing that argues against the presumption that they could belong to the species of *Proëtus* occurring in the same beds since there does not seem to be anything remarkable in the fact that the protaspis of this genus and that of *Calymene* were rather like each other.

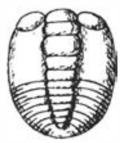


Fig. 10. *Calymene senaria* CONRAD. Protaspis much enlarged (After RUEDEMANN).

That the earlier development of the cephalon was similar in all trilobites seems presumable, and one might transcribe BEECHER's doctrine, quoted above (p. 24), in this manner: The earlier larvæ of more primitive trilobites had a larval ridge, the lateral portions of which still partly remained in the adults and formed the eye ridges and the eye lobes (*Elliptocephala, Sao, Liostracus*); in somewhat higher forms the eye ridges were differentiated already at the protaspis stage and had disappeared in the adult (*Triarthrus*); and finally in the highest forms they did not even remain in the protaspis (*Dalmanites, Acidaspis*).

With regard to the facial sutures they seem never to have been observed in the anaprotaspis. As to the larvæ of later protaspis stages (meta- and paraprotaspis) it has been pointed out above (p. 29) that what BEECHER has interpreted as such on BARRANDE's (1852, Pl. VII) figs. 2 b and 3 b of *Sao hirsuta* are more probably the lateral border furrows. The same might hold good for the »facial sutures» in the metaprotaspis of *Ptychoparia kingi* MEEK (BEECHER, 1895b, Pl. VIII, fig. 6). In no other case the sutures are figured or mentioned in these stages, but first in the larvæ at nepionic stages. In the Leptæna limestone at Kallholn the writer has found a small larva evidently belonging to *Calymene Leptænarum* with one thoracic segment (1st nepionic stage), and in it the sutures are discernible (Pl. IV, fig. 9). In the larvæ of *Dalmanites socialis* figured by BARRANDE (1852, Pl. XXVI) the sutures are laid down first in the fig. 5 b (text-fig. 9 d), where according to him there are two free thoracic segments (2d nepionic stage). With regard to *Sao hirsuta* the free cheeks are first mentioned (BARRANDE, 1852, p. 389) in the larvæ of the same stage.

That the facial sutures are not observed in the earlier larvæ need not, of course, be taken as a proof that they were not developed, as it must be very difficult, nearly impossible, to discern them in the small and generally rather badly preserved specimens. But possibly they were not yet developed or in function. BERNARD (1894) considered, as is well known, that the posterior branches of the facial sutures correspond to the line of fusion between the lateral projections of the 1st segment and the pleuræ of the 2d. He believed that the 1st segment was partly bent down ventrally and that the dorsal part of it formed the preglabellar part of the cranidium, the frontal lobe and the free cheeks with the eyes. He evidently regarded the whole of the eye lobe in *Elliptocephala* as the eye, and, partly because of this, he drew the conclusion that the free cheeks belonged to the same segment as the frontal lobe.

BEECHER (1897) and JAEKEL (1901) consider the hypostoma to be the 1st segment, whereas the free cheeks are regarded as the pleural parts of the 2d segment, the middle part of which should consist of the rostrum or the middle portion of the continuous free cheeks. According to this supposition the whole of the facial sutures and the rostral suture should follow the posterior boundary of »an oculiferous head segment». BEECHER believed, as already mentioned, that the free cheeks, and thus the whole of this segment, were originally situated on the ventral side of the cephalon, and considered this proved by the larval development, which, as just pointed out, seems to have been a misconception and is also contrary to BERNARD's view. There does not seem to be anything which indicates that any part of the dorsal side of the cephalon originally was situated on the ventral side. On the contrary the larval development, as far as it is known, argues against this presumption, except that the earlier protaspis is so strongly arched that the borders are almost beneath the other parts of the shield. With the assumption that the rostrum should form the middle part of a segment, the pleural parts of which were the free cheeks, the development of such forms as *Holmia* and *Kjerulfia* with their long rostrum (hypostome attachment) and »remarkable run» of the anterior branch of the facial suture (see below p. 35 and text-fig. 11) are very difficult to interpret. The pleuræ of the »oculiferous» segment would then, if this were right, be inserted between different parts of the next segment. Then it appears more probable that the rostrum represents the whole of a segment, as KJER (1916, p. 83) has suggested.

WALCOTT (1910, p. 238) has, with regard to the Mesonacidæ, tabulated the segments included in the cephalon as follows:

1. Anterior border segment.
2. Ocular segment, carrying the visual surface of the eye.
3. Palpebral or first glabellar segment, from which the large anterior lobe of the glabella was largely developed, also the so-called »ocular» ridge and the palpebral lobe.

4—6. Second—fourth glabellar segments.

7. Occipital segment.

»The expansion of» the ocular segment may according to the aforesaid author »form the anterior portion of the first glabellar» (frontal)

»lobe as indicated in *Olenellus logani* (Pl. 41, fig. 6), where the furrows on the glabella in advance of the palpebral segment apparently outline the segment.» That there existed a segment anterior to this in the primitive cephalon of the Mesonacidæ, he thinks »is indicated by the antero-lateral spines of the young of *Olenellus gilberti* (Pl. 36, figs. 11—14) and the larval-like cephalon of *Olenelloides* (Pl. 40, figs. 2 and 3) and by the cephalon of *Callavia bicensis* (Pl. 41, fig. 9) where there are two pairs of furrows in front of the palpebral ridge». In the last-named species the lateral glabellar lobes seem to be divided by transverse furrows. Probably the »1st frontal furrow» corresponds to these, and does not seem to be of any significance in this connection. As spines other than pleural spines, very often occur in the trilobites, those mentioned need not necessarily have had that character either, and thus there does not seem to be any real ground for assuming the presence of a special border segment.

With the supposition that the trilobites originally had 6 pairs of cephalic appendages (the pair belonging to the occipital segment included), the 1st pair of antennæ (the antennules) would belong to the ocular segment; the supposedly reduced 2d pair to the palpebral segment etc. The ocular segment would thus belong to the preoral part of the head, all the following segments to the postoral part. That the attachment of the muscles of the antennules was in the frontal lobe seems probable; the posterior limit of the middle portion of the preoral part of the head would thus have been at the frontal furrow. That this furrow is often not developed might partly depend on the circumstance that the 2d pair of appendages was often (perhaps always) reduced, and partly, provided that the cephalic segments were not marked off »en bloc», on the fact that the anterior postoral segment was first incorporated in the primitive cephalon, and consequently the boundary between this and the preoral part of the head earlier obliterated than the boundaries of the posterior segments, and this at so early a stage that it was generally not marked even in the protaspis. Often the posterior furrows are also, especially the 1st, obliterated in the adult though developed in the larva, and cases are known, as already pointed out (p. 10), where the frontal furrow is marked in the larva but not in the adult, e. g. *Holmia Rowei* WALC. (1910, Pl. XXIX). This indicates that it is a primitive feature, which is also emphasized by the circumstance that it is more often to be found in the Cambrian than in the geologically younger trilobites.

If this interpretation of the cephalic segments is right, it is evident that the anterior branch of the facial suture did not follow the limit of a segment. Whether this was the case with regard to the posterior branch, is a question connected with the one whether the facial suture is to be considered an original trilobite character of a homologous nature in all forms. Most scientists seem to have been of this opinion, whereas SWINNERTON (1915) considers, apparently in agreement with WALCOTT (1912a), that »the earliest trilobitic organisms had no facial suture» (p. 492) and further that »true sutures have developed independently at least three times» (p. 539) among the trilobites.

He advances in support of the former consideration that it is not developed in *Marrella* and *Nathorstia* and in most of the Mesonacidæ. As I have tried to show above, there does not appear to be anything which indicates that *Marrella* is very closely related to the trilobites, and with regard to *Nathorstia*, WALCOTT's (1912a) description of it is based on a specimen which is said to be flattened and to have the left side crushed, so that it seems possible that there could have been a facial suture which was not discernible. Even if it should be proved that it was not developed in *Nathorstia*, it might have been secondarily reduced.

The oldest trilobites known, the Mesonacidæ, which, as is well known, are found in older strata than the forms just mentioned, evidently had no sutures. But whether this is a primary character is doubtful. WALCOTT (1910, p. 236) defines the Mesonacidæ as having »the facial suture rudimentary, or in a condition of synthesis» and in another place (Ibid., p. 242) he says: »The facial sutures are rarely represented, even by elevated lines on the exterior surface or depressed lines on the interior surface of the cephalon.» He has not described any sort of line or impression that he considers to be the anterior branch of the facial suture. In one specimen of *Pædeumias transitans* (Ibid., Pl. XXXIII, fig. 1) he has found an elevated line »having the usual curvature of the posterior facial suture», but he does not think it probable that this line really represents the suture, »but it suggests that conclusion» (p. 242). This line, however, does not start from the posterior end of the eye, as it naturally would if it represented the facial suture.

In *Kjerulfia Lundgreni* MOB. and occasionally in *Holmia Kjerulfi* LNRS., MOBERG (1899) and KJER (1916) have pointed out that there is »a fine raised line, that runs in an arc from the posterior edge of the eye to the posterior margin in front of the intergenal spine» (KJER, p. 81). This line the latter author has also found in *Kjerulfia lata* KJER (text-fig. 11), and he thinks that MOBERG's assumption seems reasonable »that this is a case of a remainder of the obliterated facial suture» and that MOBERG probably was right also »in giving the same interpretation to the remarkable lines that sometimes are seen in both the above genera running from the anterior edge of the eye to the marginal brim.»[1] He continues: »If this represents the front branch of the facial suture, the latter would certainly have a remarkable course.» But at a closer examination one will find that in these genera it must have had just this course. In trilobites that have a rostrum, the anterior branches of the facial sutures are, as is well known, continued on the ventral side of the cephalon by the connective sutures, which separate the rostrum from the doublure of the free cheeks. In *Holmia* and *Kjerulfia* and in others, e. g. *Pædeumias* (WALCOTT, 1910,

[1] In two of WALCOTT's (1910) figures of *Cavallia Crosbyi* WALC. (Pl. XXVIII, figs. 1 and 4) a line is seen which has about the same run.

Pl. XXXIV), according to KJER (1916, p. 82) perhaps in all genera of the Mesonacidæ, the rostrum, or as it has been called by MOBERG and KJER the hypostome attachment, is very broad, nearly reaching to the genal angles (text-fig. 12 a), and therefore, if the conditions were the same as in other trilobites, the anterior branches of the facial sutures must reach nearly as far back. Some species of *Paradoxides* (text-fig. 12 b) seem in this respect to be intermediate between the Mesonacidæ and other trilobites, as is also indicated by KJER.

In some of WALCOTT's (1910) figures of *Elliptocephala asaphoides* (Pl. XXIV), *Mesonacis vermontana* HALL. (Pl. XXVI) and *Callavia Bröggeri* WALC. (Pl. XXVII) lines corresponding to those running from the posterior edges of the eyes in *Holmia* and *Kjerulfia* are to be seen, and RAYMOND (1917, p. 206) seems to be right that these represent the posterior branches of the facial sutures, whereas the lines in WALCOTT's figure of *Callavia*

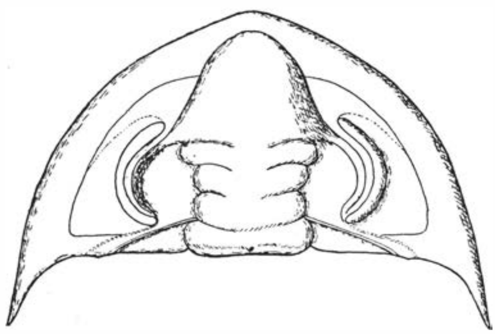


Fig. 11. *Kjerulfia lata* KJER. Reconstructed cephalon. (After KJER.)

Callavei LAPW. (Pl. XLII, fig. 1), which he evidently regards as the anterior branches, probably are only fractures in the test, since they do not appear to start from the foremost ends of the eyes.

It is clear that KJER considered the Mesonacidæ to have originated from forms with real facial sutures, which later on became obliterated, especially since he is opposed to WALCOTT's view that the Paradoxidæ would be descendants from them, just because the sutures in that case must have been reformed, which he does not think probable (1916, p. 88). It is, however, not clear whether WALCOTT really considers the sutures to have been secondarily reduced in the Mesonacidæ. To be sure he says (1910, p. 242): »If we accept BEECHER's view that the sutures are in a condition of symphysis (BEECHER, 1897, p. 191), and that the elevated and depressed lines represent the suture between the cranidium and free cheeks, the latter bear the visual surface of the eye», but it is uncertain whether he really believes that BEECHER's view is correct. SWINNERTON (1916, p. 492) thinks that WALCOTT is leaning towards the same point of view as himself, »viz. that the facial sutures were not necessarily present in primaeval Trilobites and that the Mesonacidæ exhibit the Trilobite organization just when these lines are coming into being». SWINNERTON seems to take »the depressed and elevated lines» for some sort of elementary facial sutures, and in such a case they might perhaps be regarded as lines of weakness along which the test would have split at the ecdysis, and which later on were developed into real open sutures. But then there ought to have been found in the beds where these forms occur a great number of cranidia and free cheeks separated along these lines, since the fossil remains probably represent not only dead animals but also moulted tests. To judge from published descriptions and figures, this seems not to have been the case. If these lines did not function as facial sutures, it is difficult to interpret them as incipient, and it is more likely that they ought to be considered as vestiges of sutures that were normally developed in the ancestors of the forms concerned.

That the object of the facial sutures was to facilitate the ecdysis is, as is well known, a generally accepted opinion, and also that they are intimately connected with the position and development of the eyes. In forms where the latter are reduced, the sutures appear partly to lose their significance. In some blind forms they still remain, but have altered their original position and moved towards the margin of the cephalon, so that the free cheeks have become very narrow and the fixed ones broader. This seems to be the case in *Conocoryphe, Ampyx, Placoparia, Dindymene* and in some species of *Phacops* and *Illænus* etc. In *Phacops Volborthi* BARR. (BARRANDE, 1852, Pl. XXIII) that is not blind but where the eyes are very much reduced, this has also happened with the free cheeks, and similar conditions are to be seen in other forms. Presumably, when during the ontogenetic development the eyes were never formed or were checked at an early stage, the growth of the free cheeks was also checked. In *Conocoryphe* they have about the same relative size as in the larvæ of the related genus *Sao,* and in *Phacops Volborthi* as in the larvæ of *Dalmanites.*

It is evident that in these forms the sutures were still functional at the ecdysis. In *Harpes* and *Trinucleus* on the other hand, where, according to the opinion of most modern investigators, the eyes were also secondarily reduced — the vestiges of them, where they still remained, holding their normal position — but the free cheeks were fully developed and the facial sutures lost by fusion, the test opened along the margin of the fringe, so that the ventral part of it became separated from the dorsal part. It is said that there was a marginal suture, and this has generally been considered as a secondary adaptation (see below).

In the Mesonacidæ it does not seem to have been necessary to develop a new suture at the presumed disappearance of the facial suture, as the test probably opened along the rostral suture, which here runs along nearly the whole of the margin.

That no trace of the facial suture is found in the forms supposed to be the most primitive of the known Mesonacidæ, e. g. *Nevadia,* need not be taken as a proof that their ancestors also were devoid of it, as its reduction might have been accomplished more rapidly in some genera than in others, and as there is no need to believe that *Nevadia,* even if it agreed with those ancestors in most characters, could not in some features differ from them. It is not impossible either that further researches will show that this genus and other Mesonacidæ in this respect were similar to *Holmia* and *Kjerulfia,* viz. that traces of both the anterior and posterior branches will be found, especially as it seems as if the American forms were generally in a considerably worse state of preservation than those found in Scandinavia.

If, however, one adheres to the view that the facial sutures were not originally developed in all trilobites and, as SWINNERTON evidently presumes, had come into existence only in some of the Mesonacidæ, but still regards the mentioned lines as traces of obliterated sutures, *Nevadia* must be taken as a representative of those forms in which they were never developed, whereas *Holmia* and *Kjerulfia* would represent that part of the family that originally had real sutures, later on lost by fusion. But this seems rather improbable.

SWINNERTON further considers, as mentioned above, that the facial sutures »have developed independently at least three times, viz. among Mesonacida, among other Opisthoparia, and among Proparia» (1916, p. 539). He arrives at the conclusion that they developed independently among Mesonacida and among other trilobites, since he considers the absence of sutures as primary both in *Marrella* and in *Nathorstia,* and further that, if the former »'foreshadows' any one type more than another, that type is *Nevadia*», and »on the other hand *Nathorstia*» according to him »is a persistent member of the stock which foreshadowed the type of Trilobite represented by *Conocoryphe, Ellipsocephalus,* and *Burlingia*». As pointed out above (p. 13) the relationship between *Marrella* and the trilobites seems rather doubtful. With regard to *Nathorstia,* though evidently belonging to the trilobites or at least closely related to them, it seems doubtful if it really was devoid of facial sutures, and, this being the case, if it was not rather a degenerate than a primitive character. Besides, the genus apparently was rather highly developed respecting several of its characters, and can therefore hardly be regarded as representing the ancestral stock from which all trilobites except the Mesonacida arose, as intimated by SWINNERTON. In consequence of the reasons advanced above, the occurrence of such forms as *Marrella* and *Nathorstia* cannot be taken as a proof that the facial sutures have developed independently among Mesonacida and among other trilobites.

Whether they were developed independently or not in Opisthoparia and Proparia, is a question connected with the one of the »genal spines» being homologous in the two groups. This is, however, not the view of for instance WALCOTT and REED (1916, p. 172), of which the former says (1910, p. 237) that the »genal spine» in the Proparia »is in fact the prolongation of one of the fused segments of the cephalon and corresponds in this respect to the intergenal spine of the Mesonacidæ». If this is correct, which seems probable, there does not seem to be anything which indicates that the facial sutures had not the same origin in the two groups.

To judge from the larval development of such forms as *Elliptocephala*, *Pædeumias* and other members of the Mesonacidæ, in the earlier ancestral stock of this family only the intergenal spines were developed; then followed forms that had both intergenal and genal spines; and ultimately the former were reduced. If all other trilobites came from the same ancestral stock, all Opisthoparia probably went through the above stages of development, whereas the Proparia might either have branched off already before the true genal spines were formed or else at a later stage, when both kinds of spines were developed, in which case the genal ones were afterwards reduced and their places taken by the intergenal spines.[1] The opisthoparian and the proparian conditions seem to have been evolved at so early a stage, that it appears quite natural that it is not shown, in either the larval or in the phylogenetic development of the higher members of the two groups, how this came about, and that the development of the free cheeks here followed quite different lines.

There does not seem, then, to be any real ground for assuming that the posterior branches of the facial sutures were not homologous in all trilobites; and if, moreover, they really correspond to the lines of fusion between the pleural portions of the preoral part of the head and the pleuræ of the following segment (or segments), this seems to speak also against the assumption that they arose independently in different groups. The course of the facial sutures apparently depended on the position of the eyes, so that these were always situated on the free cheeks. In forms where they were normally developed, the sutures followed their inner limit. And it seems most plausible that the remaining parts of the sutures, as far as it was possible and convenient for the ecdysis, should also have followed the limit of a segment, or, in other words, an original line of weakness.

With regard to the anterior branch of the suture, which according to the above presumption did not follow the boundary of a segment (see p. 34), it is conceivable that it was developed independently and partly at non-corresponding places in different groups. There are indeed some facts which might be considered to indicate that this had been the case. On the ventral side of the cephalon there is, as is well known, a flat rim

[1] Such a displacement of the spines apparently occurred in several of the Mesonacidæ, e. g. in *Olenelloides armatus* PEACH (PEACH, 1894, Pl. XXXII, WALCOTT, 1910, Pl. XL) and *Wanneria Halli* WALC. (WALCOTT, 1910, Pl. XXXI), in which latter the intergenal spines, however, had disappeared in the adult.

along the margin, the doublure or reflexed border of the cephalic shield. In most trilobites its middle portion forms a separate plate, the rostrum, which is divided from the cranidium by the rostral suture, from the free cheeks by the continuations of the facial sutures, the connective sutures, and from the hypostoma by the hypostomal suture. The size of the rostrum is very different in different genera, as illustrated by the text-fig. 12 a—h, and in connection with this the course of the anterior branches of the facial sutures varies also, so that in some forms where there is no rostrum they unite in front of the glabella, in which case the doublure of the cephalon is either continuous (Phacopidæ text-fig. 12 k, Aeglinidæ etc.), or transected by a median suture (Asaphidæ, text-fig. 12 i). In *Paradoxides* (text-fig. 12 b) there is no separate rostrum, though the anterior branches of the facial sutures do not meet, but are continued by the connective sutures, since the portion of the doublure between these is not separated from the dorsal part of the cranidium.

It is of course conceivable that these differences are of a primary nature and that all the sutures in question were developed independently in different groups, and that some of these originally had a very large rostrum, some a comparatively narrow or a very narrow one, while in others it was never developed, the median part of the doublure being either separated from the cranidium but not from the free cheeks (forming together with these a continuous piece or divided in the middle by a suture), or continuous with the cranidium but separated from the free cheeks. It seems then very remarkable that the conditions are so alike in different groups which otherwise do not appear to be very closely related, while they are different in such groups that in other characters show great similarities to each other. It is further very difficult to understand in what manner and for what purpose the different sutures have developed, especially with regard to such forms as *Encrinurus* (text-fig. 12 h) where the two connective sutures run close to one another.

If, on the other hand, one presumes that all forms originally had a large separate rostrum like that in *Holmia* and *Kjerulfia* (text-fig. 12 a) the whole matter becomes much simpler. It appears, as mentioned above, as if in several genera of the Mesonacidæ, according to KJER (1916, p. 82) perhaps in all of them, there had been such a large rostrum, and the author just mentioned thinks it probable that this is »a primitive state and gives evidence for the supposition that» the rostrum »represents a special anterior segment of the cranidium, which segment in the course of further development has either fused with the doublure or been reduced to varying degrees» (1916, p. 83).[1] If this supposition is right, the rostral and the connective sutures would follow the original boundary of a segment, and thus of all the sutures in the cephalon only the anterior parts of the facial sutures must be regarded as really new constructions.

[1] The possibility that the rostrum represents a special segment is also pointed out by REED (1916, p. 172). Cf. also RAYMOND, 1917, p. 208.

But whether it is justified to assume the existence of such an external anterior segment in the preoral part of the head, seems doubtful because of the supposed composition of the brain of the primitive arthropods (Cf. HOLMGREN, 1916). But even if the rostrum does not represent a special segment, it might nevertheless from the beginning have been developed as a separate plate, or else the rostral and connective sutures might have developed at an early stage to facilitate the ecdysis. Both *Apus* and *Limulus* are said to moult by splitting along the frontal edge, and that sutures were formed at corresponding places in the trilobites does not seem inconceivable.

In trilobites with well-developed eyes it was apparently suitable that the test should split just inside of these, and a suture was formed here also, probably following part of the boundary of a segment. That these sutures, the position of which might be said to be more or less settled

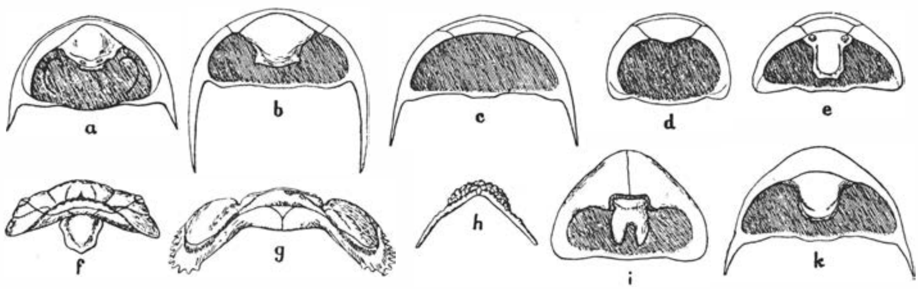


Fig. 12. Cephala of trilobites to show the progressive development of the rostrum. a, *Kjerulfia lata* KJER. b, *Paradoxides bohemicus* BOECK. c, *Ptychoparia striata* EMMR. d, *Illænus Bouchardi* BARR. e, *Calymene Blumenbachi* BRONGN. f, *Pliomera Fischeri* EICHW. g, *Placoparia grandis* BARR. h, *Encrinurus Seebachi* SCHMIDT. i, *Asaphus platycephalus* STOKES. k, *Dalmanites socialis* BARR. (a after KJER.; b—e, g, i, k after BARRANDE; f, h after SCHMIDT.)

beforehand, must be connected, was of course necessary, and this was done by the anterior parts of the facial sutures, which one has a right to presume originally had the »remarkable» course which is seen in *Holmia* and *Kjerulfia*. During the progressive evolution the rostrum became more and more reduced; and at the same time also the anterior parts of the fixed cheeks did so, while the free cheeks increased in size until they, or at least their ventral parts, finally met and grew together.[1] Among the trilobites there is a series of types which represent this evolution, though they are not to be regarded as representing a phylogenetic series, as the reduction of the rostrum and the fixed cheeks and the corresponding growth of the free ones no doubt were more rapid in some groups than in others. Next to such forms as *Holmia* and *Kjerulfia* (text-fig. 12 a)

[1] In his paper of 1917 (p. 208) RAYMOND suggests a similar explanation of the development of these parts, an explanation which, however, he evidently does not adopt himself.

stands, as far as it is known, *Paradoxides* (text-fig. 12 b). Here the anterior parts of the fixed cheeks and the rostrum (which latter has grown together with the dorsal part of the cranidium) are still very broad, broader than the hypostoma. This seems also to have been the case in *Ptychoparia striata* (BARRANDE, 1852, Pl. II, B, fig. 26), in which the rostrum (text-fig. 12 c), however, is considerably narrower than the anterior part of the cranidium, and the ventral parts of the free cheeks reach nearer to the median line than their dorsal parts do, which is also the case in many other forms. In a great number of genera, e. g. *Conocoryphe* (BARRANDE, 1852, Pl. II, B), *Bronteus* (Ibid.) and *Illænus* (text-fig. 12 d), the posterior margin of the rostrum (the anterior one is often broader) has the same width as the anterior margin of the hypostoma. In *Calymene* (text-fig. 12 e), *Proëtus* (BARRANDE, 1852, Pl. II, B) and others, it is narrower, and considerably so in *Pliomera* (text-fig. 12 f). In *Placoparia* the rostrum forms a small triangular plate, in *Placoparia grandis* (text-fig. 12 g) only reaching half along the doublure so that the connective sutures partly unite to a median suture. In *Encrinurus* (text-fig. 12 h) it is still narrower, and pointed at the ends, so that it becomes entirely enclosed between the free cheeks, which meet both above and below it. In the Asaphidæ (text-fig. 12 i) it has entirely disappeared, but the free cheeks are still separated by a median suture, which finally in the Phacopidæ (text-fig. 12 k), Aeglinidæ and several more has become obliterated. With regard to these latter forms, it is of course conceivable that it is the connective sutures which have disappeared, and that the rostrum has been fused with the free cheeks, but this must then have taken place at a comparatively late stage, since the course of the facial sutures must otherwise have been different. There does not, however, seem to be any real ground for assuming that the development in this case has followed a different line than in others.

It is presumable that during the phylogenetic evolution, the rostrum was very rapidly reduced in some groups, as already in several Cambrian trilobites, e. g. *Peltura* and *Eurycare,* the free cheeks meet in the median line of the cephalon, which indicates that the rostrum has disappeared or at any rate has grown very small. There is of course also the possibility that it still remains, but has become separated from the cranidium by the free cheeks. It seems, however, more probable that it is reduced and that the conditions in this respect are as in the Asaphidæ.

As already mentioned, it occurs very often that the reflexed parts of the free cheeks have grown farther towards the middle line than the dorsal parts. This is especially the case in such forms where the free cheeks meet or have grown together. Often the foremost portions of the dorsal parts have increased in size as fast as the doublure but not the portions behind. Sometimes this may have depended on the fact that the glabella was in the way and prevented the growing of these posterior portions, but in many forms where the rostrum is reduced also considerable portions of the anterior parts of the fixed cheeks and of the preglabellar field remain. This is very often the case in geologically older trilobites, and is especially to be noted in such Cambrian forms as *Peltura* and *Eurycare,* where the free cheeks meet in front. The same is to be seen more or less pronouncedly among the Asaphidæ. In younger forms the reduction of the fixed cheeks in front of the eyes seems to have followed the reduction of the rostrum more closely, so that they have often quite disappeared at the sides of the glabella also and in some species of *Phacops* (s. lat.) and in *Encrinurus* parts of the free cheeks even are included in the glabella. The development of the anterior part of the free cheek at the expense of the fixed one does not, however, seem to be only dependent on the reduction of the rostrum, but was presumably connected with the development and migration of the eyes. Possibly the reduction of the rostrum and the anterior part of the cranidium is also due to the shifting of the eyes.

If the development really was as outlined above, this might be taken as a proof that the anterior branch of the facial suture, as well as the posterior one, was of the same origin in all trilobites, and thus speak against SWINNERTON's presumption that the »dorsal facial sutures appeared independently in several distinct lines of descent» (1919, p. 109). On the other hand it might seem to strengthen his opinion (Ibid.) that the earliest members of the trilobite group had no such sutures, but underwent ecdysis along a line which he calls the marginal suture, and which, with regard to the Mesonacidæ, is the same as the one called rostral suture in this paper, and that only later on dorsal facial sutures were developed »to facilitate the removal of the covering of the eye in moulting» (RAYMOND, 1917, p. 208). He emphasizes »the fact that taken as a whole the true facial suture is composite, being made up of a new dorsal portion intimately associated with the eye, and an anterior portion[1] which is probably a section of the marginal suture», and further points out that »the posterior section of the latter seems to have been completely replaced functionally by the newly instituted line running behind the visual area». It does not seem improbable that the need of a dorsal facial suture first arose when the rostrum and the rostral suture became reduced, and the eyes were better developed, and had moved farther away from the margin. That the posterior branches of the facial sutures all the same opened at the division line between segments which already were fused, is not inconceivable, since at some time during the ontogenetic development there must have been here a line of weakness. In analogy with this, it might possibly be presumed that the facial sutures were not yet developed in the younger larval stages.

[1] He evidently does not recognize any special rostral suture but regards this as part of the facial suture in forms where it is not so extensive as in the Mesonacidæ and where there are open dorsal facial sutures.

Swinnerton bases his opinion chiefly on the conditions in the Mesonacidæ, among which he considers the absence of facial sutures to have been primary, some of them exhibiting the stage when the sutures were just »coming into being». Even if this is not quite impossible, there are several things which speak against such a supposition. In the first place it is, as pointed out above, difficult to believe that »the elevated and depressed lines» in these latter were fresh constructions, and secondly, such being the case, and provided that the sutures were developed only once in the history of the trilobites, all trilobites with true facial sutures must have descended from these or closely related forms, which does not seem very probable. Apparently all the genera referred to the family Mesonacidæ are closely allied. The forms concerned, though on the whole primitive, are rather specialized in some characters, and since other trilobites with true facial sutures, which are specialized in other directions, are found in the same or even older strata, it seems probable that these latter and the Mesonacidæ already at a very early period followed different lines of development.

To form a more definite opinion of this matter does not seem possible with our present knowledge, but it appears to me most probable that even if the ancestors of the trilobites had no facial sutures (possibly at first no rostral suture either), these were formed at a very early period and that all known trilobites originated from forms in which both the facial and rostral sutures were developed as true sutures.

It may be a matter of choice whether, like Swinnerton, one regards the rostral suture as a part of the facial suture or gives it a separate name. The latter is, however, more in accordance with the general terminology, and seems also to be most practical especially with regard to the conditions in the Mesonacidæ. To call their rostral suture facial suture might cause confusion but to give it a different name here and in forms where it is more reduced, is very inconsistent and just as confusing. Swinnerton (1919, p. 110) is of the opinion that in such forms as *Trinucleus* which »became blind secondarily and thus had no special use for a dorsal suture», »the whole of the marginal suture was liable to be resuscitated».

He also suggests that the suture near the margin in *Conocoryphe* and *Ampyx* might not be a true facial suture but a »marginal» one. The »marginal suture» in the Mesonacidæ, however, only separates the rostrum from the other parts of the cephalon, and since *Conocoryphe* also has a separate rostrum, only the part of the suture in question in front of it can be homologous to that. That the posterior parts of the suture are the facial sutures and the parts of the cephalon outside of them the free cheeks, is indicated by the close affinity between *Conocoryphe* and *Ptychoparia*, in which latter the eyes and free cheeks are normally developed, and by the corresponding conditions in several other forms, e. g. among the Illænidæ. That the facial sutures really move nearer to the margin when the eyes become reduced, seems to be proved by the occurrence of such forms as *Phacops Volborthi,* where the eyes, though not entirely reduced, are very degenerate, and where the sutures, which, since they run inside these, beyond doubt are the facial sutures, have moved very near to the margin, though the removal has not proceeded as far as in *Conocoryphe.* With regard to *Ampyx* it is true that it has no rostrum, but to homologize its continuous free cheeks with the rostrum in other forms seems quite impossible, since the former, apart from such characters which probably are connected with the reduction of the eyes, are normally developed with long genal spines and generally with a typical border and sometimes, e. g. in *Ampyx Rouaulti* BARR. (BARRANDE, 1852, Pl. XXX), with comparatively wide dorsal parts. There does not seem either to be any reason to believe that the suture is secondarily instituted and not formed by the facial sutures, which have united in front, the rostrum being entirely reduced.

The »marginal suture» in *Trinucleus* and *Harpes* on the other hand cannot be homologous to the facial sutures in other groups, which seems to be proved beyond doubt by different investigators (RICHTER, 1915, REED, 1916, SWINNERTON, 1919, a. o.), though these proofs do not seem to have convinced RAYMOND (1917). Both REED (1916) and RICHTER (1915) regard the marginal suture in these genera as a secondary adaptation for facilitating the moulting when the ordinary facial sutures had disappeared. REED (p. 171) has, however, also suggested another explanation of its nature, according to which the ventral side of the fringe, which bears the genal spines, is an anterior underbent segment, which might be regarded as corresponding to the rostrum in other forms, their rostral suture being »the abbreviated representative» of the marginal suture. If we accept the existence of a special rostral segment (Cf. p. 41) this last explanation is not inconceivable, and, since the »genal spines» of the Opisthoparia and of the Proparia evidently belong to different segments, it is conceivable that they might have been borne on yet another segment in the genera concerned, as is also emphasized by REED. His suggestion that this anterior segment would be the questionable »anterior border segment», which WALCOTT (1910, p. 238) considered might have existed in the primitive cephalon of the Mesonacidæ, cannot be accepted, since, if it corresponds to the rostrum in other forms, it must of course also correspond to the rostrum of the Mesonacidæ.

The explanation first mentioned, viz. that the suture is secondarily instituted, seems, however, more acceptable. A fact which seems to confirm this is that an open marginal suture probably did not exist in all species of *Trinucleus.* It appears as if REED had only observed it in some of the species examined by him, and to judge from RAYMOND's statements in his paper of 1917, this author has not observed the suture in any entire specimen, but concludes that it existed because the ventral plate evidently is separable along a clearly defined line. The present writer has examined several specimens of *Tr. seticornis* HIS. with exceedingly well-preserved tests, and in them there does not seem to be an open suture, but along the same line as where the suture is seen in *Tr. concentricus* EATON and *Tr. Bureaui* OEHL. according to REED (1912 a, p. 347) and OEHLERT (1895, p. 317), there is only a very thin outer layer of the test, the inner part of which is pierced by a fissure. As seen from isolated ventral plates and cranidia, the splitting takes place along this line. It is of course conceivable that the fusion is secondary, just as the fusion of the pillars representing the communicating pits on the upper and lower surfaces of the fringe is considered to be (Cf. REED, 1916, ps. 173, 175), but it seems more probable that the fissure is secondary, and only in some forms fully developed as an open suture. REED (1916, p. 172) has made a comparison with *Limulus* and *Apus,* which »are said to moult by splitting along the frontal edge of the carapace». RAYMOND (1917, p. 202) observes that in *Limulus* »the crack extends only around the front and sides of the cephalothorax, does not extend to the angles, and does not cut off a separate plate», and: »If the marginal suture in the Trinucleidæ were a similar makeshift cracking, there seems no reason why it should not be similarly incomplete». But if the way of splitting in *Limulus* and *Trinucleus* is independently and secondarily evolved, why should it take place exactly in the same manner? In *Limulus* there is no fringe, and it is possible for the animal to moult when only the anterior and lateral parts of the margin opened. In *Trinucleus* (and *Harpes*) on the other hand it is evident that the whole of the dorsal and ventral parts of the fringe must separate, to enable the thin part of the body between them to free itself from the old test.

As has already been mentioned several times, the course of the facial sutures is dependent on the position of the eyes, and the development goes on the whole in the direction that these migrate nearer and nearer to the glabella and to the posterior margin of the cephalon, while the free cheeks increase at the expense of the fixed ones. This is seen in the development of the larvæ, and is also largely exhibited by a comparison between lower and higher forms. From the relative size of the free and fixed cheeks in different species one cannot, however, always conclude which is the most primitive. In the oldest known trilobite family, the Mesonacidæ, the fixed cheek is very narrow compared with the free cheek, and this character is very pronounced already in its geologically oldest representive, *Nevadia*, which is also considered the most primitive, whereas in other ancient forms belonging to other groups the conditions are reversed.

As shown in the larval development, the Mesonacidæ, like all other trilobites, have descended from forms with very narrow free cheeks. The fixed cheeks are, however, already in the earlier larvæ also comparatively narrow, and the growth of the free ones during the progressive development does not on the whole seem to have taken place at the expense of these, except with regard to their hindmost parts. The backward and inward migration of the eyes in higher trilobites never goes farther than that their inner margins come in a line with the outmost parts of the frontal lobe, and their posterior ends never lie farther in than the anterior ones, neither of which would be practical with regard to the sight. In forms which have a wide frontal lobe the portion of the fixed cheek lying within the eye lobe is also rather wide, even when the part in front is very much reduced, as for instance in *Phacops* and *Bronteus*. In the Mesonacidæ with their elongate eye lobes, that nearly reach the frontal lobe, it is only the posterior parts of these which can move more inwards, and this is just what happens during the larval development. In its later stages it is only the portions of the free cheeks lying outside these parts of the eye lobes which increase in size. At least this is the case in *Elliptocephala;* in *Pædeumias* the conditions in this respect are somewhat different. Also in the larvæ of other trilobites the axis of the eyes (or of the germs of the eyes) has an obliquely outward direction, and only in later stages their posterior ends have come as far inwards as the anterior ones. Possibly this might indicate that it is the posterior parts of the eyes which are earliest developed.

In this respect the adult *Nevadia* seems still to remain on a larval stage, as here the anterior part of the eye, or at least the eye lobe, the eye itself is not observed, reaches considerably farther inwards than the posterior part. In most other adult Mesonacidæ the eyes seem to have the ideal direction, and seem to have reached the utmost degree of development with regard to their position,

The circumstance that in other Cambrian trilobites the fixed cheeks are so much broader and the eye lobes situated more forward and farther away from the glabella, does not prove that these are more primitive than the Mesonacidæ, but is apparently connected with the form of the eye lobes. Elongate eye lobes have been considered a primitive character, as indicated by the fact that most of the oldest trilobites have this kind of eye lobes. Also the occurrence of eye ridges in forms with short, or relatively short, eye lobes might perhaps be taken as a proof that they have arisen from ancestors in which the eye lobes reached nearer to the glabella, since the eye ridges may be considered as more or less reduced palpebral lobes, even if they were possibly later on adapted to serve other purposes. That the possession of eye ridges must be considered a primitive character, is shown by the fact that they have disappeared in higher forms, and are sometimes developed in the larva, but not in the adult.

The shortening of the eyes might conceivably have occurred in two different ways. Either the whole of the originial eye lobe, that is to say nearly the whole of the pleural part of the palpebral segment + the eye, was shortened, or else only the eye became shorter, and the palpebral lobe was partly transformed. Probably both these things actually happened, and in some Mesonacidæ, e. g. some species of *Olenellus* (WALCOTT, 1910, Pl. XXXVII) and *Wanneria* (Ibid. Pl. XXX, XXXI), only the former seems to have been the case, but generally it appears as if what first happened was that the anterior parts of the eyes became reduced, and the corresponding parts of the palpebral lobes were transformed so as to constitute the eye ridges. This is indicated by the fact that in most Cambrian trilobites, with the exception of the Mesonacidæ, the eye lobes are situated at rather a great distance from the glabella and that between them and the frontal lobe there are eye ridges. At this reduction of the anterior parts of the eyes the remaining parts could not very well hold their original position, since in that case they would have been directed obliquely backwards. But at the same time as they became shorter, the eye lobes apparently curved outwards and forwards so as to keep their right adjustment. In connection with this the eye ridges were turned more straight outwards, and the fixed cheeks increased in size. In such forms with very short eyes, as *Olenus* and *Eurycare*, the eye ridges are directed nearly straight outwards, while in other primitive tri-

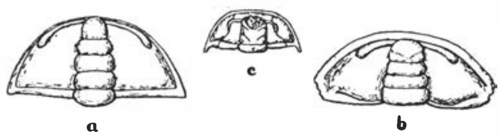


Fig. 13. *Olenus mundus* LAKE, Cephala. a-b, Successive larval stages much enlarged. c, Adult enlarged. (After LAKE.)

lobites where the eye lobes are less reduced, e. g. *Strenuella* and *Ellipsocephalus*, they are still directed more backwards. *Ptychoparia* represents in this respect evidently an intermediate stage of development. HOLM (1887) has pointed out that the fixed cheeks in *Holmia Kjerulfi* are comparatvely broader than in most other Mesonacidæ, and he puts this in connection with the direction of its eye lobes, the posterior parts of which do not reach so close to the glabella as in the latter. This seems partly to be due to the width of the frontal lobe, but might partly depend on the circumstance that the anterior ends of the eye lobes are situated at a little distance from the frontal lobe and connected with it by the short eye ridges. *Kjerulfia* corresponds in this respect with *Holmia,* whereas it seems as if in most other Mesonacidæ there were hardly any eye ridges, since the eye lobes reach nearly to the frontal lobe. This indicates that the shortening and outbending of the eye lobes had already begun in the mentioned genera.

Partly simultaneously with the outcurving movement of the eye lobes and ridges, it seems as if these parts also were shortened. At first the shortening apparently did not take place as rapidly as the outbending movement, and consequently the eye lobes became situated farther away from the glabella at the same time as they moved more forwards. In the earliest larva of *Olenus mundus* LAKE (text-fig. 13 a) figured by LAKE (1908, Pl. VI) the eye ridges are still relatively long and rather curved and the eye lobes situated at a great distance from the glabella. In the larva of a somewhat later stage (text-fig. 13 b), the latter have moved farther forwards and inwards, and in connection with this the eye ridges have grown shorter and straighter. In the adult (text-fig. 13 c) the eye lobes are situated still nearer to the glabella, and have got their normal adjustment, and the ridges are directed straight outwards. In this case the shortening of the ridges has evidently, during the later stages of the larval development represented by the specimens figured, proceeded more rapidly than the outbending, and probably continued after this was ended.

With regard to such forms where the eye lobes are situated close to the glabella and far forwards, it is conceivable that the shortening of the ridges and the outbending movement was finished at the same time, but this is contradicted by the circumstance that in primitive trilobites with short eye lobes, these are situated at a comparatively great distance from the glabella, even when far forwards; and it is only among less primitive forms that they have moved close to it. It is likewise contradicted by the fact that the distance between the eye lobes and the glabella varies considerably in species belonging to the same genus, though the former are situated as far forwards as exemplified in *Olenus*, *Eurycare* and other Olenidæ. In *Olenus* they are, however, always situated rather far outwards, whereas in some species of the younger genus *Eurycare* they have come close to the glabella. It seems, thus, as if the shortening of the eye ridges partly was simultaneous with the outbending, partly was continued after this was finished. The result of the outbending movement appears then generally to have been that the eye lobes became situated more forwards and outwards than they originally were, on the presumption that the Mesonacidæ in this respect represent the condition in all primitive trilobites. But as the evolution on the whole evidently tended towards their coming near to the glabella and the posterior margin of the cephalon, they have later on remigrated inwards and backwards, or, perhaps, more correctly speaking, as the eyes were better developed, the free cheeks increased in size while the fixed cheeks diminished, the result of which was that the eye lobes came closer to the glabella and the posterior margin. This seems to have occurred in a somewhat different manner in different groups. In the larva of *Acidaspis tuberculata* (text-fig. 8 a) the position of the eye lobes is rather near the lateral and anterior margins of the cephalon; in most of the geologically younger species of *Acidaspis* (s. lat.) where the eyes and eye lobes are normally developed[1], their position in the adult is near the glabella and the posterior margin, while in several of the older species they have an intermediate position. This indicates that the eye lobes migrated inwards and backwards at the same time. In the larva of *Dalmanites socialis* (text fig. 9) on the other

[1] In such forms where the eye lobes are prolonged into spines or where the eyes are very degenerate, the conditions in this respect may be different.

hand, the eye lobes, though situated far forwards, lie very near the glabella, and in the adult they have only shifted farther back. Here the evolution apparently has gone in the direction that they moved first inwards and later on backwards.

This outbending movement of the eye lobes and eye ridges and the shortening of the latter seem to have influenced also the front part of the cephalon, since the reduction of the rostrum and the anterior parts of the fixed cheeks probably may be put in connection with these events. It appears, however, as if this reduction was due also to other causes, since in several cases it has gone further than seems to be accounted for only by the shifting of the eye lobes, and since there are forms with, as it appears, primarily elongated eye lobes in which the anterior branch of the facial suture cuts the margin of the cephalon rather far forward, indicating that the reduction of the rostrum has proceeded relatively far, e. g. *Zacanthoides* and larval forms of *Paradoxides*.

As long as the eye lobes reached nearly to the posterior margin of the cephalon, only the hindmost parts of the fixed cheeks could grow farther to the sides. When they moved more forwards a larger portion of the latter was at liberty to increase in width. In forms where the genal spines belonged to the free cheeks, they seem to have impeded this growth to a certain extent. In proparian forms on the other hand it could go farther, so that the largest part of the cheek region was formed by the fixed cheeks, while the free ones were rather short. During the following remigration backwards of the eye lobes the free cheeks again increased in size. This explains why the larvæ and the geologically older forms of the Proparia have shorter free cheeks than the adults and the younger forms, and also the different development in this respect in the Pro- and Opisthoparia. On this point it ought to be remarked that in proparian forms, where the genal spines have disappeared, the growth of the free cheeks seems to have been stronger than in forms with spines; or perhaps they were never so much reduced in the former. The result of this is that in several of them the posterior branch of the facial suture cuts the border at or near the genal angle. On the other hand in some spineless Opisthoparia the fixed cheek may have become so broad that here also the point of section is at the genal angle or even a little in front of it. Because of this it might often be difficult to decide whether forms which are devoid of spines belong to the one or the other of the two groups, if no related forms with spines are known.

It appears as if the eyes were rather weakly developed in most Cambrian trilobites, no matter whether they were elongate or short. In younger trilobites, where they are not secondarily reduced, they seem to be better developed and often rather elongate, if not in comparison with the eyes of the Mesonacidæ. In some of the Phacopidæ for instance the eyes are long though of a different shape than in the Cambrian trilobites. To judge from the ontogeny of *Dalmanites socialis* they have, however, originated from ancestors with short eyes situated near the anterior margin of the cephalon (and probably also originally at a great distance from the glabella). This is also confirmed by the fact that in the geologically younger and more highly developed members of this family, the eyes are generally longer than in the older ones.

In other cases the development might have been different. In some lines of descent the eyes probably never were so much reduced or so far removed from their original position, but only grew better developed, and it is often very difficult to judge which line the evolution has followed. In types with primarily rather long eyes and in which the anterior parts of the fixed cheeks never were so very much reduced, the anterior branches of the facial sutures diverge, and this must in this case be considered as a primitive feature. But these parts of the sutures might have had about the same course in types which during the progressive evolution have passed a stage where the eyes were small and situated near to the anterior and the lateral margins, later on increasing in length at the same time as they remigrated closer to the glabella and to the posterior margin. If not (as the conditions appear to have been in *Acidaspis*) the fixed cheeks in front of the eyes decreased in width simultaneously with the remigration of the latter. It is, however, probable that primarily and secondarily elongated eyes would be of a somewhat different shape (in the latter case most likely more curved), but in some extreme cases it might be difficult to decide whether the course of the facial suture indicates a higher or lesser degree of primitiveness.

If, then, it is not always possible to judge from the relative size of the free and fixed cheeks whether a form is more primitive than another, it is still conceivable that one might be guided by the relative size of the free cheeks in different forms, provided that, as confirmed by the larval development, all trilobites originated from ancestors with narrow free cheeks, and that the increased growth of the fixed cheeks, in connection with the altered position of the eye lobes, must not necessarily have taken place at the expense of the free ones, but that the whole of the cheek region might have become broader, the free cheeks having retained their original size or even increased when the eyes were better developed, since their growth apparently is connected with the development of these.

This last statement, though correct to a certain extent, must, however, be taken with some reservation, since this growth evidently also depended on other causes. The width of the free cheeks in most of the Mesonacidæ cannot very well be due only to the degree of development of the eyes, which presumably were rather imperfect, and the difference in size between the free and the fixed cheeks in comparison to other groups can just as little be explained only by the different position of the eye lobes. One must presume that the width of the cheek region in this case is an adaptation to a special mode of life, and is so to speak of a more fortuitous nature. It is nearest to be compared to the development of the broad fringe in such forms as *Harpes* and *Trinucleus*, though in the more primitive forms first mentioned no special fringe was developed. In some of the Mesonacidæ e. g. *Mesonascis*, the cephalon and also the other parts of the body are narrower, which shows that the conditions in this respect might vary among rather closely related forms, which moreover is exemplified in several other cases. In most of the Cheiruridæ, for instance, the free cheeks are rather large, but in such forms as *Deiphon* and *Sphærocoryphe,* which presumably were highly specialized for a planktonic mode of life, they are extremely small, though the eyes seem to have been fairly good.

Because of the circumstance that the free cheeks are so very narrow in the larvæ, one need not expect to find among the normally developed adult trilobites forms in which the conditions are quite the same. In the former the segments of the thorax and the pygidium are also at first, as is well known, fewer than in the adults, and though this indicates that the trilobites have developed from ancestors with few body segments, this goes so far back in time that is impossible to expect that it could be seen in the phylogenetic evolution after they had became trilobites. The case might, to a certain extent, be the same with regard to the free cheeks, but only to a certain extent, since their continued growth during the progressive evolution of the trilobites is exemplified in several instances. SWINNERTON (1919, p. 109) has suggested that »the backward shifting of the eye during development has no phyletic significance, but is merely associated with the cessation of the larval planktonic mode of life and the assumption of the benthic habits of the adult». This suggestion, though rather attractive and probably applicable to some cases, does not, however, explain the fact that in several phylogenetic series the eyes in the younger forms are situated more backwards than in the older, or the circumstance that the eyes are situated so far backwards in such forms as *Acidaspis,* which in other respects shows characters generally regarded as indicating planktonic habits; in consequence of this it does not seem acceptable.

When attempting to give a natural classification of the trilobites, the actual course of the facial suture and the relative size of the free and fixed cheeks must not be too one-sidedly emphasized, as has been done by BEECHER. On the contrary one must bear in mind that a great number of different causes has swayed the evolution.

The Suggestions for a Revised Classification of Trilobites given by SWINNERTON (1915), though partly based on BEECHER's, differs from this in several respects and must be considered as decidedly better, even if it is not entirely satisfactory. As a result of his researches he has given the following table. The names Micro-, Hetero- and Isopygous are the names of some of GÜRICH's (1907) suborders, which names SWINNERTON has adapted for describing the stages in the process of caudalization. For the earliest »Trilobites and Trilobite-like organisms

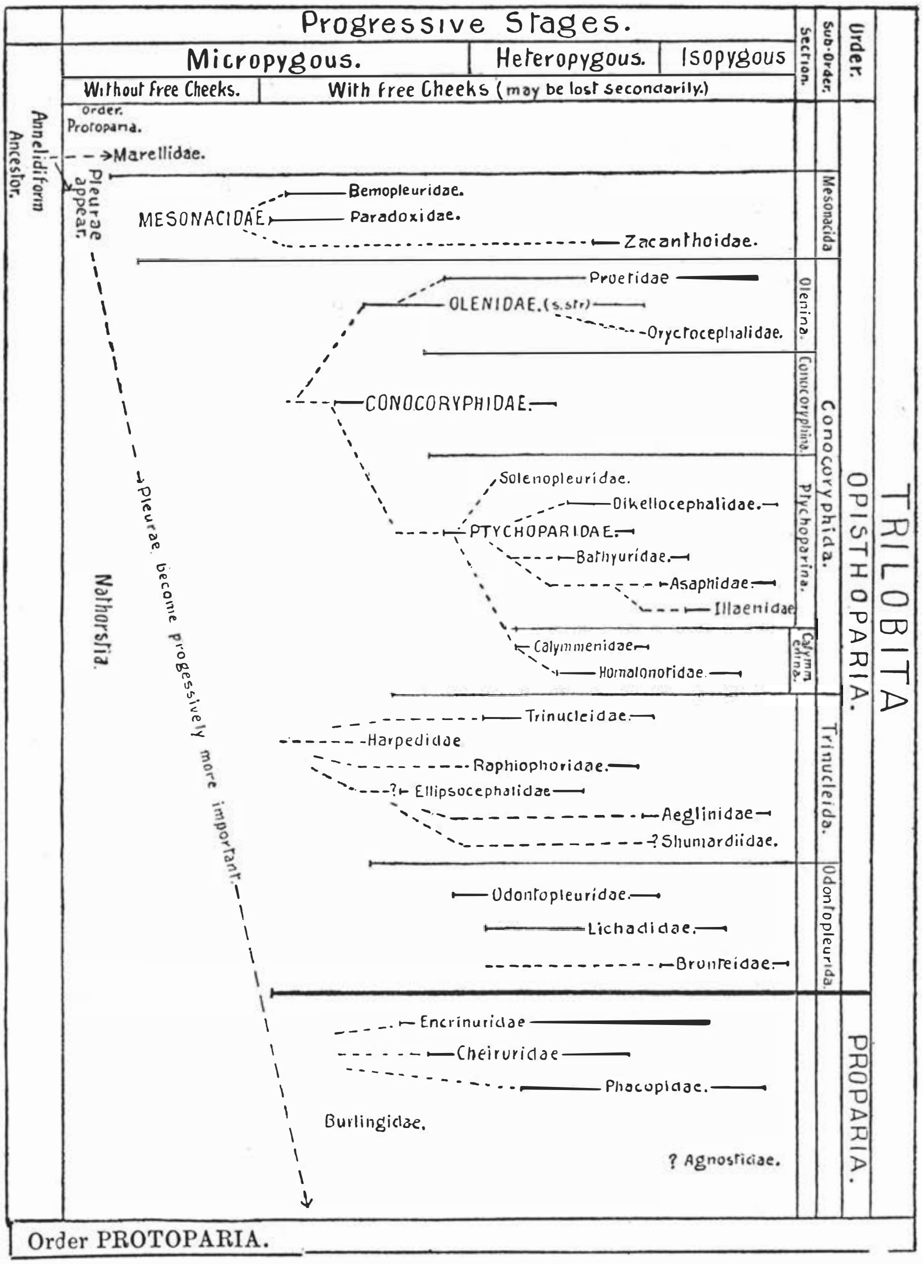


Fig. 14. Table showing the main lines of modification which occur amongst Trilobites and the probable general relation of Trilobite families to one another (According to SWINNERTON 1915).

in which», according to the last-named author, »the absence of facial sutures is primary», he considers that »the Order Protoparia may be instituted» (1915, p. 493), which order apparently is not regarded as having the same classificatory value as the others, as it is based on a progressive character. As is seen from the table, SWINNERTON rejects BEECHER's order Hypoparia but keeps the two orders Opisthoparia and Proparia. To the former he refers the same families as BEECHER did and further the Calymenidæ and the whole of BEECHER's order Hypoparia excepting the family Agnostidæ, which, with some doubt, is referred to the Proparia. As already mentioned, RAYMOND (1917) has tried to show that the order Hypoparia ought to be retained, since »it hardly seems that there is strong evidence at the present time for removing any of the families» (referred to it by BEECHER) »from that order» (p. 205). In a later paper (1919) SWINNERTON has met most of RAYMOND's arguments, and I agree with him that this order is not acceptable, and that the families referred to it must be regarded as degenerate Opisthoparia and Proparia. I also agree with SWINNERTON that, if BEECHER had »given more attention to the larvæ of the Mesonacidæ, he would never have instituted the division *Hypoparia*» (1919, p. 109), and one might add that probably he would no more have done so, had he studied the larvæ of other groups more closely, since they largely agree with the larvæ of the Mesonacidæ.

According to the assumption that all known trilobites descended from forms which had true facial sutures, the order Protoparia can, of course, not be retained. With regard to the orders Opisthoparia and Proparia, as established by BEECHER, SWINNERTON (1915, p. 488) says that they »are almost above reproach», but with regard to the former he can hardly mean that it is a quite natural order, since he refers to it also those trilobites with true facial sutures which he supposes to be descendants of the Mesonacidæ, and since he considers the sutures to be formed independently among these and among other trilobites. Truly this objection cannot be applied if one does not assume this to have been the case, but at the same time the aspect of the question becomes different. The dissimilarity between the Opisthoparia and the Proparia is not to be found in the development of the facial sutures but in the question which of the two pairs of spines, with regard to the Mesonacidæ called the genal and intergenal spines, became dominant. To judge from the ontogeny of the Mesonacidæ, the intergenal ones were first developed, and probably there have been forms which had both kinds remaining more or less unreduced in the adult. Evidently no such species have been found, since the forms which have been given the specific name *Olenelloides armatus* seem to have been larvæ. It does not appear probable, however, that all groups in which the genal spines became dominant adopted this character at the same time. On the contrary it seems more likely that the opisthoparian conditions were evolved independently and at different times. If this was the case, there is no reason to regard the Proparia as a natural group in opposition to the Opisthoparia.

All the different families referred to it do not, in other characters, show very great similarities to each other. If, all the same, one wishes to keep the divisions Opistho- and Proparia, which may be convenient, one must remember that probably they are not to be regarded as phylogenetically natural groups.

As the first suborder of the Opisthoparia SWINNERTON has establiched the Mesonacida, to which he refers the families Mesonacidæ, Paradoxidæ, Zacanthoidæ and Remopleuridæ, of which the three latter are supposed to have descended from the former. The Mesonacidæ comprises, as is well known, the oldest known trilobites, and represents with regard to most characters a very primitive group, which in several respects differs from other trilobites. The forms to which they offer the greatest resemblance are, as often remarked by different authors, *Paradoxides, Zacanthoides, Redlichia, Olenopsis,* and *Albertella.* All these, however, have true facial sutures, and cannot because of this, as pointed out by KJER (1916), be regardad as descendants from types in which the sutures were lost by fusion.[1] They probably separated from the ancestral stock of the Mesonacidæ before the sutures had disappeared. In *Redlichia* COSSMANN (WALCOTT, 1913, Pls. VII, XXIV) and *Zacanthoides* WALC., (WALCOTT, 1908, Pl. III, 1913, Pl. XXIV) the eye lobes have the same shape and position as in the Mesonacidæ, but the anterior parts of the free cheeks are more reduced than is the case in *Holmia* and *Kjerulfia.* In *Redlichia* the reduction has not proceeded very far. In *Redlichia chinensis* WALC. (WALCOTT 1913, p. 104, Pls. VII, XXIV), which is the best known species, probably of Lower Cambrian age (Ibid., p. 104), the anterior branches are directed nearly straight outwards, and also in other characters it is very primitive; the glabella is elongate, tapering anteriorly, there are a great number of thoracic segments, the 5 posterior ones with strong median spines, and the pygidium is very small and platelike. In all these characters it shows resemblances with the Mesonacidæ.

Zacanthoides, of the Middle Cambrian fauna, appears to be rather closely related to *Redlichia* though the glabella is of more uniform breadth, the thorax consists of fewer segments, and the caudalization has proceeded farther, but the pleuræ of the pygidium are still produced into spines. There are generally short intergenal spines remaining in the adults. Such have not been found in *Redlichia,* but this might be due to the defectiveness of the specimens, since, to judge from the figures, the posterior lateral parts of the cephalon are not preserved in any of them. It does not seem improbable that *Zacanthoides*, which genus seems to be geologically younger than *Redlichia,* might have descended from this or from some closely related form.

SWINNERTON refers the early Middle Cambrian genus *Albertella* WALC. (WALCOTT, 1908) to the family Zacanthoidæ (WALCOTT has referred both it and *Zacanthoides* to Paradoxidæ). In *Albertella Bosworthi*

[1] This presumption is not made by SWINNERTON, since he regards the absence of sutures in Mesonacidæ as primary.

WALC. (WALCOTT, 1908, p. 22, Pl. I) the eye lobes are somewhat shorter and situated a little farther away from the glabella and the posterior margin than in *Zacanthoides*. In *Albertella Helena* WALC. (Ibid., p. 19, Pl. II) the shortening and removal of the eye lobes have proceeded considerably farther. In both species the glabella reaches to the anterior border, whereas, at least in most species of *Zacanthoides* as in *Redlichia*, it is separated from this by a short preglabellar field. In *Albertella* the thorax only consists of 7 segments, the pleuræ terminating in short spines, those of the 3d (*Alb. Helena*) or 4th (*Alb. Bosworthi*) in longer spines. In *Zacanthoides* there are 9 thoracic segments all with comparatively long spines; in the young of *Zacanthoides idahoensis* WALC. (WALCOTT, 1908, p. 26, Pl. III) the spines of the 3d segment are also more extended than those of the others, a character which has disappeared in the adult. In *Albertella* as in *Zacanthoides* there is a rounded elongate tubercle in the inner end of the pleural furrow. In the pygidium of the latter genus all the pleuræ are produced into spines, as has already been mentioned. In *Albertella* there is only one pair of pygidial spines, and the border of the posterior part of the pygidium is smooth. It seems as if *Albertella* in most characters was less primitive than *Zacanthoides*, and since it is found in older strata, one cannot presume either of the two genera to have descended from the other. Since they show so many similarities, it is probable that they had the same origin from a *Redlichia*-like ancestor, and that the *Albertella* line at an early stage was specialized in some directions, while *Zacanthoides* remained more primitive. *Albertella Bosworthi* might be regarded as representing a stage intermediate between *Zacanthoides* and *Albertella Helena*.

RAYMOND (1913) refers *Albertella* to the family Ceratopygidæ, evidently on account of the pygidium of *Ceratopyge* also having a pair of caudal spines. But since such spines are also found in several other trilobites of different groups, this need not prove that the two genera are very closely related, especially as they disagree in some other characters, even if it is not inconceivable that the latter genus might have descended from an *Albertella*-like ancestor in which the number of thoracic segments was greater than in *Albertella*, since at least in *Ceratopyge canadensis* WALC. (WALCOTT, 1912b, p. 233, Pl. XXXV) the thorax consists of 10 segments.

In the adult *Paradoxides* the eye lobes are, as a rule, comparatively short and somewhat removed from the glabella and the posterior margin of the cephalon, but in the larvæ their anterior ends reach close to the glabella, though always distinctly separated from it, and their hindmost parts nearly attain to the posterior border. The anterior branches of the facial sutures are also in the larvæ generally directed more outwards than in the adult, their course being about the same as in the adult *Zacanthoides*. In this respects *Par. rugulosus* CORDA (BARRANDE, 1852, Pls. IX, XIII), *Par. Hicksii* SALT. (SALTER and HICKS, 1869, Pl. III, LINNARSSON, 1882, Pl. III) and some allied forms seem to be more primitive than other species of this genus. (Cf. RAYMOND, 1914a, ps. 235, 241). In the allied genus *Centropleura* ANG. (*Anopolenus* SALT.) (ANGELIN, 1878, Pl. III, HICKS, 1865, p. 481, 1872, Pl. VII) the eye lobes are also very long and the anterior branches of the facial sutures directed nearly straight outwards. In the larvæ of *Paradoxides* the intergenal spines are developed, but have disappeared in the adult, and the pleural spines of the two anterior thoracic segments, expecially those of the 2d, are larger in the larvæ and the young individuals. As seen from what is stated above, and which could be further exemplified, *Paradoxides* and *Zacanthoides* agree in several characters. There are, however, also several dissimilarities. The frontal lobe of the former is always very broad, a character which is pronounced already in the earlier larvæ, the thorax consists of several more segments etc. The two genera can hardly be regarded as very close relations, but it seems probable that *Paradoxides* as well as *Zacanthoides* and *Albertella* descended from a *Redlichia*-like ancestor.

It is conceivable that *Olenopsis* BORN. (BORNEMANN 1891) came from the same stock. With regard to the construction of the thorax and the pygidium it agrees rather closely with *Redlichia*. At least in some species the form of the glabella is about the same as in this genus, but the eye lobes are considerably shorter, and in connection with this the fixed cheeks have increased in width, and the anterior branches of the facial sutures are directed more forwards. The reduction of the eyes has, however, proceeded to a very different extent in different species. In *Ol. Zoppii* MENEGH. (MENEGHINI, 1888, BORNEMANN, 1891, Pls. XXXVI, XL, WALCOTT, 1912c, Pl. XXXVI) and *Ol. Bornemanni* MENEGH. (MENEGHINI, 1888, BORNEMANN, 1891, Pls. XXXV, XXXVI, XL) they are still still rather elongate and situatad comparatively close to the glabella. In *Ol. Roddyi* WALC. (WALCOTT, 1912c, Pl. XXXVI) they are much shorter and situated at a great distance from it. In the larvæ and young specimens figured by BORNEMANN (1891, Pl. XXXV), of which at least some probably belong to *Ol. Zoppii* or *Bornemanni*, the eye lobes are more elongate than in the adult of these species. Another primitive character of this genus is that the segmentation of the lateral parts of the cephalon is distincly indicated in the larvæ even on the nepionic stages.

POMPECKJ (1901) considered it probable that *Olenopsis* was derived from *Paradoxides;* WALCOTT (1912c) thinks it more likely that it is »a form intermediate between *Holmia* (restricted) and *Paradoxides*, or that the two genera are descendent from the *Holmia* type of the Mesonacidæ», since there does not appear to be any evidence that *Olenopsis* occurs in younger formations than *Paradoxides*, but on the contrary is found below the horizon of the Middle Cambrian or at the base of this in America. The age of the beds in which the genus is found in Sardinia does not seem to be quite clearly made out, but WALCOTT thinks it probable that they are beneath the Middle Cambrian *Paradoxides* beds.

With regard to the shape of the glabella *Holmia* seems to be more specialized than *Olenopsis*. And as there are true facial sutures in the latter, it cannot be regarded as descendent from any of the Mesonacidæ. The reduction of the eyes has proceeded farther than in *Paradoxides*. In other characters it is not more like this latter genus than *Redlichia* is, except perhaps that in some forms (*Ol. longispinatus* BORN.) the pleural spines of the hindmost thoracic segment are more extended than the others, as is also the case in some of the Paradoxidæ. MATTHEW (1899) has compared *Olenopsis* to *Protolenus* MATTH. The possible relationship of these two genera will be further discussed below.

The Remopleuridæ have generally been considered as related to the Paradoxidæ on account of the form and position of their eye lobes, their comparatively wide free cheeks, the small thoracic pleuræ and the telson-like pygidium. As mentioned above SWINNERTON derives them also from the Mesonacidæ. With regard to the eyes they are, as is well known, situated quite close to the glabella, only separated from it by the narrow palpebral lobes. This is not the case either in Mesonacidæ or in Paradoxidæ. And evidently the position as well as the shape and largeness of the eyes, here as in *Aeglina,* is due to the adaptation to nocturnal habits, which is also pointed out by the author just mentioned. The free cheeks of the Remopleuridæ, especially in the genus *Caphyra* BARR. (*Remopleurides radians* BARR. and allied species) are very different from those in Paradoxidæ and Mesonacidæ. The thorax, at least in some genera of the latter family, e. g. *Holmia* and *Kjerulfia* (Cf. KJER, 1916, p. 79) shows in the articulation of the segments some correspondence with *Remopleurides* (s. str.). In the latter there is sometimes (*R. laterispinifer* PORTL.) a pair of extended pleural spines, but they never belong to the 2d segment, as in some of the young *Paradoxides*, or to the 3d, as in *Zacanthoides, Albertella,* and some of the Mesonacidæ, but to the 7th. In *R. dorsospinifer* PORTL. the 8th thoracic ring has a long median spine, and such spines are, as is well known, also found on the thoracic rings of some of the other forms just mentioned. But since thoracic spines occur among other groups of trilobites, this character need not be taken as a proof of a close relationship between the forms concerned. The pygidia of *Caphyra* and *Remopleurides* (s. str.) are rather unlike each other, and, except their being small, neither of the two types are similar to the pygidia of the other families here in question.

If, on the one hand, there does not seem to be much that indicates a close relationship between these and the Remopleuridæ, there are on the other hand several things which speak against such a presumption. Apart from what has just been pointed out, the following characters, in which the latter family differs from the former, might be mentioned: the comparatively small number of body segments, the quite differently-shaped glabella, and especially the complete reduction of the rostrum, the increasing and fusion of the free cheeks, and the differently-shaped hypostoma.

HADDING (1913) has pointed out the close correspondence in several characters between *Remopleurides* (s. lat.), *Aeglina* and *Telephus*. To a great extent these are probably due to the adaptation to the same mode of life, but possibly some of them might depend on a near relationship. With regard to forms thus specialized for a certain habit, it does not, with our present knowledge, seem to be possible to form a decided opinion about their relation to other groups. As to their mutual relation, I agree with HADDING that each of these genera must be regarded as representing a family. This question as well as the one regarding the relation between the Remopleuridæ and *Apatocephalus* will be further discussed below.

To his second suborder, Conocoryphida, SWINNERTON refers the vast majority of other opisthoparian families. Among these he regards Conocoryphidæ (*Conocoryphe, Ctenocephalus*, and *Atops*) as the most primitive; all the others he derives from a Conocoryphid-like stock. Also the suborders Trinucleida and Odontopleurida he apparently believes to have originated from the same stock, though, on account of the absence of connecting links, he thinks it necessary to refer them to special suborders. He (1915, p. 539) quotes BEECHER (1897, p. 191) in saying that »from a phylogenetic standpoint the family Conocoryphidæ is at the base of this extensive order» (Opisthoparia), and continues: »Its narrow marginal free cheeks, the diminution anteriorly and clearly marked segmentation of its glabella, the presence of eyelines, the great number of free segments, the micropygous condition, all indicate its primitive character.» With regard to the character first mentioned, to which BEECHER evidently attached the greatest importance, it is probably secondary and due to the fact that all the Conocoryphidæ are blind, since, as pointed out above, in many higher trilobites also the free cheeks have been reduced simultaneously with the eyes. BEECHER apparently regarded the blindness of the Conocoryphidæ as primary, whereas SWINNERTON considers »the absence of eyes» as »probably secondary» (p. 496), but he has evidently not thought of putting the narrowness of the free cheeks in connection with the reduction of the eyes, at least not in the paper of 1915 just quoted.[1] Otherwise the genus concerned, though undoubtedly a primitive form, does not seem to be more so than several other Cambrian trilobites (outside of the Mesonacidæ). That it is not advisable to start from a secondarily reduced form, when attempting to establish a natural classification, is evident.

Just because SWINNERTON considered all the Opisthoparia, except the Mesonacida, to have originated from a Conocoryphid-like stock descendent from a *Nathorstia*-like ancestor, the chasm between these and the Mesonacida becomes, according to his opinion, so great, much greater than it seems to have been. One might say that *Albertella* and *Olenopsis*, with regard to several characters, represent intermediate forms between this latter suborder and other Opisthoparia, and that they illu-

[1] As to the explanation of the nature of the suture in this genus suggested by him in 1919, see above (p. 44).

strate stages in the progressive evolution of these. Neither does it seem improbable that several of these originated from the same ancestral stocks to which *Albertella* and *Olenopsis* respectively belonged. In both genera the shortening and the removal of the eye lobes from the glabella and the posterior margin of the cephalon have proceeded comparatively far. In the former the process of caudalization has also gone rather far, and the number of thoracic segments is reduced to such a high degree that the genus, in this respect, must be regarded as more specialized than several younger genera.

MATTHEW (1899) thinks it likely that *Olenopsis*, especially *Ol. Zoppi*, is closely related to *Protolenus*, and only represents a higher stage of development of this genus. POMPECKJ (1901) and WALCOTT (1912 c) reject MATTHEW's conception, and I agree with them that it does not seem probable that there existed a close relationship between the two genera. In *Protolenus* the eye lobes are very long, situated at a great distance from the glabella, their posterior ends reaching to the posterior border furrows. The parts of the fixed cheeks (only comprising the posterior borders) behind the eye lobes do not reach farther outwards than they, and the free cheeks are narrow. In the species of *Olenopsis* which have elongate eye lobes, the portions of the fixed cheeks within them are narrow, the portions behind them extended rather far outwards and the free cheeks wide. The position and direction of the parts formed by the eye ridges + eye lobes in the former genus are about the same as those of the lateral parts of the larval ridge in the protaspis of *Elliptocephala*. If the foremost parts of the eyes in the ancestors of *Protolenus* originally reached close to the glabella, which is presumable, it is probable that the inner anterior portions of them were reduced at such an early stage of the phylogenetic evolution that the posterior portions never had grown close to the glabella (i. e. that the eyes had not yet got their ideal adjustment) or the posterior parts of the fixed cheeks past the eye lobes. This indicates that the *Protolenus* line separated from the Mesonacidæ—*Redlichia* line at a very early period. It is also confirmed by the fact that there are forms corresponding to *Protolenus* with regard to these characters which occur in still older strata, viz. some of the Ellipsocephalidæ. According to the line of development which KJER (1916) has demonstrated in this family, the younger genus *Ellipsocephalus* ZENKER is derived from the older *Strenuella* MATTH. The same author (Ibid., p. 54) suggests that *Protolenus* might be connected with primitive forms of the *Strenuella* group, which seems very likely.

SWINNERTON considers *Protolenus* to lie at the base of one offshoot of trilobites, »to which the family name of Olenidæ (s. str.) should be strictly limited» (1915, p. 540), and he refers to it the genera which PERSSON (1904) and LAKE (1908) have grouped into the Continuæ, Abruptæ, and Inermes. *Ptychoparia* he regards as the basal type of another group, family Ptychoparidæ, which according to him includes the genera *Ptycho-*

paria, Protypus, Euloma, Sao, Triarthrus, Liostracus, Bavarilla, and *Neseuretus.* The restriction of the family Olenidæ seems to be justifiable, except that *Triarthrus* most likely ought rather to be referred to it than to Ptychoparidæ. Whether all the other genera included in the latter family really belong here, appears doubtful. According to REED (1918, p. 319) it seems as if »*Neseuretus* must be regarded as a composite and heterogeneous assemblage of species», and had »no right to be retained as a separate generic designation». With regard to *Protypus,* its relation to the others seems doubtful.

SWINNERTON presumes that *Protolenus* and *Ptychoparia* arose from the same (Conocoryphid-like) stock, and that the two genera had followed different lines of development. The chief characters in which the latter differs from the former, are that the eye lobes are shorter and situated farther away from the posterior margin, that the outline of the cephalon is semicircular (in *Protolenus* it is short and wide, and of a more tetragonal outline), and the posterior branches of the facial sutures are directed more outwards, cutting the posterior margin of the cephalon just inside the genal spines. In most of these characters and also with regard to the form of the glabella and the course of the anterior branches of the facial sutures, *Ptychoparia* shows more likeness to *Olenopsis* than *Protolenus* does. It does not seem improbable that it originated from the *Redlichia—Olenopsis* stock though it is a narrower form.

If the Olenidæ really originated from *Protolenus*-like forms, which, however, does not seem quite certain, they and the Ptychoparidæ presumably separated at a very early period. That the two families resemble each other in several characters might be due to parallel development; there are moreover several dissimilarities. In the latter the thoracic pleuræ are not spinose, as is generally the case in the former family, and in *Ptychoparia* the caudalization has proceeded farther than among the Olenidæ. In the latter the eye lobes are very small and situated far forwards, in most of them at a considerable distance from the glabella, but in some, generally younger forms, they have moved close to it. But even in such forms where the eye lobes lie rather far from the glabella, the reduction of the rostrum and of the anterior parts of the fixed cheeks seems to have proceeded very far, the corresponding parts of the free cheeks have increased in size, and in several genera their foremost portions meet each other in front of the glabella at the dorsal side of the cephalon. It has evidently not been observed whether in other genera where the anterior branches of the facial sutures cut the anterior border at a relatively great distance from each other, the doublures of the free cheeks meet or not. To judge from the free cheeks figured, this generally seems not to have been the case, since the doublure most often is only slightly more extended than the rest of the free cheeks; possibly it might have been broken off, but it does not seem improbable that the conditions were different in different genera, viz. that the reduction of the rostrum had proceeded unequally. It is not known how *Protolenus* stood in this respect, but, to judge from the specimens figured, it appears as most probable that it had a rostrum of about the same width as the anterior part of the cranidium.

In the Ptychoparidæ the shortening of the eye lobes has not proceeded as far as in the Olenidæ in general, and at least in *Ptychoparia striata* (text-fig. 12 c) there is a broad rostrum, which, however, is narrower than the anterior part of the cranidium. In some other species belonging to this genus the foremost portions of the dorsal parts of the free cheeks have extended rather far inwards, but in no case, either in this genus or in others referable to this family, are they known to meet, which makes it seem probable that, as a rule, the rostrum was developed. Generally the glabella tapers anteriorly, whereas it is more parallel-sided in the Olenidæ. In this respect *Triarthrus* is more like the latter and also with regard to the fact that the rostrum seems to be completely reduced to judge from the figures of the ventral side of *Tr. Becki* and from LAKE's (1913, p. 70) assumption that the facial suture in *Tr. shinetonensis* RAW. is probably marginal in front. That in several other respects also *Triarthrus* much resembles some of the Olenidæ confirms the conception that it is more closely related to these than to the Ptychoparidæ.

SWINNERTON regards it as probable that the Proëtidæ have arisen from an Olenid stock. BEECHER (1897) derives them from *Arethusina* BARR. (*Aulacopleura* CORDA), which sometimes has been referred to Proëtidæ, sometimes (e. g. by RAYMOND, 1913 a) to Olenidæ. In *Arethusina* as in the Olenidæ the eye lobes are short and situated far forwards, the eye ridges are distinct, the number of thoracic segments is great, and the pygidium small. The pleuræ, however, have straight furrows, not oblique ones as in the Olenidæ, and are not spinose. The preglabellar field is considerably longer than in these, where it generally is very short or where, in some forms, the glabella reaches close to the anterior border. The glabella tapers anteriorly, and the anterior branches of the facial sutures are more divergent than is generally the case among the Olenidæ. In some of these characters it resembles the Ptychoparidæ more than the Olenidæ. If it really came from the same stock as the latter, it must have separated from them at a very early stage, and it does not at any rate seem justifiable to refer *Arethusina* to the Olenidæ.

Neither does it seem correct to refer it to the Proëtidæ on account of the different shape and position of the eye lobes, or on account of the different course of the facial sutures connected with these. In these characters it agrees more or less with *Cyphaspis* and also with regard to the shape and lobation of the glabella, and the construction of the thoracic segments and of the pygidium. In the latter genus, however, the eye ridges, as a rule, have disappeared, and the eye lobes moved farther backwards, the number of thoracic segments is less, the pygidium generally consists of more segments, the hypostoma is rather different and the preglabellar field often shorter. OEHLERT (1886) has excluded both *Arethusina* and *Cyphaspis* from the Proëtidæ, and regards the former as a »Cyphaspis chez lequel tous les charactères se sont exagérés». It seems as if the two genera might be brought together, at least provisionally, and *Arethusina* be regarded as a primitive member of the family Cyphaspidæ. In *Cyphaspis* as well as in the Proëtidæ (s. str.) there is a rostrum. The chief differences between the two families are that in the latter the eye lobes are elongate and situated close to the glabella and the posterior margin of the cephalon, the posterior branches of the facial sutures cut the posterior margin farther from the genal angles, and the thorax consists of fewer segments (8—10). Their number is, however, rather varying among the Cyphaspidæ; in *Arethusina* there are 22, in *Cyph. Halli* BARR. 17, and in *Cyph. Barrandei* CORDA only 11. The two families, however, resemble each other in so many respects that they must be regarded as closely allied. It is quite conceivable that the elongate eyes in the Proëtidæ developed from short eyes of about the same type as those in *Cyphaspis;* there are also some Proëtidæ, e. g. *Pr.* (*Phaet.*) *striatus* BARR., which have comparatively short eyes. That the eye lobes in *Cyphaspis* are situated at such a great distance from the glabella, might probably be put in connection with the convexity of the cheeks, since of course the eyes must lie either on their highest parts or on their outer slope. As OEHLERT (1886, p. 123) has pointed out, *Arethusina* has many points of resemblance with *Harpes*. Otherwise it seems difficult to find any connections between the families Proëtidæ and Cyphaspidæ and other groups of trilobites.

SWINNERTON is of the opinion that the family Oryctocephalidæ »must be regarded as a separate branch of the same» (Olenid) »stock, a branch in which caudalization began early and rapidly reached its acme» (1915, p. 541). This is not quite inconceivable, but it seems to be more natural to look for their ancestors among *Albertella*-like forms. To the family in question RAYMOND (1913 a) has referred the genera *Oryctocephalus* WALC., *Zacanthoides* WALC., *Olenoides* MEEK, and *Neolenus* MATTH.. *Dorypyge* DAMES, which genus by some scientists (GRÖNWALL, 1902) has been considered as congeneric to *Olenoides*, also belongs here. The genus *Vanuxemella* WALC. WALCOTT (1916) has also referred to this family and pointed out that it »has some features suggesting *Albertella*». With the exception of *Zacanthoides,* which in several respects shows different and more primitive characters, all these genera seem to constitute a very natural group, which in many features resembles *Albertella,* or shows a somewhat higher stage of development. The glabella is wide, generally expanded in front, its furrows do not continue across, but are more or less strongly marked, in some cases (e. g. species of *Neolenus*) there is a pair of furrows dividing the frontal lobe as in *Alb. Helena.* The eye ridges are developed, and the eye lobes reach comparatively near to the glabella and to the posterior margin of the cephalon. With regard to this character most of the genera concerned have, however, reached a higher degree of development than *Albertella*. There are 7 thoracic segments, except in *Vanuxemella* which has only 4, but according to WALCOTT (1916, p. 221) in this genus 3 »otherwise true thoracic segments» have fused with the pydigium. Axial rings, as in *Albertella* and *Zacanthoides,* with median tubercles or short spines. Pleuræ more or less strongly spinose. Pygidium comparatively large, formed by a varying number of segments (sometimes their number varies much in the same genus, e. g. *Neolenus*). One or several pairs of the pygidial pleuræ extended into spines. The hypostoma, as far as it is known, is also rather like that of *Albertella,* and possibly this genus ought to be included in the family in question on account of its many similarities with the genera referred to it. *Zacanthoides,* on the other hand, can hardly be regarded as belonging to the Oryctocephalidæ, since in several characters it differs so much from them. At any rate it seems justifiable to presume that the Oryctocephalidæ and *Albertella* were closely allied.

As pointed out by WALCOTT (1916), the Oryctocephalidæ appear to stand close to the family Corynexochoidæ, to which he refers the Lower and Middle Cambrian genera *Corynexochus* ANG., *Dolichometopus* ANG., and *Bathyuriscus* MEEK, and which according to him (p. 308) has, among others, the following characters. »Glabella usually expanded anteriorly and with only narrow limb and border in front. Eyes of medium to large size, with strong palpebral lobe and with palpebral (ocular) ridge crossing fixed cheek. Thorax with 7 to 11 segments». »Pygidium more or less strongly ribbed». The form of the glabella, the size and the position of the eye lobes vary much even inside the same genus, but there are transition forms and also such forms which in these characters are similar to some of the Orycthocephalidæ. In *Dolichometopus* and *Bathyuriscus* there is a short median spine or tubercle on each thoracic axial ring. The pleural furrows are broad, and, in some species of the two genera last mentioned, there is an elongate triangular ridge extending from the axis and out into the pleural furrows, as in *Albertella* and *Zacanthoides.* The thoracic pleuræ of *Corynexochus* are more like those of *Dorypyge.* The pygidium consists of a varying number of segments, the pleural furrows are more or less strongly marked, the margin is generally smooth, but in some species there is one or more pairs of pleural spines (see WALCOTT, 1916, Pls. XLVII, LV, LVI and LVII). The hypostoma recalls that of the Oryctocephalidæ. The forms and lobation of the glabella, the eye lobes and the course of the facial sutures in some species of *Bathyuriscus* and the long eye lobes in *Dolichometopus* show more resemblance to *Zacanthoides* than to the Oryctocephalidæ. WALCOTT's (1916, p. 308) presumption that the three genera might have arisen from the same early Lower Cambrian ancestor seems acceptable, and it appears probable that it belonged to a Zacanthoid-like stock, that *Albertella* and the

Oryctocephalidæ originated from the same or from closely allied forms, and that the Corynexochoidæ separated from the Oryctocephalidæ line at an earlier period than *Albertella*.

From the Ptychoparidæ SWINNERTON derives several families, viz. Solenopleuridæ, Dikelocephalidæ, Bathyuridæ, Asaphidæ, and Illænidæ, which three latter he regards as belonging to the same line, and further the more distantly related Calymenidæ and Homalonotidæ.

Of these the Solenopleuridæ appear to be closely allied to the Ptychoparidæ. They differ chiefly in having a shorter glabella, which, like the whole of the cephalon, is more convex and situated closer to the anterior border. The eyes are generally short and the free cheeks wide.

SWINNERTON (1915, p. 542) agrees with RAYMOND (1911) in tracing »the main lines of Asaphid development» back to *Ogygopsis* WALC. of the Middle Cambrian, and considers that the strong resemblance between the young of this genus and *Bathyuriscus* (as pointed out by WOODWARD, 1902) »proves the Bathyuridæ to be an early offshoot of the ancestral Asaphid stock», which he thinks probably must »be looked for among the Ptychoparidæ, for *Bathyuriscus* differs from the latter only in the degree of progressive development». It seems, however, to be more justifiable to refer the last-named genus to the Corynexochoidæ than to the family Bathyuridæ, since in so many respects it differs from the other genera referred to this family, and as I have just tried to show, it appears probable that the Corynexochoidæ belong to the same stock as the Oryctocephalidæ, viz. the *Zacanthoides—Albertella* stock. From the Ptychoparidæ *Bathyuriscus* differs in several characters, as for instance in the form and lobation of the glabella, the absence of a preglabellar field, the form and position of the eye lobes, the course of the anterior branches of the facial sutures, the construction of the thoracic segments, and the tendency to spinosity both in the thorax and in the pygidium. In several of these characters *Bathyuriscus* seems to be more primitive than the Ptychoparidæ.

Whether *Ogygopsis* is closely related to *Bathyuriscus* or even has the same origin, is difficult to say. It is true that there are many points of resemblance, but on the other hand there are also many dissimilarities, as has also been pointed out by WOODWARD. Further it does not seem appropriate to refer *Ogygopsis* to the family Asaphidæ. One of the characteristics of this family is, as is well known, the absence of a rostrum, whereas it appears as if *Ogygopsis* had a comparatively broad one, to judge from the figure given by WALCOTT (1916, Pl. LXVI, fig. 1 b) of a hypostoma probably belonging to *Ogygopsis klotzi* ROMING. which is connected with a plate that must be the rostrum. It is true that the Asaphidæ must be regarded as descendants from ancestors which had a rostrum, but also with regard to other characters *Ogygopsis* differs from them. Apart from the difference in the glabella, the different shape and position of the eye lobes, and the development of eye ridges, which all might be regarded as more primitive features, the pleural furrows in

Ogygopsis are broad and comparatively straight, and in the Asaphidæ narrow and oblique, the axis of the pygidium does not taper so strongly posteriorly in the former, and, to judge from the figures, it seems as if the doublure both of the cephalon and of the pygidium was considerably narrower. It is, of course, not precluded that the Asaphidæ arose from *Ogygopsis*-like ancestors, but there is nothing to prove that this was the case.

The Cambrian genus *Asaphiscus* MEEK has also been referred to the Asaphidæ (e. g. by BEECHER, 1897, p. 193, and by WALCOTT, 1916, p. 375). In several characters it reminds one of the true Asaphidæ, especially with regard to the large pygidium, which, however, evidently is formed by a less number of segments, and since there is only one thoracic segment more (at least in the more typical species), this cannot only be due to the fact that the process of caudalization has not proceeded so far in the older genus as in the younger ones. The construction of the thoracic segments seems to be about the same, and also the course of the facial sutures, apart from what depends on the circumstance of the eye lobes being situated farther away from the glabella in the older genus and on its probably having a rostrum. Other characteristics to be mentioned here are that the cephalon of *Asaphiscus* is surrounded by a strongly and clearly defined border, the glabella convex, conical in outline, strongly defined from the cheeks and from the comparatively long preglabellar field, and the hypostoma rounded behind. The rostrum is not figured or mentioned in the descriptions, but probably it was developed. At all events the genus in question seems to differ so much from the true Asaphidæ that it ought not to be referred to the same family; possibly it might have originated from the same stock. That the pygidia resemble each other need not prove anything in this respect, since the same type of pygidium is found in many other forms evidently belonging to different groups.

The same tendency towards the rapid reduction of the rostrum and of the foremost part of the cranidium, independent of the changes in the parts behind, is found in Olenidæ and Asaphidæ, but with regard to other characters the similarity is not great, and the relation between the latter and other families seems on the whole to be very difficult to decide.

The Illænidæ are generally considered as relations, or even as descendants of the Asaphidæ, but they differ from them in several characters, as for instance in the development of a rostrum, in the shape of the hypostoma, and in the number and construction of the thoracic segments. With regard to some characters there are species of *Dolichometopus* which resemble the Illænidæ rather closely. The form of the hypostoma is about the same, and the Illænid pygidium might conceivably have developed from that of *Dolichometopus*, where in some species it chiefly differs from that of *Illænus* in having a more elongate and more strongly defined axis. The form and number of the thoracic segments, however, are different, and also the cephalon shows several dissimilarities.

The Bathyuridæ have also been regarded as rather closely allied to the Asaphidæ (this is, as just mentioned, SWINNERTON's opinion), which on account of the correspondence of several characters does not seem improbable, though the connecting links are wanting. WALCOTT (1916, p. 308) regards »the Bathyuridæ as an offshoot from some *Bathyuriscus*-like ancestors in late Cambrian or early post-Cambrian time».

As mentioned above, SWINNERTON derives also the family Dikelocephalidæ (to which he refers *Crepicephalus* OWEN and *Dikelocephalus* OWEN) from the Ptychoparid stock, chiefly on account of the resemblance in the construction of the cephalon of the former and of *Ptychoparia striata*. WALCOTT (1914) has eliminated *Crepicephalus* from the Dikelocephalidæ, and in a later paper (1916) referred it to the family Ceratopygidæ. From *Ceratopyge* CORDA it differs, however, considerably in the form of the glabella, whereas there are greater similarities in the position of the eye lobes, the course of the facial sutures, and the form of the pygidium. It seems doubtful, though, whether the two genera are really closely related to each other. The relationship between *Crepicephalus* and the Ptychoparidæ appears more acceptable. The greatest differences are that in the former the postero-lateral margin of the pygidium extends backwards on each side in a shorter or longer spine, and that the pleuræ generally have a more or less strongly marked backward direction. In these respects *Crepicephalus* agrees to a certain extent with some species of *Dikelocephalus,* though in this genus the pleuræ are most often directed still more backwards, and the pygidial spines, when developed, shorter and of a different type. With regard to the cephalon the latter genus differs very much from *Crepicephalus* and from the Ptychoparidæ. The glabella is sub-quadrangular in outline, with a broadly rounded front; the posterior glabellar furrow extends across. The anterior branches of the facial sutures meet in front, at least in some species, e. g. *Dik. minnesotensis* OWEN (WALCOTT, 1914, Pl. LXI, fig. 1). The eye lobes are rather elongate and the fixed cheeks narrow. The doublure of the pygidium is wide and with imbricating lines; in the more typical species of the genus there is no defined border round the cephalon, and the doublure of the free cheeks also appears to be wide. In several of these characters *Dikelocephalus* resembles to a certain extent the Asaphidæ, especially *Niobe,* but the form of the pygidium is different and its axis shorter. Also the direction of the thoracic pleuræ is different, the pleural parts of the whole body are wider and the marginal parts more decidedly flattened. Thus there does not seem to be any close relationship between *Dikelocephalus* and the Asaphidæ. Whether the former is more closely related to *Crepicephalus* and the Ptychoparidæ, appears also doubtful.

POMPECKJ (1898) has derived *Calymene* through *Pharostoma* from *Bavarilla*, and *Homalonotus* from *Neseuretus*. SWINNERTON evidently accepts this presumption, and considers the two families Calymenidæ and Homalonotidæ as descendants of the Ptychoparid stock. The former author, however, does not regard *Bavarilla* as the ancestor of all the species previously referred to *Calymene,* but believes that some of them, including the oldest known forms (the *C. Tristani* BRONGN. and the *C. Arago* RAU. groups and the subgenus *Ptychometopus* SCHMIDT), like *Homalonotus* have descended from *Neseuretus,* and refers them to a separate genus, *Synhomalonotus.* As mentioned above, REED (1918) has pointed out that *Neseuretus* is not a separate genus. Consequently the line of descent traced back to it cannot be accepted. *Bavarilla* on the other hand really seems to be rather like *Calymene*, but whether or not this indicates a close relationship, is difficult to say. With regard to the species referred to *Synhomalonotus*, it is true that they differ rather much from the true *Calymene* and *Pharostoma* in several characters, but at least some of them show more points of resemblance with these than *Bavarilla* does, and seem at any rate to be more closely related to them than to *Homalonotus.* They appear to represent a special offshoot of the Calymenidæ (s. str.) which at a comparatively early stage followed a different line of development. That they are more like the Homalonotidæ than the younger members of the family are, seems only natural, if the two families arose from a common stock, which appears probable. REED (1918, p. 320) has also pointed out that the earlier species of *Homalonotus* »undoubtedly come nearest to *Calymene*», and he expresses the opinion that the former genus »may be linked with *Calymene* by means of *Synhomalonotus,* though it must have diverged at an early period or more probably have originated from a common stock» (p. 327). He seems to be of the opinion that *Homalonotus* ought to be referred to Proparia, since »some of the Devonian species had the point of section» (of the posterior branches of the facial sutures) »in front of the genal angles, and it is not improbable», according to him, »that some of those from the Grès de May» (i. e. some of the oldest known members of the genus) »possessed the same character» (p. 319).

BEECHER (1897) and RAYMOND (1913a and 1917) also refer Calymenidæ (s. lat., including the Homalonotidæ) to the Proparia. According to the latter (1917, p. 210), BEECHER should have declared that the genal spines in *Pharostoma* belonged to the fixed cheeks. This does not, however, seem to be the case. It is true that the statements of some authors concerning these things are rather obscure. BARRANDE (1852) at any rate has clearly stated that in *Calymene (Pharostoma) pulchra* BARR. the spines are borne on the free cheeks, which is also distinctly to be seen both on his (Pl. XIX) and CORDA's (1847, Pl. V, fig. 49) figures, and SCHMIDT (1894) has defined *Pharostoma* as having the posterior branches of the facial sutures cutting the border within the spines. Since the possession of genal spines seems to be a primitive character, one must presume that all the Calymenidæ have arisen from ancestors which, with regard to this feature, were like *Pharostoma,* and when the spines became reduced, the points of section of the facial sutures shifted to the genal angles, as also evidently was the case with regard to other spineless trilobites both among the Opistho- and Proparia. If they really are to be considered as related to *Bavarilla,* this fact would also confirm the above presumption, and, if the Homalonotidæ came from the same stock as the Calymenidæ, which appears probable, they must have gone through the same stages of development, though in some of the younger species it had proceeded so far that the points of section came to be situated somewhat in front of the genal angles. Consequently SWINNERTON apparently is right in referring both the families concerned to Opisthoparia. Their relation to other families does not seem possible to decide, but it is not inconceivable that they originated from the *Ptychoparia* stock. Their direct ancestor must evidently have been a form in which the shortening and migration of the eyes had proceeded farther than in *Bavarilla,* since the larval development of *Calymene senaria* indicates that at least the Calymenidæ have passed a phylogenetic stage where the eyes were short and situated near the glabella and the anterior margin of the cephalon. The special characteristics which *Calymene* (s. str.) and *Pharostoma* have in common with *Bavarilla* need not depend on a lineal descent, but might be due to parallel development, perhaps the result of the same hereditary tendencies, if they came from the same stock.

The families Trinucleidæ, Raphiophoridæ, and Harpedidæ SWINNERTON includes in the suborder Trinucleida, to which he places Ellipsocephalidæ, Aeglinidæ, and Shumardiidæ provisionally as an appendix.

The three former families have generally been considered related to each other, and the genera which RAYMOND (1913a) includes in Raphiophoridæ (*Ampyx* DALM., and the closely allied *Raphiophorus* ANG., and *Lonchodomas* ANG.) have often been referred to the family Trinucleidæ (s. lat.). The thorax and the pygidium of *Trinucleus* and *Ampyx* are really very similarly constructed, and also the cephala of the two genera resemble one another in several characters. Both are, as is well known, blind forms. In the latter there is still an open facial suture, situated near the lateral margin, whereas in the former it is lost by fusion, and the cephalon is surrounded by a wide pitted fringe. It is, however, not devoloped in the earlier larvæ, which indicates that *Trinucleus* originated from ancestors that in this respect were like *Ampyx*. LAKE (1907) has pointed out the great similarity between these genera and the Cambrian and Lower Silurian genus *Orometopus* BRÖGG., which he refers to the Trinucleidæ, and in which the eyes and the course of the facial sutures are normal, wherefore it might be regarded as representing the ancestral type from which *Ampyx* and *Trinucleus* have developed along different lines (Cf. also SWINNERTON, 1915, p. 543, and 1919, p. 107). To the Trinucleidæ the genus *Dionide* has also been referred. It is also a blind form, but differs from the genera just mentioned with regard to several characters. But since there are also many similarities, and since there seems to be transition forms, it might be justifiable to include it in this family.

With regard to the construction of the cephalon, *Harpes* resembles *Trinucleus* in many points. Perhaps these similarities ought, however, to be regarded rather as adaptations for the same mode of life than as indicating a close relationship. The many-jointed thorax and the small pygidium in *Harpes* differ very much from those in *Trinucleus* and *Ampyx*. SWINNERTON emphasizes that *Dionide* here, as partly also with regard to the construction of the cephalon, »bridges the gap, for, whilst some species» of the latter »have an almost typically Trinucleid trunk and tail, others» »are like *Harpes* in outline, and though the pygidium is large, show clear indications of numerous segments». The thoracic segments are, however, very unlike in character in the two genera and the hypostomata of too different a type to make it seem probable that they were very closely related to each other. In some respects *Harpes*, and the probably closely allied *Harpides*, resemble *Arethusina* and also to a certain extent *Ptychoparia*, but if this indicates any close relationship is doubtful. The affinities of *Harpes* will, however, be further discussed below in connection with the description of the species found in the Leptæna Limestone. Anything indicating that the Trinucleidæ (s. lat.) were nearly allied to any other groups, I have not been able to find.

SWINNERTON points out that the Ellipsocephalidæ have »an almost Trinucleid shape of body». He does not consider that they can be regarded as the ancestors of the Trinucleidæ but that »it is not unreasonable to regard» them »as an early offshoot of the same stock, and therefor subject to the same morphological tendencies». I cannot see that the similarities are so very great, however, and already the oldest genus referred to the Trinucleidæ, *Orometopus*, has a cephalon that is so very different from that of the Ellipsocephalidæ that there does not seem to be any reason for such a presumption.

The Aeglinidæ have also, as the Trinucleidæ, few segments in the thorax and a small pygidium. This latter is, however, of a rather different type, somewhat like the Asaphid pygidium but evidently including a less number of segments. Another character in which they resemble the Asaphidæ and also the Trinucleidæ is the absence of a rostrum. The cephalon is, however, on account of their presumably nocturnal habits so very specialized that it is not possible, at least not with our present knowledge, to judge about their possible relationship to other more normally developed trilobites, as has already been pointed out (p. 59).

The points in which the Shumardiidæ agree with the Trinucleidæ, are chiefly that they have few thoracic segments and a small pygidium, but both the latter and the cephalon are rather differently constructed and some of the thoracic pleuræ in *Shumardia* prolonged into spines. There does not, then, exist anything indicating a relationship. But they do not show any closer connection with either the Agnostidæ or the Olenidæ

(s. lat.), in one of which families they have been placed by different authors (Cf. LAKE 1917, p. 40), or with any other group of trilobites.

The two families Acidaspidæ (Odontopleuridæ) and Lichadidæ are generally grouped together. SWINNERTON (1915, p. 544) emphasizes that »the tendency to develop numerous spines is an adaptation characteristic of planktonic forms», and that »the thinness of the carapace in the latter family is also characteristic of pelagic animals», wherefore these features may »be left out of account». On the other hand he considers that »the usual stability of the glabella in other families and sub-orders emphasizes the genetic and classificatory value of the strong tendency towards the breaking up of the glabella into separate lobes shown in these two families», for which he provisionally institutes the suborder Odontopleurida. There are also some other points in which the two families resemble one another. As indicated by the larvæ of *Acidaspis tuberculata* (text-fig. 8 a) and *Lichas (Corydocephalus) consanguineus* (text-fig. 8 b), both families originated from forms with small eye lobes situated far forwards and outwards. The hypostoma of some species of *Acidaspis* is rather like that of some of the Lichadidæ. The thoracic pleuræ, it is true, are generally of a different type, inasmuch as the Lichadidæ have grooved, the Acidaspidæ ridged pleuræ, which character BEECHER (1897) mentions as one of the chief differences between these »closely related» families. As I have tried to show above (ps. 5, 6), the difference between the two types of pleuræ is not so very important, and some of the Lichadidæ, e. g. *Corydocephalus palmata,* have pleuræ which are of a type intermediate between the furrowed and the ridged ones, and rather like those in some of the Acidaspidæ. In the former the posterior bands of the pleuræ of the two foremost pygidial segments form swollen ridges. The same is the case with regard to the anterior segment of the pygidium in those members of the latter family in which the posterior pleural band of the thoracic segments is also more swollen than the anterior one. Whether these similarities prove a close relationship between the two families, which in many other features are rather differently specialized, is difficult to say, but it seems probable.

BEECHER (1907, p. 196) has also pointed out that many species of *Bronteus* have a glabella which is broken up into separate lobes. In this genus the axis of the pygidium is very much reduced and the lateral and posterior parts expanded. The author just mentioned considers that *Lichas* and *Acidaspis* show »the decline of these characters» (»the pygidial limb becoming more or less deeply lobed and finally the lobes are represented by spines»).

As SWINNERTON (1915, p. 545) points out, the Bronteidæ have fewer segments in the thorax and more in the pygidium than the Lichadidæ, i. e. that the caudalization has gone farther in the first-named family, which consequently cannot be regarded as representing the ancestral type of the latter. He does not consider that the Bronteidæ have descended from the Lichadidæ either, but that »they carry the Lichadid type of organization along lines parallel to and quite as advanced as some of those which characterized the Asaphidæ», and that therefore they »may be provisionally relegated to the sub-order Odontopleurida». Like the Acidaspidæ, the Bronteidæ have ridged pleuræ but of a rather different type. Their hypostoma is very unlike that of the former family and of the Lichadidæ, and the points of agreement between them and the two latter families are too slight to justify any conclusions as to their relationship.

The genus *Bronteopsis* WYV. THOMPS. has also been placed in the family Bronteidæ. The genotype *Br. scotica* SALT. (REED, 1904, p. 94, Pl. XIII, figs. 5—13, 1914, p. 26, Pl. IV, fig. 6) resembles *Bronteus* in most of its chief characters, though its pygidium has a longer axis, which, however, is continued by a narrow postaxial ridge as in this genus, and the ridges on the side lobes do not radiate from a centre, and die out before reaching the margin. Both in regard to the cephalon and the pygidium, this species seems to represent a transition form between *Bronteus* and *Bronteopsis ardmillanensis* REED (REED, 1904, p. 92, Pl. XIII, figs. 1—4, 1914, p. 26, Pl. IV, fig. 7). The latter has many points of resemblance with *Stygina latifrons* PORTL., and, as pointed out by WIMAN (1906, p. 294) and REED (1914, p. 27), especially with the species described as *Holometopus limbatus* ANG. and *Holometopus nitens* WMN, which species perhaps, as possibly also *Br. ardmillanensis*, ought to be referred to the genus *Stygina*, a question which will be further discussed below. *Stygina* has been placed by several authors in the family Illænidæ. Already SALTER (1864) has pointed out that »in the partial obliteration of the glabella, number of body rings, and course of the facial suture, it is closely allied to *Illænus*». Other points of resemblance are to be found in the form of the pygidium, the wide striated doublure of this and of the cephalon, and the broad rostrum [which is broader in *Styginia latifrons* than in *Illænus* (Cf. REED, 1914, p. 19, Pl. III, fig. 7)]. The hypostomata also seem to be of almost the same type. In the species referred to *Holometopus*, especially in *Holometopus limbatus*, the glabella is more strongly defined, and sometimes the furrows on the side lobes of the pygidium are slightly indicated.

Bronteus has also, as is well known, a broad rostrum and wide striated pygidial and cephalic doublures. Its hypostoma is somewhat different from the Illænid hypostoma, but is on the whole of the same type. The number of thoracic segments is the same as in some species of *Illænus*, and their pleuræ are without, or have only very slightly indicated furrows. The same tendency to the shortening of the pygidial axis is found in the Bronteidæ and in the Illænidæ. In consequence of the facts stated above, it seems probable that the two families have arisen from the same ancestral stock. *Stygina* and *Holometopus* probably also came from this stock. With regard to the long axis of their pygidium, the shape of their glabella, and its stronger limitation in the latter, they are evidently more primitive than *Bronteus* and *Illænus*. They cannot, however, be regarded as representing the ancestral type from which either of the two latter genera arose, since the obliteration of the furrows on the side lobes of the pygidium has gone farther than in *Bronteus*, and the position of the eye lobes seems to be less primitive than in *Illænus*. It does not therefore seem appropriate to refer them either to Bronteidæ or to Illænidæ. Neither can they be referred to Asaphidæ, in which family *Stygina* has been placed by some authors, since they evidently had a normally developed rostrum, though they agree with the Asaphidæ in regard to several other characters. Consequently they must be placed in a separate family, which then ought to be called Styginidæ (*Stygina* being the name earliest introduced, by SALTER 1852), which family appears to be rather closely allied to the Bronteidæ and to the Illænidæ, and further seems to form a connecting link between these and the Asaphidæ.

To the order Proparia SWINNERTON refers the families Encrinuridæ, Cheiruridæ, Phacopidæ, and Burlingiidæ, and further, with some hesitation, the Agnostidæ. In this order WALCOTT (1916) has also placed the families Menomonidæ and Norwoodiidæ, described by him after SWINNERTON's paper of 1915 was published. With the exception of Agnostidæ, Burlingiidæ is represented in older strata, Middle Cambrian and lower part of the Upper Cambrian, than any of the other families of this order, and the two genera referred to it, *Burlingia* WALC. (WALCOTT, 1908) and *Schmalenseeia* MBG (MOBERG, 1903), are also with regard to several characters the most primitive types. Both are very small, the length of the dorsal shield only about 7 mm. or less, which might indicate that the specimens found were larvæ; but of both genera, each only represented by a single species, there have been found several specimens, and no larger form which might be regarded as the adult of the same species evidently occurred among them.[1] The eye lobes are narrow and elongate and apparently primarily situated near the glabella. In *Burlingia* their foremost parts nearly reach to the glabella, while the distance between their hindmost ends and the posterior margin of the cephalon is somewhat less than half their length. The eye lobe is directed a little outwards, which also might indicate that they were not full-grown. In *Schmalenseeia* the eyes are shorter and situated farther away from the glabella, and it is thus in this feature less primitive than *Burlingia*, whereas its narrow glabella, which tapers anteriorly and has clearly defined furrows, is more larval in character than that of the latter, which is wider and more parallel-sided and where the furrows are indicated only by two pairs of pits. In both genera the anterior branches of the facial sutures are directed obliquely outwards, so that the foremost part of the cranidium is very wide. The posterior branches of the sutures run nearly parallel to the anterior ones, and cross the

[1] The same is the case with regard to the very small forms referred to the genus *Norwoodia* WALC.

lateral margins of the cephalon at rather a great distance from the genal angles, so that the free cheeks become very short. *Burlingia* has a thorax of 14 segments and a small elongate pygidium without defined furrows or side lobes; the anterior part, the axis, is more convex than the posterior part. In *Schmalenseeia* the number of thoracic segments is unknown. Pygidium large, axis with 6 furrows, side lobes divided by 6 pairs of ridges, according to MOBERG (1903) probably formed by the hindmost edges of the pleuræ of the pygidium. It is easy to conceive that this pygidium was formed by the fusion of the posterior thoracic segments and the primitive pygidium of a *Burlingia*-like ancestor.

The genera referred to the family Menomonidæ (WALCOTT, 1916) have no genal spines, the genal angles are rounded, and the posterior branches of the facial sutures cut the borders rather far backwards. Since these genera have many points of resemblance with the partly older, partly contemporaneous genera *Acrocephalites* WALLERIUS (see WALCOTT 1916, Pls. XXIV—XXVI) and *Alokistocare* LORENZ (Ibid. Pls. XXV—XXVI), of which at least some species have genal spines and the posterior branches of the sutures cutting the border within these, it seems as if the Menomonidæ ought rather to be regarded as belonging to Opisthoparia than to Proparia. It appears as if this family and also the two genera just mentioned might have belonged to the same stock as *Ptychoparia* and *Solenopleura*, though, in regard to the great number of thoracic segments (23—42) and small pygidium, they are more primitive than these latter.

In the Norwoodiidæ, only genus *Norwoodia* WALC. (1916), the proparian conditions are distinct. They have genal spines, and the posterior branches of the facial sutures cut the margins well in front of the genal angles. Their anterior branches are directed nearly straight forwards. The eye lobes are rather short and situated far forwards and at a comparatively great distance from the glabella. At least some species have eye ridges. The glabella is conical, generally marked with three pairs of short lateral furrows. Thorax with 8—9 segments. In several species some of the axial rings of the thorax and the neck ring bear spines. The pygidium is rather broad, including 4—6 segments. Like the Burlingiidæ the Norwoodiidæ are, as already mentioned, very small. The largest complete dorsal shield found is 11 mm. long.

As is well known, BEECHER (1907) referred the Agnostidæ (s. lat.) to the Hypoparia, whereas JAEKEL (1909) considered them to be highly specialized forms, in which, however, the small number of body segments was primary. WALCOTT (1912a, p. 195) thinks it »highly probable that the new genera *Mollisonia* and *Tontoia* will come within the family Microdiscidæ Coquin, 1896» (Agnostidæ s. lat. pars), and points out that in *Moll. symmetrica* WALC. the presence of eyes and facial sutures is suggested, and, since the course of the latter seems to be of the proparian type, SWINNERTON (1915) has referred the Agnostidæ to that suborder. Whether the genera in question are really closely related to the Agnostidæ, is difficult to say, though it seems possible. That the Middle Cambrian genus *Pagetia* WALC. (WALCOTT, 1916) belongs to these, appears beyond doubt. It differs from the typical members of this family only in having eyes, eye ridges, and true facial sutures on the dorsal side of the cephalon. The fixed cheeks are very broad, the eye lobes small, situated on a line with the middle part of the glabella, just inside the lateral border, of which the facial suture cuts out a short and narrow semicircular-shaped portion, the free cheek. The two branches of the suture are directed strongly outwards, the posterior one cutting the border well in advance of the genal angle. This confirms SWINNERTON's assumption that the Agnostidæ arose from true proparian ancestors. These evidently had normally developed eyes and free cheeks, and since there does not appear to have existed any adult trilobites with fully developed eyes in which the free cheeks were as small and situated as in *Pagetia*, it seems probable that the reduction of the eyes and free cheeks had already begun in this genus, and that it had proceeded farther in other Agnostidæ, so that the former had entirely disappeared. RAYMOND (1917) agrees with BEECHER's (1907) opinion that the Agnostidæ had ventrally situated free cheeks, and that this was a primitive character, and claims to have found intra-marginal sutures in some species of *Agnostus*. The part of the body in which he has observed the suture has, however, generally been considered to be the pygidium. Even if it should be proved that it is the cephalon, which does not seem probable, it is more likely that the position of the suture is secondary, the free cheeks never having become entirely reduced but part of their reflexed portions still remaining.

If *Mollisonia* and *Tontoia* belong to the same stock as the Agnostidæ, they would, with regard to the development of the parts concerned, represent an intermediate stage between *Pagetia* and other Agnostidæ, but with regard to the greater number of thoracic segments, of which there are 7 in *Mollisonia*, 4 in *Tontoia*, they are more primitive than the former, since presumably the Agnostidæ like all other trilobites arose from ancestors with many segments in the thorax.

None of the younger proparian families are very similar in character to the Cambrian ones, and thus cannot be regarded as descendants from these. In the less modified forms the glabella is elongate, rather parallel-sided and the furrows strongly marked. The Cheiruridæ and the Encrinuridæ agree in generally having ridged thoracic pleuræ, which like the pygidial ones as a rule have free ends; the cheeks are pitted, and this is also the case in some of the Phacopidæ. The hypostoma in the latter is of about the same type as in Cheiruridæ and in the genus *Cybele* LOVÉN, generally referred to Encrinuridæ. In *Encrinurus* EMM. it is rather different. With regard to the entire reduction of the rostrum, the development and position of the eyes, and the construction of the pygidium, in which the caudalization generally has proceeded very far, the Phacopidæ have reached the highest stage of development. In *Encrinurus* and in *Cybele* *bellatula* DALM. the rostrum is also very much reduced, whereas other species of *Cybele,* like the Cheiruridæ, have a broad rostrum.

Among the species which BEECHER (1907) referred to Proparia, he considered *Placoparia* CORD., *Areia* BARR., and *Dindymene* CORD. as the most primitive ones, because of their being blind and their having narrow free cheeks. These characters, however, are here, as in other cases, evidently secondary. The aforesaid author refers these genera to the family Encrinuridæ presumably on account of the circumstance that in several species of *Encrinurus*, which have small (probably secondarily reduced) eyes, the free cheeks have grown rather narrow. Of the former genera *Dindymene* shows the greatest similarities to *Encrinurus* and *Cybele;* especially its thorax and pygidium resemble those of the latter, though in *Dindymene* there are only 10 thoracic segments and two pairs of pleuræ in the pygidium, whereas *Cybele* has 12 segments in the thorax and 4 pairs of pleuræ in the pygidium.

Areia resembles the Cheiruridæ more than any other family both with regard to the construction of the thoracic segments and the pygidium, though the latter apparently consist of only 2 segments. The cephalon is very like that in *Cheirurus,* but the direction of the glabellar furrows is different. As a peculiarity should be mentioned that in *Areia bohemica* BARR. (BARRANDE, 1872, Pls. II, XVI, XXXII) the latter are continued by furrows across the cheeks similar to those found in several larvæ, e. g. *Liostracus* (text-fig. 6 e), *Elliptocephala* (text-fig. 4 a, b) and *Holmia* (KJER, 1916, text-fig. 11 a). Whether these furrows really correspond to the original limits of the pleural parts of the segments or have developed secondarily, is difficult to say. It might appear strange if these limits were still indicated in the adult of such a geologically young and otherwise rather specialized form. On the other hand the development of the cheeks has evidently, on account of the reduction of the eyes, partly remained in the larval stage, and consequently it is not quite inconceivable that also this larval character had remained. No free cheeks are known in this genus, and it is of course possible that they were not reduced, but that the sutures had disappeared. But to judge from the figures (BARRANDE, 1872, Pls. II, XI, XII, XVI and XXXII) it does not seem improbable that it had narrow free cheeks, which have not yet been found.

RAYMOND (1913a) places *Placoparia* together with *Pliomera* ANG. (*Amphion* PAND.) and *Pliomerops* RAYM. in the family Cheiruridæ, subfamily Pliomerinæ. The three genera agree with regard to their chief characters, except that the latter have eyes and normally developed free cheeks. From the other Cheiruridæ they differ in having the eyes, even when fully developed, situated farther from the glabella, in having a more reduced rostrum and a greater number of segments both in the thorax and in the pygidium. The ridges of the pleuræ are not furrowed; the posterior branches of the facial sutures cut the border farther back[1] than is generally the case in other Cheiruridæ, but this might be put in connection with the absence of genal spines. In the spineless species of *Encrinurus* the point of section is also situated farther back than in the spine-bearing species, and in *Cybele,* where the genal spines generally are not developed or very short, the point of section is very near the genal angle, and the same is the case in the spineless species of the Phacopidæ. In some of the above-mentioned characters, the Pliomerinæ agree more or less with the Encrinuridæ, and the denticulate frontal border of *Pliomera Fisheri* EICHW. forms also a point of resemblance with members of this family. It is questionable whether the Pliomerinæ ought not to be regarded as a separate family, though closely related to the Cheiruridæ and more distantly to the Encrinuridæ. Their existence indicates that the two latter families originated from the same ancestral stock, which assumption is confirmed by their resemblance in so many characters.

The similar construction of the exopodites in *Ceraurus pleurexanthemus* GREEN, *Calymene senaria* CONR., and *Acidaspis (Odontopleura) trentonensis* HALL (WALCOTT, 1918, ps. 148, 151, 153, Pls. XXVII, XXXIV) suggests that the Calymenidæ and the Acidaspidæ were more closely related to the proparian families just treated of than to some of the opisthoparian forms, in which the construction of the appendages was of a rather different type, as for instance *Neolenus* and *Triarthrus* (Cf. WALCOTT, 1918), which confirms the presumption that the Proparia and the Opisthoparia are not to be regarded as phylogenetic groups.

The Phacopidæ differ in most characters rather much from the Cheiruridæ and the Encrinuridæ, and, if they came from the same ancestral stock, they must have separated at a very early stage. It is not inconceivable that they are more closely related to some of the opisthoparian families than to other proparian forms, but they do not show particular affinities to any special group among them.

As shown by the statements made above, it does not seem possible, with our present knowledge, to establish any definite natural classification of the different trilobite families, and only an attempt is made to point out some facts which suggests that some of them are more closely related to each other, and may be grouped together. In agreement with this, BEECHER's order Hypoparia cannot be retained, and the same seems to

[1] In *Placoparia* the point of section is even somewhat in front of the genal angle, which might lead one to regard them as having originated from opisthoparian ancestors, if they were not in other characters similar to true proparian forms. In a young specimen of *Pl. Zippei* CORD. (BARRANDE, 1872, Pl. VIII, fig. 36), where the test is preserved, which according to BARRANDE (1872, p. 106) is generally not the case, the genal angles are continued by small points directed straight outwards. To judge from the figure (from the description one gets a conception contrary to this) they belong to the free cheeks. Evidently they do not, however, correspond to the genal spines in other trilobites, but are of the same nature as the denticules to be seen along the whole of the lateral border of *Pl. grandis* BARR. and on the frontal border of *Pliomera Fisheri* EICHW.

be the case with SWINNERTON's order Protoparia. With regard to Opisthoparia and Proparia they might be considered natural groups in one way, but probably not from a phylogenetic point of view, though the opisthoparian and proparian characters presumably were evolved at a very early period.

Among the oldest opisthoparian forms the Ellipsocephalidæ seem to represent one line of descent, to which probably *Protolenus,* possibly also the Olenidæ, belonged. Another line is represented by the Mesonacidæ and *Redlichia.* From the *Redlichia* stock the Paradoxidæ, the Zacanthoidæ *(Zacanthoides* and *Albertella),* and *Olenopsis* may be derived. From a Zacanthoid-like stock the Oryctocephalidæ and the Corynexochoidæ probably came, whereas the Ptychoparidæ, the Solenopleuridæ, and the secondarily blind forms referred to the family Conocoryphidæ seem to be more closely related to *Olenopsis.* The Calymenidæ and the Homalonotidæ form one group, possibly descended from the Ptychoparid stock. Another group includes the families Cyphaspidæ and Proëtidæ. The Styginidæ, the Bronteidæ, and the Illænidæ seem to be related to each other and perhaps to the Asaphidæ, with which the Bathyuridæ possibly ought to be brought together. Likewise the Acidaspidæ seem to be related to the Lichadidæ, and the Trinucleidæ to the Raphiophoridæ. That the Harpedidæ belong to the same line of descent as these latter, is hardly probable, but does not seem quite inconceivable. There are also some facts which suggest a relationship between the families Remopleuridæ, Telephidæ, and Aeglinidæ, though it appears more probable that the points of resemblance between them are due to adaptation for the same mode of life. The earlier proparian families, Burlingiidæ, Agnostidæ, and Norwoodiidæ, do not seem to be closely related either to each other or to the younger ones. Of these latter it appears as if Cheiruridæ, Pliomeridæ, and Encrinuridæ had the same origin, and it is possible that the Phacopidæ came from the same stock.

I have only had occasion to deal with a comparatively small number of trilobites in this paper, and it is probable that when the numerous Cambrian forms which are now known, principally owing to WALCOTT's researches, are more thoroughly examined and described, it will be possible to arrive at a better knowledge of the interrelationship of the trilobites, and it seems quite likely that several of the groupings suggested above will prove untenable.

Description of Genera and Species.

Family **Remopleuridæ** CORDA.

RAYMOND (1913 a) refers to this family the two genera *Remopleurides* PORTL. and *Caphyra* BARR. (*Amphitryon* CORD.) of which the latter also, by most authors, has generally been included in the genus *Remopleurides*.

Under the name of *Caphyra radians* BARRANDE (1846) first described as a tail the reversed glabella of this species, which in a later paper (1852) he has referred to *Remopleurides*, thus disagreeing with CORDA (1847) who had considered it a representative of a separate genus and changed the name to *Amphitryon Murchisonii*. SALTER (1853) retains BARRANDE's original name, and regards *Caphyra* as a subgenus of *Remopleurides* (s. lat.). According to him the difference between *Caphyra* and *Remopleurides* (s. str.) should consist in the former having 3 pairs of glabellar furrows, the furrows on the glabella of the latter being quite obsolete. This feature is, however, of minor importance, and besides there are some species which on account of their other characteristics must be referred to *Remopleurides* (s. str.), in which the glabellar furrows are quite distinct.

The chief characters in which *Caphyra* differs from *Remopleurides* (s. str.) are that it has broad, flat, free cheeks, the continuous anterior portions of which form a comparatively broad (from back to front) band in front of the glabella, broad and flat thoracic pleuræ without fulcral tubercle or notch, and a long pygidium with very short axis and elongated, backwards-directed, flat pleural part, evidently consisting of two pairs of pleuræ ending in short spines, the outer pair reaching farther backwards than the inner one. According to CORDA (1847) the number of thoracic segments should be different in *Remopleurides* and *Caphyra* (*Amphitryon*), the former having 13, the latter 11, but as BARRANDE (1852) has pointed out, this is evidently a misconception. It is true that PORTLOCK (1843, p. 254) states that *Remopleurides* has 13 thoracic »articulations, including the first, which appears a true thoracic segment, and the last, which is a small caudal segment». It is obvious that »the first articulation» is the occipital ring and the posterior borders of the cheeks and that there are only 11 thoracic segments both in the species on which he founded his description and in other species of *Remopleurides*, as far as they are known.

All the same, the differences between *Remopleurides* (s. str.) and *Caphyra* are so great that it seems correct to refer them to different genera, though it might be difficult, in such cases where only the cranidia are known, to decide to which of them they belong.

As already mentioned (p. 58), HADDING (1913) has compared *Remopleurides* (s. lat.) with *Telephus* and *Aeglina*. He states that on account of their many similarities the three genera must be regarded as representing a special type and that one might be tempted to refer them to the same family, but as on the other hand there are several rather essential dissimilarities, he comes to the conclusion that it seems most appropriate to let them represent different families. He is of the opinion that Telephidæ and Aeglinidæ are most closely allied to each other, whereas Remopleuridæ »through its finely, faceted eyes and lobated tail stands a little more isolated» (p. 45).

There can hardly have existed a very close relationship between the three families, but there are some points of agreement in addition to those pointed out by HADDING which deserve to be mentioned. The strong development of the eyes at the expence of the cheeks seems to be of less importance, since this character must be considered an adaptation for the same mode of life, and might have been attained independently. HADDING emphasizes in support of their relationship that the genera concerned appear simultaneously, and reach about the same vertical range. This seems, however, rather to explain their independent analogous evolution, since it indicates that they lived under similar external conditions. HADDING states further that *Aeglina* differs from the others in being devoid of a palpebral lobe, but this is not altogether correct, as, at least in most species of this genus, there is one, though it is very narrow.

In *Telephus* the fixed cheeks are rather broad, whilst the free ones are much reduced. In the Remopleuridæ the conditions are reversed, though the width of the free cheeks is rather different in the two genera of this family. In *Aeglina*, where the eyes are larger than in any of the other genera here in question, the fixed cheek as well as the dorsal part of the free one is very narrow. In *Aeglina* and in *Remopleurides* the rostrum appears to be entirely reduced, and the ventral parts of the free cheeks meet in front, forming a comparatively broad (from back to front) portion underneath the anterior part of the glabella, which generally is more convex than and clearly defined from the lateral parts of the doublure. Whether in *Telephus* the free cheeks meet in front, is not known, but it does not seem improbable that the conditions are the same as in the two genera just mentioned and that the median part of the doublure protrudes between the two downwards directed 'spines', thus having a strongly convex limit against the cranidium as in several species of *Aeglina*, e. g. *Aegl. prisca* BARR. and *Aegl. speciosa* CORD. (See BARRANDE, 1872, Pls. III and V.)

With regard to the short and wide form of the glabella the three genera resemble each other. As a rule the glabella is flatter in the Remopleuridæ than in the Telephidæ and Aeglinidæ, but in this respect the variations are rather great in the different genera. This is also the case with regard to the presence or absence of glabellar furrows, which, however, never are very strongly marked. As is well known, the anterior part of the glabella of the Remopleuridæ is produced into a tongue; this is, however, not so very strongly marked in all species, and also in some of the Aeglinidæ, where the eyes do not meet in front, the anterior part of the glabella is bent down and narrower than the posterior part. In *Telephus* the anterior spines correspond to this tongue. The thoracic segments in *Telephus* have no fulcral tubercle or notch; they resemble, however, those of *Remopleurides* (s. str.) more than the latter do those of *Caphyra*. The pygidium of *Telephus granulatus* ANG. (HADDING, 1913, Pl. I, fig. 10) somewhat resembles that of *Remopleurides* (s. str.), while the pygidia of other species of *Telephus* show more likeness to the Aeglinid pygidium. In *Telephus* the occipital ring and the axial rings of the thorax bear median spines, and in several species of *Remopleurides* there is a spine on one of the thoracic rings. In other species of this genus the pleuræ of one of the thoracic segments are prolonged into spines, which feature is also to be found in some species of *Aeglina*.

Whether the points of resemblance pointed out indicate a close relationship, is difficult to decide, since there are also so many dissimilarities. That the eyes are finely faceted in the Remopleuridæ while the facets are large in *Telephus* and *Aeglina*, seems to speak against a relationship between the former and the two latter, and so does the great difference in the number of thoracic segments in the Remopleuridæ and in *Aeglina*. The number of thoracic segments in *Telephus* is not known.

Under the name of *Remopleurides microphthalmus* LINNARSSON (1875, p. 494) described a *Remopleurides*-like cranidium that was found together with pygidia which, according to him, probably belonged to a species of *Dikelocephalus*. Together with cranidia of the same type have been found later on at the same locality pygidia and free cheeks which both HOLM (1897) and WIMAN (1903b) associate with the cranidium in question, and the latter points out that the pygidia mentioned by LINNARSSON probably also belong to the same species.

On account of the close resemblance between these pygidia and those of *Apatocephalus (Dikelocephalus) serratus* ANG. and *Apatocephalus (Dikelocephalus) finalis* WALC.[1] HOLM refers the species to the genus *Dikelocephalus*, and he also points out that the cranidium differs from that of *Remopleurides*, but is like the cranidium of *Apatocephalus serratus*. WIMAN is also of the opinion that the species concerned cannot be referred to *Remopleurides*, on the other hand he does not find that it resembles

[1] BRÖGGER (1896) has removed these and some other species from the genus *Dikelocephalus* and referred them to a separate genus, *Apatocephalus*.

Dikelocephalus resp. *Apatocephalus* so very closely, but refers it to a new genus *Robergia*. REED (1903, p. 33) seems to be of the opinion that the species, as represented by the cranidium, ought to be kept in the genus *Remopleurides*, and points out its close resemblance to the cranidium of *R. Barrandei* NICH. and ETHER., though in the latter there is no band in front of the tongue of the glabella, »but a similar band has», according to him, »been noticed in some Girvan specimens of *R. colbii*».[1]

REED (Ibid. p. 31) does not appear to believe that the pygidium described by HOLM and WIMAN belongs to the same form as the cranidium. But as far as one can see, there does not seem to be much reason to doubt that their presumption is correct. If it be so, the species in question cannot very well be referred to *Remopleurides*, since the pygidium evidently consists of more segments than in that genus, there being 3 pairs of pleural spines, whereas in the pygidium of *Remopleurides* there are only 2 pairs. The cranidium also differs from that of the latter genus in having a clearly defined anterior border, as is best shown in the figure given by MOBERG (1907, Pl. I, fig. 4), which is very unlike the indistinctly marked anterior band seen in *R. Nicholsoni* REED and in some other species of this genus (Cf. below ps. 83, 87).

Robergia seems to be more closely allied to *Apatocephalus*, though in most species referred to the latter genus there is a greater number of pygidial pleuræ ending in free spines and though there is a preglabellar field between the glabella and the anterior border of the cranidium and the anterior branches of the facial sutures are more divergent. Because of this it seems best to keep *Robergia* as a separate genus, at least for the present. This in correspondence with MOBERG's (1907, p. 86) opinion, who, however, points out that the difference between *Apatocephalus* and *Robergia* on the one hand and between the latter and *Remopleurides* on the other, is not so very great and who regards the three genera as belonging to the same line of descent, with *Apatocephalus* as the first and *Remopleurides* as the last link.

REED (1914, p. 15) comes to a similar conclusion regarding the relationship of the two latter, and calls attention to several points of agreement between the species of the two genera, the principal points of distinction being the presence of a preglabellar area on the cephalon of *Apatocephalus* and the absence of deflection in the tongue of its glabella. He further emphasizes that »there appears to be reason to believe that the pre-glabellar area has only been much reduced in *Remopleurides*». This presumption seems rather acceptable, especially as the reduction of this part (and perhaps of the rostrum) conceivably depended on the growth of the eyes brought about by the altered mode of life. On the whole there seems to be more reason to believe that the Remopleuridæ were allied to *Apatocephalus* than that their affinities were with *Telephus* or *Aeglina*.

[1] This Girvan form REED (1914) has later referred to a separate species *R. Nicholsoni*.

Genus **Remopleurides** PORTLOCK.

Of the 5 species of this genus found in the Leptæna Limestone 4 are represented only by isolated cranidia, which makes it difficult to decide whether they belong to *Remopleurides* (s. str.) or to *Caphyra,* but the former seems to be most probable, wherefore I have referred them to that genus.

Distinguishing characters of the species. —

1. Anterior tongue less than half as wide as posterior part of glabella 2.
Tongue more than two thirds as wide as posterior part of glabella 4.
2. Length of glabella about four fifths the width. Tongue strongly convex, about three fourths as long as wide 3.
Length of glabella two thirds the width. Tongue slightly convex (from side to side), about half as long as wide *R. latus* OLIN var. *kullsbergensis* n. var.
3. Posterior part of glabella very slightly convex. Test of all parts of cranidium distinctly striated *R. emarginatus* TQT.
Posterior part of glabella rather strongly convex. Test of cranidium not striated *R. dalecarlicus* HOLM in mus.
4. Glabella and occipital ring finely striated. Length of glabella seven eighths of width *R. latifrons* HOLM in mus.
Glabella and occipital ring not striated. Glabella as long as wide *R. minimus* n. sp.

Remopleurides latus OLIN var. **kullsbergensis** n. var. Pl. I, figs. 1—6, text-fig. 15.

Specific Characters. — Cephalon sub-semicircular. Glabella slightly convex, two thirds as long as wide, widest just behind middle; anterior tongue strongly arched down, rather slightly convex, parallel-sided, about one third the length of posterior part of glabella and less than half as wide as this; antero-lateral parts of tongue flattened, forming parts of narrow border, marked off by furrow interrupted in the middle; posterior part of glabella constricted at base. 3 pairs of lateral furrows present, placed at about the same distance from each other, all extending inwards to about the same distance, leaving an unfurrowed band down the middle, about one fourth the width of glabella. Anterior pair of furrows very short, directed obliquely backwards and inwards, its inner ends situated at about two thirds the distance from the occipital furrow to the tongue of the glabella. 2d pair directed more straight inwards, slightly curved, situated opposite middle of eye, ending at a little distance from lateral margin of glabella. Basal pair not reaching quite so far outwards as 2d, its outer parts parallel to it, the inner parts directed more backwards, ending at a distance from the posterior margin about equal to the distance between the furrows. Palpebral lobes, marked off by strong furrows; narrow, widest at base, their anterior parts, at sides of tongue, very narrow. Where the test of the glabella is preserved, it is seen to be finely striated except on the middle of tongue, where the test is smooth. Occipital furrow narrow, well marked. Occipital ring flattened, slightly arched from side to side, narrowing at each side outside base of glabella, finely denticulated on posterior edge; test not preserved, but presumably striated as on other parts of the body. Posterior parts of facial sutures abruptly bent outwards.

Eyes large, vertically bent down, semi-annular. At the front end as wide (high) as the tongue is long, gradually narrowing towards base of glabella, composed of numerous very small, closely set lenses. Below the eye there is a narrow, raised lower eye lid, marked off from the outer part of the free cheek by a strong furrow. Outside this the anterior dorsal part of the free cheek forms only a narrow border. Posterior part of cheek (text-fig. 15) triangular, slightly bent down, ending in slender tapering spine, the length of which is not known. Inner part of cheek gently arched, outer (lateral border-part) and spine flattened. As in several other species of this genus, spine not arising from true genal angle, which is slightly prolonged, but in front of it, its inner margin meeting lateral margin of hindmost portion of cheek (posterior border) at acute angle. This hindmost portion at a lower level than spine and anterior part of cheek, from which latter its inner part is separated by strong furrow. Its posterior edge near dorsal furrow with deep notch, the margin of which is raised, to receive fulcral tubercle of anterior thoracic pleura, just as in the pleuræ of the thorax. On the whole this posterior portion of the cheek is shaped very like the anterior bands of the thoracic pleuræ, the furrow in front corresponding to the pleural furrows and like these not reaching the margin. Test of cheek ornamented with sub-parallel striæ, towards the margin the parts between the striæ are raised, forming narrow ridges; direction of striæ longitudinal except on hindmost portion of cheek, where they bend and take an inward direction. Doublures of free cheek meet in front, underneath tongue. They do not seem to have grown quite together, since there are traces of a median connective suture to be seen. Whether it is a real open suture or only a groove, I have not been able to decide. Middle portion of doublure, underneath tongue, clearly set off from lateral parts, broader (from back to front) than they, and gently convex with anterior margin arched forwards and posterior edge produced into short rather bluntly ending tip. Doublure striated as dorsal part of cheek, but, except at anterior half of median part, the ornamentation is coarser, the ridges being higher and broader.

g. 15. *Remopleurides latus* OLIN var. *kullsbergensis* n. var. Free cheek ×4.

Only 8 thoracic segments and part of the 9th preserved (probably there were 11 as in other species of *Remopleurides*); they decrease gradually in size posteriorly. Axis moderately convex, tapering towards pygidium, 8th axial ring having three fourths the width of 1st one, which is about as wide as occipital ring; along the whole of its length about three fourths the width of thorax. Rings flattened, with transverse, slightly sinuous striæ (where the test is preserved), lateral parts of posterior edge finely serrated. Side lobes narrow, diminishing in width posteriorly. Pleuræ falcate, directed downwards and backwards with short, free, recurved points; pleural furrows oblique, deep, and broad, not reaching margin; anterior pleural band near dorsal furrow with strong projecting fulcral tubercle; posterior edge of pleura with corresponding notch, the margin of which is raised all round. Surface of pleuræ ornamented by striæ, sub-parallel to margin.

Pygidium as wide as long (from articulating furrow to ends of posterior pleural spines). Axis composed of 2 segments, convex, gradually sloping posteriorly, a little less than half the length of pygidium and more than two thirds the width, backwards continued by indistinctly defined, triangular post-axial portion. Axial furrows outside foremost part of axis indistinctly marked, posteriorly becoming deeper and broader, reaching to post-axial portion. 1st axial ring with clearly defined articulating half ring; posterior part very short in the middle, widening towards the sides. Posterior part of axis consisting of a pair of slightly swelled sub-elliptical portions, anteriorly almost meeting in the middle line, posteriorly separated by a more flattened triangular piece, separated from post-axial portion by very fine furrow uniting axial furrows. Side lobes composed of 2 pairs of pleuræ. 1st pair falcate, directed nearly straight backwards, ending in short spines and with rather weakly marked pleural furrows; front edge with fulcral knobs, fitting into notches on last thoracic segment.[1] 2d pair of pleuræ separated from 1st pair by weak interpleural furrows and directed backwards, ending in longer and more sharply pointed spines, enclosing an acute angle; no peural furrows present. Surface of pygidium ornamented with fine striations, the posterior and median parts also by minute tubercles; on 1st pair of pleuræ the striæ are longitudinal, on axis and on anterior parts of 2d pair of pleuræ, transverse, but on the spines of the latter they bend, and take a more longitudinal direction.

R e m a r k s. — The material on which the above description is based consists of the specimen of the cephalon and part of thorax figured on Pl. I, figs. 1—4, the pygidium figured on the same plate, figs. 5—6, and an inner cast of part of the free cheek with rather a large portion of the spine preserved. All three specimens are from the same locality, Kullsberg

[1] This feature has not come out distinctively in the figures (Pl. I, figs. 5, 6), but the knobs are like those on the last thoracic segment seen in the same figures and those in the figure of the pygidium given by WIMAN (1907, Pl. VIII, fig. 26).

(the pygidium and cast of cheek found in the same piece of rock), and that they belong to the same species, seems to be beyond doubt.

In OLIN's figures of *R. latus* OLIN (OLIN, 1906, p. 55, Pl. II, figs. 5—9) from the Chasmops beds in Skåne, the glabella is broader, the tongue especially, which is about as wide as the base of the glabella, in var. *kullsbergensis* considerably narrower; the striation continues all over the tongue, and is said to be coarse; the palpebral lobes are broader, and the side lobes of the thorax also seem to be broader. At least one of the thoracic rings bears a median spine, but as this probably was the 9th as in the allied *R. Nicholsoni* REED (REED 1903, p. 36, Pl. V, figs. 17a, b and 1914, p. 12, Pl. II, figs. 3—9, in the earlier paper described as *R. Colbii* PORTL.), this fact is of no consequence, since the segment in question is not preserved in the specimens from Dalarne. Otherwise these seem to correspond rather well with the form from Skåne, as far as this one is known.

The pygidium appears to be very like that figured by OLIN on Pl. I, fig. 29 as *Lichas quadrispinus* ANG., which beyond doubt is a *Remopleurides*, and, as WIMAN (1907a, p. 134) has pointed out, probably belongs to *R. latus*. It also very much resembles the pygidium of this species found in Östersjö Limestone from the North Baltic Area figured by WIMAN (1907, Pl. VIII, fig. 26); in fact, the agreement is closer than it appears from the figures. In WIMAN's figures (Ibid. figs. 25, 27) of the cranidium, the glabella is narrower than in OLIN's, and it has also a comparatively much narrower tongue, thus being more in correspondence with the variety from Dalarne, though the form of the posterior part of the glabella is a little different and the tongue seems to be more protruding.

Because of the facts stated above, it appears reasonable to regard the form in question as a variety of *R. latus*. Possibly WIMAN's specimens ought to be referred to this variety rather than to the type form.

ANGELIN's species *Lichas quadrispinus* was founded only on the pygidium, the figure of which (ANGELIN, 1878, Pl. XL, fig. 20) agrees rather well with the pygidium of the species in question; quite likely it belongs to it. Since, however, other species of *Remopleurides* have similar pygidia, it is not certain, wherefore it seems best to allow his specific name to be forgotten and keep the name given by OLIN.

Affinities. — This species appears to be very closely allied to the Grivan form *R. Nicholsoni*. The greatest difference is to be seen in the pygidia, that of *R. Nicholsoni* having the side portions of the posterior axial part much more swollen and the post-axial portion forming a distinctly marked, narrow, pointed ridge. The posterior part of the free cheek of this species does not seem to end in a produced tip as in the form from the Leptæna Limestone. The tongue of the glabella and the side lobes of the thorax are wider than in this. In these characters it agrees more with the type form, and the form of the glabella is rather like that in OLIN's Pl. II, fig. 6, but it does not appear to be striated, and the striæ on the occipital ring are said to be very delicate. There are only 2 pairs of lateral glabellar furrows present; this, however, may depend on the 1st pair not yet being observed. It is possible that the Girvan form belongs to *R. latus,* but until this latter is more completely known, this is impossible to decide.

The presence of a median spine on one of the thoracic segments, recalls *R. dorsospinifer* PORTL. (SALTER, 1853, Pl. VIII, figs. 3, 4), though in this species the spine belongs to the 8th segment, not to the 9th as in *R. Nicholsoni* and probably also in *R. latus,* since in the var. *kullsbergensis* the 8th is not spine-bearing. As REED (1914, p. 14) points out, the pygidium in both the two latter species also resembles SALTER's figures of the pygidium of *R. dorsospinifer.*

The presence of a subgenal notch on the free cheek, is a character found both in *R. latus* and *R. Nicholsoni,* and also in other species of *Remopleurides,* e. g. *R. sexlineatus* ANG. (OLIN, 1906, p. 55, Pl. II, figs. 3—4), *R. (Teratorynchus) bicornis* REED (REED, 1903, p. 33, Pl. V, figs. 5—16). It is also met with, though less pronounced, in *Apatocephalus,* e. g. *A. pecten* WMN (WIMAN, 1905, p. 6, Pl. I, figs. 7—12), which, as emphasized by REED (1914, p. 15), confirms the presumption that the two genera are allied to each other.

REED also points out that a similar feature is found in some of the Mesonacidæ, »and therefore it is to be regarded as of a primitive or reversionary nature». In these, however, the conditions do not seem to be the same. In the former both the genal angle and the spine belong to the free cheeks, whereas in the latter the genal angle, inside the spine, appears to belong to the fixed-cheek region, and probably indicates the vestige of the reduced intergenal spine, as confirmed by the comparison of different forms where the genal spine is not situated at the genal angle and in which the reduction of the intergenal spine has proceeded differently far [Compare for instance WALCOTT's (1910) figures of the cephala of *Wanneria Halli* WALC. (Pl. XXXI), *Olenellus Gilberti* MEEK (Pl. XLIII) and *Olenellus fremonti* WALC. (Pl. XXXVII, XXXVIII)].

Locality. — Kullsberg.

Remopleurides emarginatus TÖRNQUIST. Pl. I, figs. 9—11.

1885. *Remopleurides emarginatus,* TÖRNQUIST, p. 37, Pl. I, fig. 39.
?1894. *Remopleurides emarginatus,* SCHMIDT, p. 89, Pl. VI, figs. 37—38.

Specific Characters. — Glabella very slightly convex, three fourths as long as wide, widest in middle of posterior part; tongue strongly arched down, rather convex, about one third the length of posterior part of glabella, nearly parallel-sided, about half as long as wide, anterior edge slightly excavated in the middle, its lateral parts flattened, marked off by short furrows, which do not meet; posterior part of glabella transversely sub-oval, constricted at base. Surface of glabella with fine, but very distinct, transverse, sinuous striæ. On some specimens the striation is interrupted so as to indicate the course of the 3 pairs of lateral glabellar furrows not otherwise marked and having about the same position and direction as in *R. latus* var. *kullsbergensis*. Palpebral lobes marked off by strong furrows, somewhat broader than in the form just mentioned, gradually decreasing in width anteriorly, finely striated. Occipital furrow sharply marked. Occipital ring flattened, narrowing towards the sides, middle part behind occipital furrow slightly arched, lateral parts, which are cut obliquely by posterior parts of facial sutures, more strongly bent down. Surface striated as glabella and minutely serrated at posterior edge, except just in the middle. Minute median tubercle near anterior margin.

Remarks. — The above description is based on the same specimens as TÖRNQUIST's, 10 cranidia all from the same locality, Boda. There is another badly preserved cranidium from Skattungbyn, which probably belongs to this species. Whether the specimens referred to *R. emarginatus* by SCHMIDT (1894) belong here, is not possible to decide from his brief description and rather indistinct figures, but as far as one is able to judge, it seems probable.

Affinities. — Since of this and of the following forms, which will be described below, only the cranidia are known and since these are of about the same type in several of the Remopleuridæ, it is not possible to decide their affinities, not even to say for certain whether they belong to *Remopleurides* (s. str.) or to *Caphyra*, though the former seems most probable.

Localities. — Boda, Skattungbyn(?).

Remopleurides dalecarlicus HOLM in mus. Pl. I, figs. 7—8, Pl. XI. fig. 34.

Remarks. — In the State Museum of Nat. Hist. Stockholm, there is a cranidium of a *Remopleurides* from Osmundsberget labelled by HOLM *Remopleurides Darlecarlicus* nov. sp., and at the same locality the present writer has found another cranidium similar in character, though much smaller. They differ from the cranidium of *R. emarginatus* chiefly in having the posterior part of the glabella and the occipital ring comparatively strongly convex, the glabellar furrows more distinct, though not impressed, and a smooth test, except that there is a small tubercle on the occipital ring and that the posterior edge of this latter is denticulated. The denticules are coarser, and continue farther inwards than in *R. emarginatus*, and to judge from the largest specimen, which is 14 mm. long, this form seems to reach larger dimensions than that species.

Locality. — Osmundsberget.

Remopleurides latifrons HOLM in mus. Pl. I, figs. 12—13.

Specific Characters. — Glabella slightly convex, about seven eights as long as wide, widest behind middle; tongue rather strongly bent down, moderately convex, nearly one third as long as posterior part of glabella and more than two thirds as wide, about one third as long as wide, decreasing somewhat in width towards anterior margin, which is gently arched upwards. Posterior part of glabella transversely sub-oval; basal portion comparatively broad, but very sharply set off. Surface of glabella with fine, transverse, sinuous striæ strongest marked at basal and lateral parts, hardly discernible on middle of tongue. 3 pairs of lateral glabellar furrows directed nearly straight outwards, indistinctly marked by interruptions in the striation, similarly placed as those in the species described above, all extending about equally far inwards, leaving a comparatively wide unfurrowed portion down middle of glabella. 1st pair very short, nearly straight; 2d pair slightly curved, reaching near to lateral margin of glabella; 3d pair somewhat shorter than 2d, rather strongly curved. Palpebral lobe marked off by strong furrow; rather narrow, decreasing in width anteriorly; not striated. Occipital furrow deep, but rather narrow. Occipital ring flattened, slightly narrowing towards the sides, gently arched, striated as the glabella, but, as far as can be seen on the specimen, which is not perfectly preserved, without median tubercle and with smooth posterior edge.

Remarks. — The cranidium described above belongs to the State Museum of Nat. Hist. Stockholm, and is labelled by HOLM, *Remopleurides latifrons* nov. sp. Dalarne (Lept. k.). It seems probable that it is from Osmundsberget or possibly from Boda.

Remopleurides minimus n. sp. Pl. I, figs. 14—15.

Specific Characters. — Glabella sub-elliptical in outline, slightly convex, about as wide as long, widest near base, tapering anteriorly to tongue, which is not very distinctly set off but distinctly arched down and rather strongly convex (from side to side). It is about one third as long as posterior part of glabella and, at the base, about four fifths as wide, tapering slightly towards edge, about three fourths as long as middle width; margin slightly arched upwards. Basal part of glabella rather indistinctly set off. Under a high magnifying power the anterior portion of the glabella is seen to be ornamented with transverse sinuous striæ, the posterior portion with minute tubercles. No traces of lateral glabellar furrows to be seen. Very little of the palpebral lobe is preserved, but it seems to be of the type common in this genus. Occipital furrow strongly marked. Occipital ring flattened, comparatively broad (from back to front), and gently arched. It is badly preserved, so that one cannot see whether it was ornamented.

Remarks. — The smallness of the cranidium described above, of which only a single specimen is found, suggests that it might have belonged to a young individual, but because of its rather unusual form, it cannot be referred to any species yet known. Of the species from the Leptæna Limestone it most resembles *R. latifrons,* which probably is from the same locality, but the glabella is comparatively longer, its basal parts and the tongue not so sharply set off.

Locality. — Osmundsberget.

Family **Telephidæ** ANGELIN.

Genus **Telephus** BARRANDE.

Telephus Wegelini ANGELIN. Pl. I, figs. 16—18.

1854. *Telephus Wegelini,* ANGELIN, p. 91, Pl. XLI, fig. 23.
1885. *Telephus fractus*, TÖRNQUIST, p. 89.
1913. *Telephus Wegelini,* HADDING, p. 40, Pl. II, figs. 18—19.

Characters of cranidium from the Leptæna Limestone. — Cranidium about two thirds as long as wide. Axial furrows outside occipital ring very shallow, outside glabella deep and gently arched upwards, at first slightly, but gradually getting more strongly convergent; at the anterior margin of glabella they bend nearly straight inwards and somewhat downwards, and are united by the short, nearly straight, and considerably narrower preglabellar furrow. Glabella slightly more wide than long, oval, truncated at base, rather swollen, highest just in front of occipital furrow, posteriorly slightly keeled, front part somewhat overhanging. On the sides of the glabella rather far forwards, there is a pair of very shallow, hardly discernible impressions recalling the more distinct impressions in some other species of this genus, e. g. *T. Mobergi* HADD. (HADDING, 1913, p. 37, Pl. II, figs. 12—17), *T. americanus* BILL. (Ibid. p. 41). Another slight impression is seen near the base of the glabella on one side, on the other the test is not preserved at the corresponding place. Probably these impressions represent the glabellar furrows. Occipital furrow shallow, rather broad, not reaching axial furrows, its middle part slightly arched forwards, its lateral parts backwards. Occipital ring broad in the middle (from back to front), tapering towards the sides; convexity of anterior edge about the same as of posterior part of glabella, postero-lateral portions more strongly bent down and flattened, antero-lateral portions gently rounded; different portions separated by fine furrow, which disappears at base of median spine, which latter is broken off in this specimen. Glabella and occipital ring ornamented with sparse tubercles and net of very fine ridges, except at impressed places on glabella, in the anterior pair of which are a few rounded pits irregularly distributed. Doublure of occipital ring with fine transverse striæ.

Fixed cheeks gently bent down, rather narrow, widest just behind front of glabella, gradually decreasing in width posteriorly to posterior margin; this continues far outside part in front, is rather strongly bent down and obliquely cut off by posterior branch of facial suture, which here takes a sharp turn outwards. Anterior margin of cheek directed somewhat backwards; antero-lateral angle rounded. Inner part of cheek rather flat in the middle, sloping down towards the margin. Inner anterior portion with net of ridges coarser than on glabella, a more strongly raised ridge along lateral and posterior margins. Palpebral lobe set off by clearly marked furrow, extending round anterior and lateral margins of inner part of cheek, flattened, slightly bent down at antero-lateral angle, rather broad in front, gradually tapering posteriorly. Anteriorly it continues underneath overhanging anterior portion of glabella along foremost part of dorsal furrow. Where this furrow meets preglabellar furrow (which here is the same as the anterior border furrow of cephalon, since there is no preglabellar field), the palpebral lobe bends steeply downwards, forming, together with lateral part of narrow, more swollen, and strongly arched anterior border, the small anterior spine characteristic for this genus.

Remarks. — Only one imperfect cranidium of this species is known from the Leptæna Limestone. It belongs to the Museum of the Geol. Survey of Sweden, and is labelled by LINNARSSON *Telephus superstis* n. sp., but since it is very similar in character to *T. Wegelini* from the Black Trinucleus Shales in Dalarne, there does not seem to be any reason to refer it to a separate genus.

The difference as to the form of the glabella and the direction of the margins of the free cheeks, of the occipital furrow and of the anterior spines to be noted between HADDING's and my figures, is evidently due to the fact that the former are drawn after specimens which are very much pressed. I have examined several specimens in Black Trinucleus Shales from Amtjärn in Dalarne and found that some of them, which are not so much pressed, agree very closely in these characters also with the specimen from the Leptæna Limestone. This latter has about the same size as the larger of those found in the shales.

Affinities. — Only the cranidium of *T. Wegelini* is known as yet, but as far as one can judge from this one, the species seems to be very closely allied to *T. fractus* BARR. (BARRANDE, 1852, p. 891, Pl. XVIII, figs. 30—34), and TÖRNQUIST has even referred the Swedish form to that species, but, as HADDING has already pointed out, this does not seem correct. In *T. fractus*, as figured, the glabella is shorter and broader, more parallel-sided, its anterior end is more truncate, and there does not appear to have been any lateral impressions (Cf. HADDING, op. cit.).

Moreover the Bohemian form seems to attain much larger dimensions than the Swedish one.

Localities. — The species is only known from Dalarne, where it is found in the Leptæna Limestone at Boda and in the Black Trinucleus Shales at Amtjärn, Skattungbyn, and Vikarbyn.

Family **Asaphidæ** BURMEISTER.

Genus **Brachyaspis** SALTER.

Brachyaspis? Leptænarum n. sp. Pl. XI, fig. 20.

Specific Characters. — Pygidium rounded in outline, about three fourths as long as wide, slightly convex. Axial furrows very shallow, dying out posteriorly. Axis in front about one third the width of the pygidium and extending fully six sevenths its length, tapering rather rapidly at first; posterior part nearly parallel-sided, very slightly convex, ending with a hardly raised apex; front margin gently arched forwards;[1] faint traces of 5 axial furrows to be seen, the 1st, the articulating furrow, a little more strongly marked than the following. Side lobes gently and gradually bent down, without concave border; 1st pair of pleural furrows rather broad but shallow, in front of them anterior edges of side lobes slightly raised. In a certain light traces of posterior furrows may be seen. Fulcrum situated at about one third the distance from axis to lateral margin. Doublure ornamented with closely set sub-parallel striæ, rather wide, at middle of pygidium extending about halfway underneath side lobe; marginal portions of anterior parts slightly concave, inner portions of these and posterior part convex. Test not preserved.

Remarks. — This single pygidium from Osmundsberget is the only representative of the family Asaphidæ found in the Leptæna Limestone. I have been rather doubtful what genus to refer it to. It cannot be an *Isotelus* DEKAY, since its surface does not show any traces of a concave border, but may belong either to *Brachyaspis* SALT. or to *Onchometopus* SCHM. (Cf. RAYMOND, 1912, p. 115, 1914b, p. 258).

In the genotype of the latter *Onch. Volborthi* SCHM. (SCHMIDT, 1901, p. 82, Pl. X, figs. 9—12) from the East Baltic Silurian Area, the pygidium is, however, much more convex, and this seems to be the case also in the American species referred to this genus (RAYMOND, 1910a, p. 64, RAYMOND and NARRAWAY, 1910, p. 51). Moreover SCHMIDT's form, which is the only European species of *Onchometopus* known, is found in much older strata (B_2).

[1] A little more of the anterior edge of the pygidium is preserved than is seen on the figure. After this was printed, I have been able to extricate part of the right side (to inner margin of doublure) from a piece which was broken off when the rock was split.

Brachyaspis, on the other hand, occurs in strata of about the same geological age as the Leptæna Limestone of Osmundsberget both in Europe and America, and the convexity and general appearance of the pygidium in question, is more in accordance with the pygidia of the species referred to this genus than to that of *Onchometopus.* It is narrower than the pygidia of *Br. lævigatus* ANG. (ANGELIN 1878, p. 53, Pl. XXIX, fig. 1) and *Br. rectifrons* PORTL., SALTER's (1866, p. 166, Pl. XXV, figs. 6—10) genotype — which, according to SCHMIDT, is identical with *Br. robustus* RÖM. (SCHMIDT, 1901, p. 93, Pl. XI, figs. 9—11, Pl. XII, figs. 3—4) — the ratio of the length to the width being about the same as in *Br. notans* BILL., as figured by RAYMOND (1912, Pl. I, fig. 1). In this latter, however, the course of the facial sutures seems to be somewhat different, and there does not appear to be any traces of ring furrows on the axis. These facts seem to indicate that the pygidium from Osmundsberget belongs to a species of *Brachyaspis,* though it cannot be referred to any of those previously described.

Locality. — Osmundsberget.

Family **Styginidæ** n. fam.

Cephalon and pygidium sub-equal. Glabella expanding in front, without distinct furrows. Eyes small and close to the glabella and to the posterior margin of the cephalon. Rostrum large. Facial suture cutting the posterior margin of the cephalon well inside genal angle. Thorax of 9 segments, with smooth pleuræ. Pygidium with long, indistinctly annulated axis, continued by narrow post-axial ridge, and generally smooth side lobes.

Remarks. — To this family the species attributed to the genera *Stygina* SALT. (1852) and *Holometopus* ANG. (1854) are referable, possibly also the form described as *Bronteopsis ardmillanensis* REED (REED, 1904, p. 92, Pl. XIII, figs. 1—4, 1914, p. 26, Pl. IV, fig. 7).

In a paper on *Holometopus* ANG. WIMAN (1906) points out the close resemblance between *Holometopus limbatus* ANG. and *Stygina latifrons* PORTL. on the one hand and between the former and *Bronteopsis ardmillanensis* on the other. When describing the latter species REED (1904, p. 93) had emphasized the great similarity between its pygidium and some (Pl. V, figs. 17, 19) of those found in Borkholm Limestone and attributed by WIMAN (1901) to *Stygina latifrons.* According to REED the latter might also be referable to *Bronteopsis,* which WIMAN (1906) »auch unter gewissen Bedingungen für möglich halte». WIMAN expresses the opinion that »*Holometopus limbatus* A. entspricht ganz gut dem, was die Engländer unter *Bronteopsis* verstehen», but points out that ANGELIN's generic name is older than the name of *Bronteopsis* and that there is still another name which might be thought of, viz. *Stygina,* which name was introduced already 1852. He comes, however, to the conclusion that the whole discussion had better be postponed until there is found more of the species concerned, the purpose of his paper being only to draw ANGELIN's genus into notice, which was rather needful, as it was impossible to get a true apprehension of its character from ANGELIN's figures and descriptions only.

Even if it is not possible as yet to solve the question of the interrelationship of these forms, the new material gathered since WIMAN's paper was published, might justify some further discussion.

One of the characteristics of *Br. ardmillanensis* is that the axis of the pygidium is continued by a narrow post-axial ridge. This feature is also distinct in the pygidia mentioned above, which WIMAN has attributed to *St. latifrons,* and this fact seems to be REED's chief reason for regarding them as belonging to *Bronteopsis,* since a ridge evidently is not observed in the English specimens of *St. latifrons* (SALTER, 1864a, REED, 1904 etc). Neither can it be seen in the one figured by LINNARSSON (1869, Pl. II, fig. 41). As WIMAN (1901, p. 172) has pointed out, this might, however, be due to the state of preservation. LINNARSSON's specimen, which I have had occasion to examine, is rather pressed, and the same appears to have been the case with those figured by SALTER (Cf. SALTER, 1866, explanation of Pl. XVIII). In the individual figured by WIMAN in his paper of 1907 (Pl. VIII, fig. 1), this part of the pygidium is broken off, but in another small pygidium, which, like the specimen just mentioned, is found in Östersjö Limestone from the North Baltic Area, the ridge is clearly to be seen. That it belongs to the same species, is evident, and it is likewise indubitable that this form is identical with the English *St. latifrons,* or at least very closely allied to it. The only difference worth mentioning is that the genal spines are a little longer, otherwise the characters are the same. In the large cranidia the glabella is very obscurely defined anteriorly, but in a very small one it is more distinctly marked, which is quite in accordance with SALTER's description.

REED was evidently of the opinion that one of the pygidia (Pl. V, fig. 18) and the cranidia (Pl. V, fig. 16 and Pl. VII, fig. 17) figured by WIMAN 1901 belonged to *St. latifrons* (Cf. REED, 1904, p. 93 and 1914, p. 27). The only difference between this pygidium and those (Pl. V, figs. 17, 19) which, according to his opinion, might be referable to *Bronteopsis,* is that in the former the posterior part of the border is removed so as to show the striation of the underside of the doublure, and consequently the post-axial ridge cannot be seen on it. That all the pygidia and cranidia here in question belong to the same species, seems beyond doubt, and likewise that this form is very closely allied to *St. latifrons* PORTL. even if possibly not identical, there being some slight differences, which, however, hardly seem to be of specific value.

The pygidium of *Holometopus limbatus* ANG. is of quite the same type as those just mentioned, and also its cephalon resembles very closely that of *St. latifrons,* though the glabella is less expanded in front and more convex — its anterior as well at its posterior part being very sharply defined — and though the genal spine is not so sharply set off, the cranidium ornamented with transverse sinuous striæ instead of pits, and the occipital furrow more strongly marked. This form seems to have been smaller than *St. latifrons,* the largest cranidium found has about two thirds the length of that figured by SALTER, 1864a, Pl. II, fig. 1.

In *Holometopus nitens* WMN (WIMAN, 1907a, p. 112, Pl. VII, figs. 19, 20) and in the form found in the Leptæna Limestone which I have called *St. angustifrons* (This paper, Pl. III, figs, 1, 2), the post-axial ridge on the pygidium is distinct, and it appears as if this ridge was present also in *St. Murchisoniæ* MURCH. (SALTER, 1866, p. 173, Pl. XVIII, fig. 11).

In *St. angustifrons* the ratio between the frontal and basal width of the glabella is about the same as in *Hol. limbatus,* though the glabella is comparatively longer and less convex, its anterior part less strongly, though quite distinctly, defined. The cranidium, of which only one specimen is found, has about the same length as that on SALTER's figure just mentioned. In the single cephalon of *Hol. nitens* the cranidium is about half as long, the form and limitation of its glabella is about the same as in the young specimen of *St. latifrons* from the East Baltic Area mentioned above, which, however, is considerably smaller, but the form of the free check is more like that of *Hol. limbatus.*

The test both on the cranidium and on the pygidium of *Hol. limbatus,* is striated, but in some places the ridges between the striæ have grown together so as to include rounded pits. The same kind af ornamentation is seen on the pygidia from the Borkholm Limestone, though in these the pits, except on the border part, are rather more abundant than the uninterrupted striæ. On the cranidia associated with these as well as on the cranidia and pygidia of most other forms here in question, as far as their ornamentation is known, the fusion of the ridges has proceeded still further, so that the whole surface is pitted, or only a few striæ are to be seen.

Nothing of the thorax is known of the two species here mentioned, previously referred to *Holometopus,* as little as of the form which I have called *Stygina angustifrons,* but to judge from the material available, there does not seem to be any reason why they should not be included in the genus *Stygina* SALT., since they evidently agree with the genotype in their chief characters. As to the other forms included under *Holometopus, Hol.? elatifrons* ANG., which species ANGELIN (1854) placed under this genus with a mark of interrogation, is referred by BRÖGGER (1896) to the new genus *Orometopus* BRÖGG., and of the others only the pygidia are described. Some of these might possibly be referable to *Stygina* [*Hol.? lævis* POMP. (POMPECKJ 1890, Pl. V, fig. 9) is probably, as WIMAN (1906, p. 294) has pointed out, identical with *St. (Hol.) limbatus* ANG.] but until more of them is known, this seems impossible to decide.

Regarding the relation between *Stygina* and *Bronteopsis*, the genotype of the latter, *Br. scotica* SALTER (REED, 1904, p. 94, Pl. XIII, figs. 4—13, 1914, p. 26, Pl. IV, fig. 6), is evidently, as is generally considered, much more closely allied to *Bronteus* than to *Stygina* though not referable to that genus. *Br. ardmillanensis*, on the other hand, seems to agree in most characters with the species referred to the latter genus. The chief points of difference appear to be that the pleuræ (or ribs?) on the pygidium are much more strongly marked and that the thoracic pleuræ probably are furrowed. Since this species is not entirely known, and since I have not seen the original material, only the figures, I cannot form a decided opinion about its affinities.

Genus **Stygina** SALTER.

Stygina angustifrons n. sp. Pl. III, figs. 1, 2.

Specific characters. — Glabella clearly defined, elongated pyriform in outline, slightly rounded anteriorly; width at occipital furrow three fifths that across frontal lobe, which is less than two thirds the length; anterior part flattened convex, posteriorly more strongly raised and slightly keeled in the middle, highest near base; no traces of glabellar furrows to be seen. Axial furrows outside occipital ring directed obliquely inwards, then somewhat divergent, slightly curved, strongly arched upwards, and sharply impressed along occipital ring and along seven eighths the length of glabella, as far as the cheek is convex; their anrerior parts as well as preglabellar furrow not impressed, only indicated by sharp limit between convex glabella and flat border — the limits between them and the preglabellar furrow not marked by rounded impressions, as is the case at least in the North Baltic form of *St. latifrons*. — Occipital furrow shallow, but rather broad, in the middle (where the test is not preserved on the specimen) distinctly marked, towards the sides hardly indicated. Occipital ring strongly arched, somewhat wider than base of glabella, with indistinctly set off median tubercle. Fixed cheeks narrow; inside palpebral lobes (which are not preserved on the specimen) about one third as wide as glabella at base, widening somewhat anteriorly, sharply raised to palpebral lobes, here higher than glabella; posterior parts nearly vertically bent down; posterior borders indistinctly defined by obscurely marked furrows; part of cheeks in front of eye lobes more gradually sloping to flat foremost portions, which pass into flat comparatively long preglabellar field. Anterior margin without raised border, slightly rounded. Eye lobes placed very far back. Posterior branches of facial sutures directed obliquely outwards so as to cut posterior margin of cranidium at very acute angles; anterior branches at first divergent, very slightly curved outwards, foremost portions nearly parallel. Test of cranidium ornamented with minute rounded pits.

Pygidium (probably belonging to the same species) nearly semicircular, length (articulating half ring not included) to width as 9 to 16, gently convex with rather narrow concave border. Axis narrow, width at articulating furrow about one fourth that of pygidium, gradually tapering posteriorly to half its frontal width, extending about two thirds the length of pygidium and continued by narrow, pointed, obscurely defined postaxial ridge reaching to posterior margin; foremost part gently convex; posteriorly nearly flat; anterior margin gently arched forwards. Articulating furrow and 1 st ring furrow distinct; 2 d ring furrow more indistinctly marked; 6 posterior furrows indicated by faint impressions on lateral parts of axis (the test is only preserved on the posterior and lateral parts of the pygidium). Side lobes with distinctly raised fulcrum situated about halfway out; 1 st pair of furrows broad, behind them faint traces of a 2 d pair. Surface ornamented as cranidium.

Remarks. — The cranidium described above is from Osmundsberg, the pygidium from Boda, but since both are of a Styginid type and since no other cranidia or pygidia which can be associated with either of them are found in the Leptæna Limestone it seems probable that they belong to the same species.

The cranidium is well characterized by its elongate, distinctly defined glabella and comparatively long preglabellar field.

Horizon and Localities. — Upper Leptœna Limestone; Osmundsberg, Boda.

Family **Illænidæ** CORDA.

With the elimination of some genera (e. g. *Symphysurus, Nileus* and *Stygina)* which sometimes have been referred to this family but generally have been recognized as belonging elsewhere, the Illænidæ form a very homogeneous and well defined group. If the generic name of *Illænus* DALM. is taken in the wide sense in which for instance BARRANDE, SALTER and HOLM use it, all the known species of the family might be referred to this genus. A great number of generic and subgeneric names have, however, been proposed by different authors.

SALTER (1867) divided *Illænus* (s. lat.) into eight subgenera.[1] HOLM (1882, 1886) only accepts *Illænus* (s. str.) and *Bumastus* MURCH. but points out (1886, p. 152) that *Ill. Linnarssoni* HOLM and some other species seem to form a quite natural and well defined group and suggests that this ought to be separated from *Illænus* (s. str.) and regarded as a third subgenus, for which he in that case proposes the name of *Stenopareia.* This suggestion has not been taken up by other writers,

[1] One of these, *Illænopsis* SALT., SALTER himself considered as »probably a distinct genus», and, as already pointed out by HOLM and other writers, it is evident that it does not belong to the Illænidæ at all, but is an Asaphid.

whereas *Bumastus* and *Thaleops* CONR. [the latter included in *Illænus* (s. str.) by HOLM] are generally regarded as distinct genera.

The latest attempt to classify the Illænidæ has been made by RAYMOND (1916). After a careful investigation of the genera and subgenera proposed by earlier writers, be comes to the conclusion that in addition to *Illænus* (s. str.), *Bumastus,* and *Thaleops* generic rank might be assigned also to *Dysplanus* BURM., *Octillænus* SALT., *Actinolobus* EICHW., and *Illænoides* WELLER; further he erects the new genus *Wossekia* RAYMOND.

The genera which are characterized by having a narrow axial lobe and a cephalon and pygidium without concave border — viz. *Illænus* (type, *Ill. crassicanda* WLB.), *Thaleops* (type, *Thal. ovata* CONR.), *Dysplanus* (type, *Ill. centrotus* DALM.). *Wossekia* (type, *Ill. Katzeri* BARR.), and *Octillænus* (type, *Ill. Hisingeri* BARR.) — are referred to the subfamily *Illæninæ* RAYMOND.

In his other subfamily, *Bumastinæ* RAYMOND, he includes *Bumastus* (type, *Bum. Barriensis* MURCH.), *Actinolobus* (type, *Ill. atavus* EICHW.), and *Illænoides* (type, *Illænoides trilobus* WELLER) and defines this subfamily as »Illænidæ with (usually) concave border on one or both shields, axial lobe generally wide, though sometimes narrow».

If all these genera should be retained, it seems as if *Stenopareia* HOLM also ought to be accepted as a distinct genus and that, further, a number of other new genera must be set up in order to include the species which cannot be referred to this genus or to any of those proposed by RAYMOND, at least not as he now defines them[1].

His classification is designed partly to remove »the forms with a more or less *Isotelus*-like pygidium» (the Bumastinæ) »from the typical *Illænus* group», partly »to separate the species with long more or less flattened shields» *(Dysplanus, Wossekia* and *Octillænus)* »from the more typical Illænids with short and abruptly deflected cephalon and pygidium« *(Illænus, Thaleops).*

His division into subfamilies of a family in which all the species apparently are so closely allied to each other seems rather unnecessary, not to say unwarranted. Moreover it seems rather doubtful if the presence or absence of a concave border on the pygidium is really a character of especially great classificatory value (if the purpose is to make a natural classification).

Actinolobus, in which genus RAYMOND includes *Ill. Masckei* HOLM, as well as *Ill. atavus,* hardly appears to be more closely related to *Bumastus* and *Illænoides* than to the other Illænidæ. HOLM (1886, pp. 22, 142) considers *Ill. Masckei* as a transition form between *Illænus* (s. lat.)

[1] It ought to be mentioned, however, that RAYMOND himself points out that the genera which he recognizes, »are based primarily upon the more conspicuous peculiarities of the type-species of each» and that »it is still too early to make any natural classification».

and *Bronteus,* and it is undeniable that in many characters it resembles the latter genus and that its existence confirms the presumption that the Illænidæ and the Bronteidæ are closely allied.[1] The pygidium of *Ill. atavus* is also of a more or less *Bronteus*-like type and very unlike that of *Bumastus,* although it has a concave border.

In *Ill. angustifrons* HOLM (HOLM, 1886, p. 130, Pl. VIII, figs. 14—22, Pl. IX, figs. 1—3) there seem to be traces of a concave border on the pygidium, and in the probably closely allied new species *Ill. Dalecarlicus* (See below, Pl. I, fig. 30, Pl. II. figs. 10—13) this feature is quite distinct, though the border is rather narrow. It is true that the cephalon of both these species resembles rather closely that of *Bumastus nudus* ANG. (See below, Pl. II, fig. 1) and also to a certain extent that of *Ill. Masckei* (Cf. HOLM, 1886, p. 134), but in other characters they are so very unlike both these and other species referred to *Bumastus* and *Actinolobus* that it seems very improbable that the points of resemblance are due to any particularly close relationship. Anyhow the species in question cannot be referred either to *Bumastus* or to *Actinolobus.*

On the larger pygidia of *Ill. oblongatus* ANG. var. *excellens* HOLM (HOLM, 1886, p. 120, Pl. VIII, figs. 1—3) too there is a narrow concave border, which gradually disappears anteriorly, while no such border is found on the smaller pygidia of this variety or on any of the pygidia of the other varieties of this species, but it is indicated on the larger ones of the apparently closely allied new species *Ill. Wimani* (See below p. 106 and Pl. I, figs. 23). As far as I am able to judge, these species, at any rate, seem to be more closely allied to the typical Illænids than to *Bumastus* or to any of the other genera which RAYMOND refers to the Bumastinæ.

As to RAYMOND's second discrimination, it is rather questionable whether the form and convexity of the cephalon and pygidium is a good basis for classification, when dealing with a group in which these characters vary so much in evidently very closely related species, sometimes even within the same species. RAYMOND seems to base his reasoning on the supposition that all forms which have a strongly convex cephalon also have the pygidium strongly convex, which is by no means always the case, just as little as the short and wide shields are always more abruptly deflected than the more elongated ones.

I do not mean to say that the genera proposed by RAYMOND might not be acceptable;[2] only as it now stands his classification is of rather

[1] HOLM regards the Bronteidæ as probable descendants of the Illænidæ, but I agree with RAYMOND (1916, p. 11), who also emphasizes the near relationship between the two families, that it seems highly improbable that either of them should have been derived from the other (Cf. p. 72 above).

[2] I am not so sure, however, of the value of his genus *Wossekia.* RAYMOND (op. cit. p. 12) himself points out that the type species, *Ill. Katzeri,* differs chiefly from other Illænids in its eyes, which are small and situated far forward. He regards it as a probably degenerate form, and it seems doubtful whether the circumstance that the eyes have

little practical value, as it makes it necessary to erect new genera. Some at least of his also need redefinition so that species which are very closely related should not be separated.

Of the species which are found in the Leptæna Limestone only *Ill. gigas* HOLM and possibly the new species *Ill. Wimani* fit into *Illænus* as restricted by RAYMOND. *Ill. parvulus* HOLM does not really answer the definition of the genus, but RAYMOND himself apparently thinks it referable to it (Cf. op. cit. p. 8). *Ill. Roemeri* HOLM and *Ill. fallax* HOLM do not fulfil the conditions of having a very convex pygidium with a high axis, but cannot be referred to any of the other genera proposed either, and as far as I can see they ought probably to be kept in *Illænus*. *Ill. Linnarssoni* HOLM, *Ill. avus* HOLM, and the new species *Ill. oviformis* belong to *Stenopareia,* if this genus is accepted. *Bumastus nudus* ANG. is evidently a *Bumastus*. *Ill. Dalecarlicus* should, according to RAYMOND's definition of the subfamilies, also belong to the Bumastinæ, though it does not fit into any of his genera. It is highly probable that it will prove suitable to refer it and *Ill. angustifrons* and possibly some other species to a separate genus. On the other hand *Ill. angustifrons* especially resembles in so many characters other species which seem to be referable to *Illænus* (s. str.) that I do not like to make such a proposition. To get a true idea how far a subdivision of the family is really justified would require a very careful investigation of most of the known species, a thing I have not had the opportunity to do. As the matter now stands I have thought it best not to introduce any new genera or subgenera but to refer all the species which I have to deal with to the old genera *Illænus* and *Bumastus,* although I have found it appropriate to draw attention to HOLM's name *Stenopareia,* since RAYMOND has not referred to it nor to the group of species for which it was proposed.

Genus **Illænus** DALMAN.

Distinguishing characters of the species.

1. Thoracic segments 10 (or their number not known but probably 10). Palpebral lobes (and eyes) large or rather large 2.

Thoracic segments 9. Eyes small. Palpebral lobes very small 6.

become reduced (and as a result of this their position altered) is reason enough to refer it to a separate genus. As is well known, there are several other Illænids in which the eyes have become reduced, and all of these do not seem to be more closely allied to *Ill. Katzeri* or to each other than to other species of the family. Anyhow, it seems more reasonable to place them together with other forms which they resemble in other characters than to refer them to separate genera. If one does not take the reduction and the removal of the eyes into consideration it is evidently as justifiable to refer *Ill. Katzeri* to *Illænus* as to include *Ill. advena* BARR. in this genus, as RAYMOND (op. cit. p. 12) does, since the convexity of the cephalon is about the same in the two species and the pygidium of the latter is flatter than that of the former.

Number of thoracic segments not known, probably 8. Palpebral lobes and eyes rather large *Ill. cf parvulus* HOLM.

2. Pygidium strongly convex. Doublure of pygidium increasing considerably in width posteriorly 3.

Pygidium flattened or moderately convex. Doublure of pygidium comparatively narrow, not or only slightly increasing in width posteriorly 4.

3. Axial furrows on cranidium only extending about one fourth the length of latter. Posterior branch of facial suture meeting posterior margin of cephalon at very acute angle. Distance between fulcrum and axis of pygidium more than one third the width of latter *Ill. gigas* HOLM.

Axial furrows extending about half the length of cranidium. Posterior branch of facial suture meeting posterior margin of cephalon at nearly right angle. Distance between fulcrum and axis of pygidium about one fourth the width of latter *Ill. Wimani* n. sp.

4. Axial furrows on cranidium extending less than half the length of latter. Pygidium slightly or moderately convex without concave border 5.

Axial furrows extending about two thirds the length of cranidium. Pygidium flattened with concave border *Ill. Dalecarlicus* n. sp.

5. Axial furrows extending at least one third the length of cranidium. Free cheeks longer than wide. Pygidium very slightly convex with flattened doublure *Ill. fallax* HOLM.

Axial furrows extending less than one third the length of cranidium. Free cheeks sub-quadrangular. Pygidium moderately convex with convex doublure *Ill. Roemeri* VOLB.

6. Width of glabella between the eyes at least half that of cranidium. Different portions of posterior branch of facial suture meeting at an angle of at least 150°. Doublure of pygidium narrow, but forming a long forwards directed, sharply pointed projection in the middle line; inner portion convex, directed nearly straight downwards; outer portion bent outwards 7.

Width of glabella between the eyes less than half that of cranidium. Different portions of posterior branch of facial suture meeting at an angle of about 120°. Doublure of pygidium very wide, convex, only the outmost parts bent outwards; its anterior margin arched backwards in the middle *Ill. avus* HOLM.

7. Axial parts of body wide. Glabella between the eyes (at least in adults) more than half as wide as cranidium. Cranidium regularly arched from back to front. Pygidium semielliptical in outline; inner part rather gently convex; lateral parts rather strongly but not suddenly bent down *Ill. Linnarsoni* HOLM.

Axial parts of body comparatively narrow. Glabella between the eyes about half as wide as cranidium. Inner posterior part of cranidium flattened; antero lateral parts strongly and suddenly bent down. Pygidium sub-triangular in outline; inner part flat; postero-lateral parts steeply and suddenly bent down *Ill. oviformis* n. sp.

Illænus gigas HOLM.

1882. *Illænus gigas,* HOLM, p. 67, Pl. I, figs. 1—11, Pl. VI, figs. 9—10.
1901. *Illænus gigas,* LINDSTRÖM, p. 59, Pl. IV, figs. 34—37.

Specific Characters. — Cephalon strongly convex, semielliptical in outline. Posterior (lateral) angles rounded. Axial furrows only reaching one fourth the length of cephalon, their posterior parts sharply impressed. Glabella rather strongly raised above the side lobes. Palpebral lobes moderately large. Eyes distant about half their own length from posterior margin, their distance from the axial furrows about equal to half the width of the glabella. Anterior branch of facial suture curved S fashion; posterior branch straight or curving slightly outwards. When the cephalon is seen from above its direction is nearly straight backwards. It meets the posterior margin of the cephalon at a very acute angle.

Free cheeks slightly convex, four-sided, with the outer and inner margins parallel to each other. Median length somewhat greater than width. Posterior margin straight, lateral margin also nearly straight. Surface of eye crescentiform. Laterally the eye is bounded by a similarly crescentiform groove.

Rostrum fusiform, its posterior margin slightly protruding in the centre. Surface wrinkled by strong, transverse terraced lines. Lateral margins continuous with posterior margin.

Hypostoma inversely triangular with posterior angles strongly truncated, wide, the width being greater than the length. Central part strongly swelled and somewhat pressed together from the sides, so that a weak, rounded keel is formed along the median line. Anterior pair of wings large, only just meeting in front of central part, nearly flat, squarely cut off so that their lateral margins meet the front margin at right angles. Behind the anterior wings the lateral edges form narrow raised borders. Posteriorly they are continuous with each other so that no specific posterior border is formed. Posterior wings small, triangular in shape, sharply pointed, inclined nearly at right angles. The furrows which bound the central part at the back are most strongly impressed at the sides at the base of the anterior wings. The maculæ (which are not mentioned by HOLM, but have been described and figured by LINDSTRÖM, 1901, p. 59, Pl. IV, figs. 34—37) are transversely elongated in shape and very small and faintly elevated.

Thorax not known, but probably there were 10 thoracic segments.

Pygidium uniformly and strongly convex, semielliptical in outline.

Greatest projected width to length as 5 to 4. Axis extending two thirds the length of pygidium, in front more than twice as wide as straight part of anterior margin of side lobes, comparatively high, convex, without trace of a keel. Its outline forms an equilateral triangle and it is bounded laterally by distinctly marked though not deep axial furrows, which become obliterated posteriorly so that its hindmost part is hardly or not at all bounded. The furrow behind the anterior margin of side lobe rather deep. Behind this there are two ribs (or half ribs), which, though generally very faintly marked, are never missing. Lateral angles only slightly truncated, so that the surface of the facet meets the rest of the side lobe at very obtuse angle.

The facet forms a rectangular triangle in which the anterior margin is twice as long as the lateral one. The former slightly longer than the straight part of the anterior margin of the side lobe. Doublure rather wide, increasing in width towards the middle, where it forms a protruding tongue; nearer the sides the anterior margin is forwards concave. There is a shallow furrow in the middle line and in casts the usual terraced lines, which are nearly parallel to the outer margin, are seen.

Surface of test ornamented especially on the free cheeks by closely set small shallow pits of unequal size. Terraced lines occur on the front part of the cephalon, along the anterior margin and parallel to it, both on the cranidium and on the free cheeks. On the doublure of the latter and on the rostrum they are especially strongly marked.

Dimensions. — *Ill. gigas* is evidently one of the largest species of the genus, though it does not seem to reach as great dimensions as *Ill. Roemeri* HOLM.

Remarks. — The foregoing description is chiefly a rather close translation of the one given by HOLM.

Ill. gigas occurs in moderate frequency in the lower part of the Leptæna Limestone in Dalarne, where it is found at several localities. No entire individual of the species is as yet known, but detached specimens of all the parts of the carapace, except the thorax, are found and on account of their resemblance in several characters to other species which are known to have 10 thoracic segments, it seems probable that the thorax of *Ill. gigas* consisted of the same number of segments.

Affinities. — As pointed out by HOLM (1882, p. 70), this species has several points of resemblance with *Ill. Esmarki* SCHLOTH. and *Ill. scrobiculatus* HOLM, and its cephalon is rather like that of *Ill. sphæricus* HOLM, but the pygidia differ very much from each other.

Horizons and Localities. — The species is found in the lower part of the Leptæna Limestone at Kullsberg,[1] Amtjärnsberg, Sinksjön,

[1] In HISINGER's collections in the State Museum of Natural History, Stockholm, there are several fossils, among others one pygidium of *Ill. gigas,* which on the labels are stated to be from »Glistjerna». This locality is probably the same as Kullsberg, since Glistjerna (or Gliskärna) is the name of the village which lies on the slope of the hill Kullsberg south of lake Glistjärn.

Östbjörka, and, according to HOLM, in a quarry north of lake Glistjärn.[1]

It is further found in the Chasmops Limestone at different localities in Västergötland, Östergötland and Jämtland.

Illænus cf. **gigas** HOLM. Pl. I, figs. 19, 20.

Description. — Cranidium about three fourths as long as the width in front of eye lobes; anterior portion strongly bent down, rather strongly convex from side to side; posterior portion comparatively flat but with postero-lateral parts of glabella and posterior parts of fixed cheeks sharply bent down. Glabella with gentle independent convexity in front, more strongly raised posteriorly, wide and short, in front of eyes about twice the width of free cheeks, increasing somewhat in width posteriorly. Axial furrows clearly impressed, converging anteriorly but with foremost ends slightly bent outwards. Fixed cheeks slightly sloping towards the sides and gently convex from back to front; posterior parts strongly bent down; inner parts of posterior margins directed straight outwards, outer parts downwards, outwards, and slightly backwards, about as long as posterior branches of facial sutures, which they meet at very acute angles, the postero-lateral parts of fixed cheeks being very narrow and sharply pointed towards the sides. Palpebral lobes large and prominent, about as long as the distance between eye and axial furrow, situated far back, their distance from posterior margin of cephalon about one fifth their own length. Posterior branch of facial suture straight, rather strongly bent outwards, about half as long as palpebral lobe and hardly more than one fifth the length of anterior branch, which latter describes a very gentle sigmoidal curve.

Test ornamented with punctæ and with the usual terraced lines along anterior margin.

Remarks. The above description is based on a single defective cranidium from Sätra. It resembles rather closely the cranidia of *Ill. gigas* HOLM and of *Ill. sphæricus* HOLM, but its anterior portion is more suddenly bent down than in these and has a less convex surface, the posterior portion, especially the front part of the glabella, is more flattened,

[1] North of this lake, at Unskarsheden, Leptæna Limestone has been quarried at several places. As seen on the map accompanying his paper of 1883, TÖRNQUIST evidently believed that the limestone here formed one continuous mass, which, as I have previously (1910) pointed out, does not seem to be the case. The fossils collected at Unskarsheden prove that the rock in most of these quarries belongs to the upper part of the Leptæna Limestone, whereas it seems probable that the rock in which *Ill. gigas* is found belongs to the lower part of this limestone and represents an isolated patch. This latter view appears to be in accordance with HOLM's opinion, since he mentions this »quarry north of Glistjärn» and Unskarsheden as distinct localities.

the eye lobes are situated farther back, the posterior parts of the free cheeks more sharply bent down, the inner and outer portions of their hind margins meeting at more acute angles, and the posterior branches of the facial sutures directed more outwards. In the shape and direction of the posterior parts of the fixed cheeks this form resembles *Ill. gigas* more than *Ill. sphæricus,* while the very prominent palpebral lobes are more like those of the latter species and it is not impossible that it is more nearly allied to this than to *Ill. gigas,* but until it is more completely known this is impossible to decide.

Horizon and Locality. — Lower Leptæna Limestone; Sätra.

Illænus Wimani n. sp. Pl. I, figs. 22—25.

1907 a. *Illænus* sp., WIMAN, p. 150.

Specific characters. — Cranidium moderately convex both from back to front and from side to side, width in front of eyes about seven eighths the distance between anterior and posterior margins; lateral parts of anterior edge slightly produced so that behind them folds are formed to receive the lateral edges of the pygidium when the animal enrolls itself. Glabella strongly raised, with the sharpest bend in the median line; nearly as long as wide and extending more than half the length of cranidium, slightly contracted between the eyes, where its width is more than half that of cranidium. Axial furrows moderately impressed, deepening posteriorly, slightly concave outwards. Fixed cheeks narrow, with base less than one third as wide as glabella, slightly swollen and sloping down towards the sides; shallow but distinct, straight posterior border furrow (at least in casts); inner parts of posterior border horizontal, very narrow (from back to front); outer parts slightly bent down and widening towards the sides so that the lateral portions of the posterior margins are directed somewhat backwards and meet posterior margins of facial sutures at slightly acute angles. Palpebral lobes comparatively long and narrow, distinctly protruding, situated not quite their own length from posterior margin, and a little in front of the middle of the glabella. Posterior branch of facial suture directed nearly straight backwards or somewhat inwards, very slightly concave inwards but with the hindmost portion curving gently outwards, or really downwards, the outermost end of the fixed cheek being rather strongly bent down. Anterior branch a little more than twice as long as the posterior one, slightly outwards convex, with the strongest curvature near anterior margin. Free cheek (only partly known) rather elongate, with slightly rounded lateral angle; lateral edge with border and fold (to receive ends of thoracic pleuræ), dying out near angle.

Thorax probably of 10 segments (only one detached segment found). Axis wide, on the segment found about half the width of thorax and four times that of straight part of side lobe, rather strongly convex. Axial furrows scarcely impressed. Inner horizontal part of pleuræ more than half as long (from side to - side) as outer part, which is strongly though not sharply bent down and not directed backwards, pointed at the end and with the posterior margin slightly backwards convex. Facet not very sharply set off on the segment described, which is probably one of the posterior ones that has become detached from the pygidium found in the same piece of rock very close to it.

Pygidium semioval, four fifths to five sixths as long as wide; inner anterior portion slightly convex, lateral and posterior portions very strongly bent down. In the larger specimens the hindmost part a little less strongly bent down, so as to form an indication of a concave border, which disappears anteriorly. Axis wide and short, nearly half the width of pygidium, rapidly tapering posteriorly, projecting on front margin, with slight independent convexity in front, bounded by shallow marginal impressions and faintly indicated axial furrows, which soon become quite obsolete. Fulcrum rather weak, distance from axis only about one fifth the width of latter and about one third the length of posterior margin of facet. Short shallow furrow behind fulcrum and very faint traces of one more furrow posterior to this. Lateral angles only slightly truncated, since the surface of facet meets the surface of pygidium at very obtuse angle, especially near the lateral margin. Outer margin of facet about half, anterior margin about three fourths the length of posterior margin; anterior margin slightly forwards concave; lateral angle rounded. Doublure very wide, increases in width posteriorly; inner part convex; narrow outer part concave; shallow median furrow dying out before reaching posterior margin.

Test ornamented with small punctæ and with terraced lines over nearly the whole of the cranidium, along the lateral margin of the fixed cheeks, on the axis of the thorax, the anterior part of the pygidial axis, the facets and the doublure of the pygidium.

Dimensions. — *Ill. Wimani* seems to attain rather large dimensions, but does not belong to the largest species of the genus. The cranidium figured (Pl. I, figs. 24—25) is the largest found, but the greatest width of the pygidium, which probably belongs to the same individual (see below), is only 35 mm. (the length cannot be determined, since the posterior part is not preserved), while the largest pygidium known (Pl. I, figs. 22—23) seems to have reached a width of at least 46 mm.

Remarks. — There is no entire individual found of this species, but in a piece of half-burnt Leptæna Limestone from Furudal in the Upsala Museum there are a cranidium, a thoracic segment and a pygidium, the position and relative dimensions of which indicate that they belong to the same individual. There is also a fragmentary cranidium with a loosely attached free cheek from Gulleråsen in the Museum of the Geological Survey and on top of this a pygidium of the type described. This confirms the presumption that the different parts belong to the same species.

The species is further represented from Kullsberg by a cranidium in the Upsala Museum, found by the present writer, and in the old collections in this museum there are two pygidia, which on the appended labels are stated to have been found at Fjeckå (Fjeckån), and a cranidium from an unknown locality in Dalarne. Possibly the latter is from the same locality as the pygidia, but what exact locality is meant by Fjeckå, I have not been able to find out. The rock in which the specimens occur is beyond doubt Leptæna Limestone, but this limestone has, as far as I know, not been found anywhere in the immediate neighbourhood of the river which runs past the old mill at Fjecka and which seems to be alternately called Fjeckå (or Fjeckan) and Moldå.

The Leptæna Limestone which occurs at Furudal and Kullsberg belongs to the lower part of this limestone. The fossils that occur in this do not seem to be represented in the Leptæna Limestone which forms the Lissberg hill in the village of Gulleråsen and which evidently is of younger geological age, since several of the species found in it also occur in the upper part of the Leptæna Limestone at other localities, e. g. at Kallholn and Osmundsberg. According to TÖRNQUIST (1883, p. 45) Leptæna Limestone occurs also at Storsveden in Gulleråsen, but it does not appear probable that the specimens of *Ill. Wimani* from Gulleråsen have been found at this locality, since v. Schmalensée, who has collected these, would in this case presumably have stated this on the appended label, all the more as in the same year he made great collections at Lissberg. It does not seem improbable, however, that the piece of rock which contains the specimens in question was found as an isolated boulder, especially as it is rather weathered on the surface.

Among the specimens of *Illænus* sp. found in boulders of North Baltic Leptæna Limestone referred to by WIMAN (1907 a, p. 150) which I have had an opportunity to examine, there are three fragmentary cranidia (found in boulder Rosenbergs Nr. 2) in the Upsala Museum, which agree so closely with the cranidia from Dalarne that I have not hesitated to refer them to the same species.

Affinities. — This species seems to be very closely allied to *Ill. oblongatus* ANG. (HOLM, 1886, p. 116, Pl. VIII, figs. 1—13). The pygidium is, however, considerably more convex, its posterior and lateral parts more sharply bent down, and its axis much broader and flatter than in any of the varieties of the latter species. The lateral angles of the free cheeks seem also to be more pointed in this than in *Ill. Wimani*.

The pygidium resembles rather closely that of *Ill. gigas,* but in this too the axis is narrower and more convex, the axial furrows more clearly impressed, and no trace of a concave border is to be seen even in the larger specimens. Moreover the cephala of the two species are very unlike each other.

Horizons and Localities. — The species occurs in Dalarne in the lower part of the Leptæna Limestone at Furudal and Kullsberg, and is also found in Leptæna Limestone at »Fjeckån» and Gulleråsen. Outside Dalarne it is found in boulders of North Baltic Leptæna Limestone.

Illænus Roemeri VOLBORTH. Pl. I, figs. 26—29.

1861. *Illænus grandis,* ROEMER, p. 69, Pl. VIII, fig. 4.
1863. *Bumastus Barriensis,* VOLBORTH, Pl. IV, fig. 14 (Cet. fig. exclus).
1864. *Illænus Roemeri,* VOLBORTH, p. 7, Pl. II, figs. 12—15 (non fig. 16 = Ill. Linnarssoni Holm).
1882. *Illænus vivax,* HOLM, p. 74, Pl. VI, figs. 1—7.
1886. *Illænus Roemeri,* HOLM, p. 125, Pl. IX, figs. 4—14.
?1896. *Illænus* sp., REED, p. 416, Pl. XX, fig. 6.
1901. *Illænus Roemeri,* LINDSTRÖM, p. 59, Pl. IV, figs. 38—41.
1907 a. *Illænus Roemeri,* WIMAN, p. 137, Pl. VIII, fig. 4.

Specific characters. — Body wide.

Cephalon very wide, transversally extended, rather strongly arched both from back to front and from side to side; the outline forming nearly the half of an ellipse, which is divided longitudinally; anterior margin consequently only very slightly arched in front and with the strongest bend at the sides. Gabella rather gently convex, short and wide, about one third the width of cephalon, decreasing in width posteriorly. Axial furrows short and shallow, in casts, sharply impressed, extending less than one third the length of cephalon and not reaching as far forward as anterior ends of eyes, converging anteriorly but with the foremost ends bent outwards. Eyes (at least in the adult) situated far forward and at a distance from the dorsal furrows about equal to half the width of the glabella. Palpebral lobes rather large, on the Swedish specimens not very prominent, on the East Baltic ones more so. Posterior branch of facial suture long, directed somewhat outwards, forming a slightly sigmoidal curve. Anterior branch short, at least in the Swedish specimens the distance from the middle point of the eye lobe to the point of section between the suture and the anterior margin is only one and a half times the distance from the former point to the point where it cuts the posterior margin, which latter distance is equal to that between the eye and the dorsal furrow.

Free cheeks rather strongly convex, very short, sub-quadrangular; their median length nearly equal to the width, lateral margins slightly arched outwards; lateral angles strongly and evenly rounded.

Rostrum with the posterior margin very strongly protruding in the middle, so that its length here is equal to nearly half the width.

Hypostoma rather like that of *Ill. gigas* but comparatively somewhat narrower; posterior margin more widely rounded; anterior pair of wings not reaching so far backward and with the lateral margins slightly converging posteriorly and gently curved; middle body more strongly raised and more distinctly keeled. The maculæ, according to LINDSTRÖM (1901, p. 59), »lie on elevated tubercles and are of a strange shape, being sharply pointed outwards, rounded inwards».

Thorax of 10 segments. Axis wide, decreasing in width posteriorly, on 5th segment nearly half the width of thorax, gently and evenly convex. Inner flat part of side lobe narrow, slightly increasing in width posteriorly, on 1st segment about one fifth the width of axis. Outer part considerably wider.

Pygidium sub-semicircular, about two thirds as long as wide, generally rather evenly though not very strongly convex (on some specimens with the inner anterior part more or less flattened and the lateral and posterior parts rather strongly bent down). Axis (in the Russian specimens according to HOLM 1886, p. 127) only seen in casts, where it is generally marked to its base by faint shallow furrows, or (in the specimens from the Leptæna Limestone) also when the test is preserved with the anterior part slightly though quite distinctly raised and bounded by short marginal depressions or short shallow axial furrows; it is wide, considerably wider than side lobes; anterior margin forming a projecting arch, which, however, is slightly excavated in the middle. Straight part of side lobe very narrow, about one third the width of axis and three fifths the length of posterior margin of facet. Anterior margin of latter three times as long as outer margin. Lateral angles truncated at about 45°. Strong furrow behind fulcrum. Doublure more or less strongly concave, narrow, somewhat decreasing in width posteriorly, neither excavated nor protruding in the middle, and with only slight traces of median furrow. Terraced lines parallel to the margin, running uninterrupted from one side to the other and not bent in the median line.

Test ornamented with small punctæ and large pits and as usual with terraced lines along the anterior margin of the cephalon and on the facets, and also across the base of the glabella, the axis of the thorax and on the anterior part of the pygidium. On the latter there are always at least a few rather coarse lines running in a curve from the axis towards the facets.

Dimensions. — *Ill. Roemeri* is one of the largest (perhaps the largest) species of the Illænidæ. In one cranidium, measured by HOLM, the projected length (= distance between anterior and posterior margin) is reported to be 80 mm. The specimens vary, however, considerably in size and quite small ones are frequently found. In the smallest cranidium which I have seen the corresponding distance is only 6 mm. (Cf. HOLM, 1882, p. 76, 1886, p. 128).

Remarks. — The foregoing description is a slightly revised summary of those given by HOLM in his papers of 1882 and 1886, except as regards the hypostoma. This was apparently not known to HOLM, and has, as far as I know, never been found in situ, but the hypostomata referred to *Ill. Roemeri* by LINDSTRÖM (1901, p. 59, Pl. IV, figs. 38—41), which belong to the State Museum of Natural History, Stockholm, were evidently found in the same piece of rock and in close proximity to other parts of the carapace of this species and seem to have been correctly attributed to it. The rock is Leptæna Limestone and the accompanying label states that it is probably from Östbjörka.

Only a rather small number of specimens of this species are known from the Leptæna Limestone, though detached parts of the carapace have been found at most of the localities where the upper part of this is, or has been, exposed. In the Museum of the Geol. Survey there is also a small, nearly complete individual (Pl. I, figs. 28—29) from Kallholn and the middle portion of a rather large cranidium from the same locality, with the rostrum, parts of 10 thoracic segments, and a fragment of the pygidium attached (Pl. I, figs. 26—27).

On the whole the specimens from the Leptæna Limestone seem to agree with those from the East Baltic Lyckholm formation (F_1) and the small points of difference are probably only to be regarded as individual variations, as was also suggested by HOLM (1886, p. 127). In the pygidium from Osmundsberg figured by this author (1882, Pl. VI, figs. 2—4) the anterior part of the axis is considerably more strongly marked than in the East Baltic specimens, but other pygidia from the Leptæna Limestone are more like the latter, since in them the axial furrows are only represented by shallow marginal depressions and only the foremost part of the axis shows a gentle independent convexity. To judge from the figures (HOLM, 1886, Pl. IX, figs. 5 and 11 a) it seems as if, at least in some of the East Baltic pygidia too, this part was slightly raised.

Some of the pygidia from the Leptæna Limestone are much flattened above and have the lateral and especially the posterior parts strongly bent down, whereas others are more regularly arched, but to judge from HOLM's figures the East Baltic specimens seem also to vary in this respect.

In the small complete individual from Kallholn the axis of the thorax and the posterior part of the glabella are comparatively strongly raised and also the anterior part of the cranidium is more convex than generally seems to be the case. The palpebral lobes are situated comparatively far backward, their distance from the posterior margin of the cephalon being only about two thirds their own length. This latter character, however, is probably due to its being a young individual, since in other still smaller cranidia from the Leptæna Limestone this distance is even shorter and in a small individual from the Lyckholm formation measured by HOLM (1886, p. 129, specimen a) it is stated to be only half the length of the palpebral lobes, whereas in the larger cranidia both from there and from Sweden it seems to be nearly equal to or even longer than this lobe.

The rostrum (Pl. I, fig. 27), which is not previously described or figured from the Leptæna Limestone, but has now, as is already mentioned, been found at Kallholn, agrees very closely with HOLM's description in his paper of 1886. It seems very probable that the rostrum from the Keisley Limestone in England described and figured by REED (1896, p. 416, Pl. XX, fig. 6) also belongs to this species, especially since both cranidia and free cheeks of *Ill. Roemeri* are reported from the same locality (REED, op. cit. p. 413).

In his paper of 1890 POMPECKI (p. 66, Pl. III, fig. 16) describes and figures a cast of a pygidium (previously figured as *Ill. crassicanda* var. by STEINHARDT, 1874, Pl. III, fig. 14 a—c) found in a boulder of hard, fine-grained, gray limestone in East Prussia which he refers to *Ill. Roemeri*. It is comparatively elongate and has also a rather long axis, but seems otherwise to agree with the pygidia of this species, but whether it really belongs to it it is impossible to say.

Affinities. — This species seems to be very closely allied to the English *Ill. Murchisoni* SALT. (SALTER, 1867, p. 201, Pl. XXVI, fig. 1, Pl. XXX, fig. 7) though the latter is apparently more strongly convex and the outline of the cephalon different (Cf. HOLM, 1886, p. 129). The Swedish species which bears the closest resemblance to it is *Ill. fallax* HOLM. The latter never seems to attain such large dimensions, however. The form and convexity of its cephalon is also different, the eye lobe situated farther backward the free cheek more elongate and the pygidium is less convex and has a flat doublure. Besides, *Ill. fallax* is a geologically older form, which belongs to the fauna of the lower part of the Leptæna Limestone and of the Chasmops Limestone.

Horizons and Localities. — *Ill. Roemeri* is found in the upper part of the Leptæna Limestone at Boda, Osmundsberg, Kallholn, Arfvet, and Klittberg.

Outside Dalarne it is known from the Red Trinucleus Shales in Västergötland, from the Lyckholm formation (F_1) in the East Baltic Area, and (according to HOLM, 1886, p. 130) from the Gastropod Limestone in Norway, from where it is also reported by KJÆR (1897). It is also found in boulders of North Baltic Östersjö Limestone and (according to HOLM, op. cit) at several places in Germany in boulders of Leptæna and Lyckholm Limestone, and seems also to occur in the Keisley Limestone in England.

Illænus fallax HOLM.

1866. *Illænus limbatus*, LINNARSSON, p. 21, Pl. II, figs. 6 a—c.
1869. *Illænus limbatus*, LINNARSSON, p. 77, Pl. II, figs. 43—44.
1882. *Illænus fallax*, HOLM, p. 82, Pl. II, figs. 1—13, 15—20, Pl. V, figs. 15—24, Pl. VI, fig. 16.
?1888. *Illænus fallax*, WIGAND, p. 76, Pl. IX, fig. 9.
1907 a. *Illænus fallax*, WIMAN, p. 113, Pl. VIII, figs. 16, 17.

Specific Characters. — Body elongate.

Cephalon semi-elliptical, moderately and evenly convex and with the front part of cranidium evenly arched. Lateral angles rounded. Axial furrows very shallow and weak, somewhat converging anteriorly, extending about one third the length of cephalon; in casts, on the contrary, very deep and sharp, their anterior ends forming an inwards convex arch. Glabella between eyes about twice as wide as the distance between eye and axial furrow, but sometimes only attaining a width which is equal to one and a half times this distance. It is moderately and evenly convex, and forms, together with the fixed cheeks, an evenly curved arch. In casts there is a minute rounded elevation near the posterior margin. This is not to be seen on the surface of the test. There must accordingly be a small pit on the inner side of the test. Palpebral lobes moderately large. Their distance from posterior margin of cephalon about equal to two thirds their own length. Posterior branch of facial suture directed straight backwards or even somewhat inwards, forming a very gentle inwards concave curve, but bent outwards just at posterior margin; consequently the fixed cheek here ends in a small point. Eye narrow, crescentiform, rather low. Free cheek somewhat varying in shape, shorter or longer, but always with length greater than width, slightly convex; the angle between its lateral and posterior margins is also somewhat varying, but it is generally about 70°; lateral margin nearly straight; posterior margin, on the other hand, slightly curved near lateral angle. Anterior margin of cephalon rounded and without projecting rim.

Hypostoma like that of *Ill. gigas* HOLM but a little narrower and more triangular in shape and with the central body more raised and more strongly keeled.

Rostrum of the usual shape.

Thorax of 10 segments. Axis wide, in the middle of thorax about half the width of this, slightly decreasing in width posteriorly. Flat part of side lobes very narrow, on the 1st segment about one sixth to one eighth, on the last, on the other hand, not quite one third the width of axis of the same segment.

Pygidium semi-elliptical. On the specimens from the Leptæna Limestone its posterior part is very wide and the outline describes a very evenly curved arch. In these the greatest width is a little behind the anterior margin. The length of the pygidium is about three fourths the width. It is only slightly convex, though variations occur, not flattened on the top but generally evenly arched. Sometimes, however, the bend is a little stronger nearest the outer margin. On the surface of the test no traces of the axial furrows, the axis consequently only indicated in its foremost part, where it forms a protruding arch on the front margin. In casts, on the other hand, the axial furrows are distinct and the axis accordingly visible, but only its anterior part is slightly raised. It extends about one third the length of pygidium and has the shape of en equilateral triangle. In casts a shallow groove runs backwards from the posterior end of the axis, which groove soon runs into a narrow raised rim continuing to the posterior margin of the pygidium. The straight part of the anterior margin of the side lobe is about one third the width of the axis. Behind it a more or less distinctly marked oblique furrow is seen. Lateral angles slightly truncated. The facet, which is only a little bent down, has the shape of a rectangular triangle, its anterior margin longer than its outer margin. Doublure of pygidium narrow, one fourth to one third the length of pygidium, hardly increasing in width posteriorly and with the anterior margin evenly arched in the middle, flat, sometimes with a shallow, narrow median furrow and, as usual, with terraced lines.

Surface of test with very closely placed minute punctæ, on some parts of the body arranged in rows, and between these, except on the glabella, along the middle and on the posterior part of the pygidium, terraced lines and transition forms between such lines and rows of punctæ. (For a more minute description of the ornamentation of the test see HOLM, op. cit. p. 85).

Dimensions. — HOLM (op. cit. p. 86) states that *Ill. fallax* is one of the smaller species of the Illænidæ, but that its size does not fall so very much below the average size of the members of this family. He considers that some specimens measured by him (one of them a cephalon with the thorax and part of the pygidium attached), in which the projected length of the cranidium is 19 to 20 mm. and the width between the eyes 21 to 22,5 mm., represent the normal size of the species. He mentions, however, that in the Leptæna Limestone he has found a few pygidia which show that the species could attain somewhat larger dimensions. The present writer has also found some rather large pygidia and cranidia in the Leptæna Limestone. In some of the latter the distance from the anterior to the posterior margin is 31 to 32 mm. and the distance between the eyes about 35 mm.

Remarks. — The above description is chiefly a rather close translation of the description given by HOLM.

The species belongs to the fauna of the Chasmops Limestone and it occurs also in considerable abundance at several localities in the lower part of the Leptæna Limestone in Dalarne. At Kullsberg I have found a cephalon (now in the Upsala Museum) with four attached thoracic segments, but no entire individual is as yet known from the Leptæna Limestone.

The hypostoma which HOLM, probably quite correctly, refers to *Ill. fallax* has been found associated with cranidia and pygidia of the species, but never attached to the cephalon.

WIGAND (1888, Pl. IX, fig. 9, see also the same paper p. 76) figures a pygidium found in a boulder of grey limestone (according to him Ortoceras Limestone) at Rostock, which he refers to *Ill. fallax*, but whether it really belongs to this species it is impossible to say. As regards its convexity, the character of the doublure and the relation between length and width it seems to agree with the specimens from the Leptæna and the Chasmops Limestone, but to judge from the figure the axial furrows are longer (the specimen seems to be a cast) and have a different course, and besides it is considerably larger than any known pygidium of *Ill. fallax*.

Reed (1896, p. 413) has also referred a small pygidium from the Keisely Limestone in England to this species and it is also enumerated by Reynolds and Gardiner (1896, p. 593) in the list of fossils from the chair of Kildare in Ireland. But since the fauna at these two places seems on the whole to correspond to the fauna of the upper (and not to that of the lower) part of the Leptæna Limestone, I feel most inclined to believe that the specimens in question here belong to some other species of *Illænus*.

Affinities. — As is already mentioned, *Ill. fallax* has many points of resemblance to *Ill. Roemeri* and is probably rather closely allied to this species.

Horizons and Localities. — The species occurs in the lower part of the Leptæna Limestone at Amtjärn, Kullsberg, Sätra, Furudal, Östbjörka and Sinksjön.

It is further found in the Chasmops Limestone at several localities in Västergötland, Dalarne, and Öland and in boulders of this limestone from the North Baltic Silurian Area and, according to Holm, in beds belonging to Kjerulf's Etage 4 in Norway.

Illænus dalecarlicus n. sp. Pl. II, figs. 10—13, 8?

?1882. *Illænus* sp. ind., Holm, Pl. VI, fig. 17.

Specific Characters. — Entire body elongate, nearly twice as long as wide; cephalon shorter than pygidium; thorax shorter than either of these.

Cephalon sub-semicircular, more than half as long as wide, comparatively slightly convex, smaller specimens somewhat more convex than the larger ones. Glabella gently convex, long, more than two thirds the length of the cephalon, rather strongly contracted between the eyes, where its width is about one third that of cephalon and half that of cranidium inside palpebral lobes, widening again at front to quite its basal width. Axial furrows rather broad and shallow, strongly concave outwards and with the anterior and posterior portions meeting at obtuse angles. Fixed cheeks and palpebral lobes very gently arched down towards the sides, a little more strongly so towards the back and front; in casts with shallow furrow extending along base and on to free cheek around eye. Eye lobes crescent-shaped, rather large and prominent, their distance from posterior margin about three fifths the length of the moderately prominent palpebral lobes, and their distance from the point of section between anterior branch of facial suture and anterior margin of cephalon about two and a half times this length. Posterior branch of facial suture straight and directed nearly straight backwards or slightly outwards. Anterior branch describing a slightly sigmoidal curve with the strongest convexity directed outwards. Free cheeks rather large, longer than wide, gently convex and rather steeply bent down; genal angles not preserved, probably rather pointed and only rounded at the extremities; in casts faint traces of posterior border furrows; posterior margins directed slightly backwards. Eyes sub-crescentiform in outline, about three times as long as wide. Doublure extending comparatively far inwards underneath cranidium.

Rostrum small, transversely fusiform; anterior edge nearly flat, middle and posterior parts regularly arched; front margin gently arched forwards; lateral margins meeting anterior margin at very acute angles and continuous with posterior margin, which latter is obtusely angulated in the centre, forming short median projection; length from back to front across middle about one fourth the width between lateral extremities.

Thorax of 10 segments, about three fifths as long as wide. Axis rather strongly convex, in the middle not quite half the width of thorax, on the 1st segment slightly narrower than on the 4 following, which are nearly equal in width, posterior part tapering slightly to pygidium. Inner flat, horizontal part of side lobe decreasing in width posteriorly to about half its frontal width, in the middle of thorax about one third the width of axis. Fulcrum weak. Outer parts of pleuræ gently bent down and directed very slightly backwards.

Pygidium semielliptical, three fourths to four fifths as long as wide, very gently convex and surrounded by narrow, flattened border, gradually increasing in width posteriorly. Axis short, hardly more than one fourth the length of pygidium, at front margin a little more than one third the width of pygidium, generally gently convex, triangular shaped, slightly projecting on front margin. Axial furrows hardly impressed even in casts, almost obsolete at base of axis. Fulcrum weak, distance from axis not quite half the width of latter and a little shorter than posterior margin of facet. Lateral angles very slightly truncated. Facet very long (from side to side) and narrow, very weakly set off, near lateral edge hardly bent down at all. 1st pleural furrow (= post fulcral furrow) distinct, though not deep, reaching to inner margin of doublure. Doublure rather narrow, gradually increasing in width posteriorly to about one and a half times its width at anterior margin, inner part convex, outer part concave or flattened; narrow median furrow across inner part. The doublure lies unusually close to the dorsal test.

Test ornamented with small punctæ and except on the middle and anterior parts of the glabella with rather fine terraced lines. On the inner and posterior parts of the fixed cheeks and on the flat part of the side lobes of the thorax these lines are directed obliquely inwards and backwards, on the other parts of the cephalon and thorax their direction is more or less vertical to the median line of the body. On the median portion of the pygidium they have about the same direction or are slightly arched backwards, but generally turning more forwards towards the sides, except near the anterior margin. On the doublure the terraced lines are, as usual, parallel to the margin.

Dimensions. — This species seems to have been of moderate size. Of the specimens found, the individual figured on plate II, figs. 10—11 has the largest dimensions. In the smallest cranidium which I have seen the distance between the anterior and the posterior margin is 10 mm.

Remarks. — An almost entire individual and several detached cranidia and pygidia is the material on which this new species is founded. They are all from Kallholn, except three small cranidia, of which one is from Osmundsberg, the other two from unknown localities in Dalarne.

In his paper of 1886 (p. 135) HOLM mentions some cranidia which he has found in the Leptæna Limestone in Dalarne and which he attributes to *Ill. angustifrons* HOLM. I have not myself had the opportunity to see these specimens, but to judge from HOLM's brief description — he states that they seem to form a transition form between the type form of *Ill. angustifrons* and the var. *depressa* HOLM — it appears probable that they belong to *Ill. dalecarlicus.*

There are also a few specimens of the hypostoma of an *Illænus* found at Kallholn, which possibly might belong to this species. It is slightly longer than the width behind the anterior wings, gently tapering posteriorly and widely rounded behind. Anterior margin gently arched forwards; lateral margins continuous with posterior margin. Anterior lobe of central body very strongly raised, depressed from the sides, broadly oval. Posterior lobe gently convex, crescentiform, with pair of small, low, oval maculæ. Median furrow distinctly marked, deepening towards the sides. Anterior border narrow (from back to front), flat, continuous with anterior wings. Lateral and posterior borders narrow, raised. Border furrow deepest at base of anterior wings. These extending about three eighths the length of the hypostoma, rather wide, gently inclined posteriorly. Posterior wings small, triangular, bent slightly inwards. The hypostoma from Unskarsheden figured by HOLM, 1882, Pl. VI, fig. 17, seems to be of the same type as those just described and might belong to the same species.

Affinities. — *Ill. dalecarlicus* resembles very closely *Ill. angustifrons* HOLM (1886, p. 130, Pl. VIII, figs 14—22. Pl. IX, figs. 1—3) from the East Baltic Lyckholm (the type form) and Borkholm (the var. *de-*

pressa) formations. In the form and convexity of the cranidium and the narrowness of the rostrum it agrees most closely with the var. *depressa*, but the posterior branches of the facial sutures seem to be directed more outwards both in this and in the type form of *Ill. angustifrons* and in neither of these are the lateral margins of the rostrum (to judge from the figures) continuous with the posterior margin, and in the variety the latter is not protruding in the middle. The pygidium is comparatively shorter than in the type form of *Ill. angustifrons* but not so short as in the variety. Its axis is considerably narrower and more strongly raised than in either of these and the doublure increases more in width posteriorly. In the var. *depressa* the pygidium seems to be more convex and there does not appear to be any depressed border. In the type form the depressed border does not seem to be so distinct either as in *Ill. dalecarlicus* and the lateral angles of the pygidium are more truncated. On account of these difference I have thought it more correct to refer *Ill. dalecarlicus* to a separate species than to regard it as a variety of *Ill. angustifrons,* which latter alternative also might seem reasonable. Possibly the var. *depressa* ought also to be separated from *Ill. angustifrons* and regarded as a distinct species.

Horizon and Localities. — Upper Leptæna Limestone; Kallholn, Osmundsberg, Unskarsheden?

Illænus cf. dalecarlicus. Pl. I, figs. 30—30 a.

Remarks. — There is one imperfect cranidium from Osmundsberg in the Geological Museum of Upsala which in most of its characters very much resembles the cranidium of *Ill. dalecarlicus.* Its anterior part is, however, much more strongly convex, and the independent convexity of its glabella is also considerably stronger, whereas the fixed cheeks are somewhat flatter. The convexity does not seem to be like that of the cranidium of *Ill. angustifrons* either. This makes it seem probable that it belongs to a distinct species, though it is presumably very closely allied to the two just mentioned.

Horizon and Locality. — Upper Leptæna Limestone; Osmundsberg.

Illænus Linnarssoni HOLM. Pl. II, figs. 14—18.

1864. *Illænus Roemeri,* VOLBORTH, Pl. II, fig. 16.
1882. *Illænus Linnarssonii,* HOLM, p. 103 (pars), Pl. IV, figs. 21, 22, Pl. V, fig. 6, Pl. VI, fig. 15.
1886. *Illænus Linnarssonii,* HOLM, p. 146 (pars), Pl. X, figs. 14—23.
1890. *Illænus Linnarssoni,* POMPECKI, p. 69, Pl. III, fig. 13.

Specific Characters. — Body oval, tapering slightly posteriorly, width across middle of thorax about three fifths the length. Cephalon longer than pygidium, thorax shorter.

Cephalon semielliptical, about two fifths the length of the whole body, about three fifths as long as wide, very strongly convex, in longitudinal direction evenly arched, in transversal direction less strongly arched in the middle but with the sides steeply bent down. Glabella rather short and wide, at least in fullgrown individuals considerably wider than half the distance between the eyes (in small specimens it is often relatively narrower), with very slight independent convexity. Axial furrows slightly impressed on the surface of the test, in casts rather deep and broad, extending about one third the length of cephalon, their posterior parts nearly parallel or slightly converging anteriorly, their foremost ends widening (in casts) and forming crescentiform impressions with the convexity directed inwards. Fixed cheeks sloping rather steeply towards the sides, less than half as wide as glabella, with narrow depressed posterior border band seen in casts. Palpebral lobes small, shorter than eyes, hardly projecting laterally, gently arched from back to front and sloping down towards the sides, though less steeply than the rest of the fixed cheeks, situated a little behind the middle of glabella and at about their own length from posterior margin. Posterior branch of facial suture at first directed nearly straight backwards or slightly inwards, near margin turning somewhat outwards, or rather downwards, on account of the cheek being so strongly bent down, the two parts meeting at rather broad angle, about 150°; generally, and always in casts, the angle itself not sharp but slightly rounded. Anterior branches long, nearly parallel, but curving convergently inwards near front margin. Free cheeks nearly vertically bent down, gently convex, rather narrow, about half as wide as long, widest in front of eyes, where they are as wide as or wider than fixed cheeks, pointed anteriorly with the points directed inwards; genal angles widely rounded off; posterior part of lateral and posterior margin generally forming a continuous curve; lateral edge of curved part generally not protruding underneath nearly straight antero-lateral margin. [1] Doublure of free cheek underneath rounded angle with shallow groove or fold to receive ends of thoracic pleuræ when the animal is enrolled. Eyes prominent, small, short and wide, the width (height) a little less than half the length, with narrow raised lower eyelid marked off by broad shallow furrow, distinct in casts and continued on to fixed cheek in front of and behind palpebral lobe.

Rostrum slightly convex, most strongly arched near posterior margin, about half as long as middle width; anterior margin gently arched for-

[1] This is at least not the case in any of the free cheeks from the Leptæna Limestone examined by the writer, but in one free cheek from the East Baltic Area, figured by HOLM (1886, Pl. X, fig. 16 a), the curved part seems to project below the straight part.

wards; posterior margin obtusely angulated in centre, forming short median projection; lateral margins gently concave outwards, or angulated a little in front of their middle, so that they meet posterior margin at unusually small angles, although the angles between them and front margin are rather acute.

Hypostoma short and wide, irregularly pentagonal in outline. Anterior margin arched upwards and slightly backwards without border or furrow. Posterior margin arched upwards and somewhat forwards. Anterior lobe of central body convex, slightly depressed from the sides, sloping down posteriorly to the flattened, exeedingly short, posterior lobe, which bears a pair of small low transversely elongated maculæ; Median furrow only impressed at sides in front of maculæ. Anterior pair of wings comparatively long and narrow, slightly inclined; their lateral margins converging forwards. Posterior wings rather large, triangular in shape, nearly vertically inclined. Postero-lateral angles slightly rounded. Lateral and posterior margins with narrow raised borders. Border furrows deepest just behind anterior pair of wings.

Thorax of 9 segments. Axis distinctly but not strongly convex, decreasing in width posteriorly, in the middle a little more than two fifths the width of thorax. Inner straight horizontal part of side lobe on 1st segment about one fifth as wide as axis, increasing in width posteriorly to 6th or 7th segment to nearly twice its anterior width; posterior part of nearly uniform width, on last segment about half as wide as axis. Outer parts of pleuræ sharply bent downwards and also rather strongly backwards, on 1st pleura about half as long (from side to side) as inner part, on last segments the two parts are of about the same length.

Pygidium semielliptical to parabolic in outline, two thirds to three fifths as long as wide. The convexity is rather different in different specimens but generally its inner anterior part is rather gently convex and the marginal parts, especially posteriorly, rather steeply though not very suddenly bent down. Axis wide, about four ninths the width of pygidium, projecting on front margin and only its anterior part with slight independent convexity. Axial furrows only indicated by pair of short shallow marginal impressions. Straight horizontal portion of side lobe narrow, less than one third the width of axis and about half the length of posterior margin of facet. Lateral angles strongly and sharply truncated, not quite straight but slightly arched outwards. Facet narrow and elongate, about six times as long as wide, slightly concave, with rounded lateral angles, so that there is no sharp limit between anterior and lateral margins. Very shallow, on some specimens hardly discernible, groove behind fulcrum. Doublure rather narrow, at first slightly increasing in width posteriorly but forming a sharply pointed forwards directed projection in the middle line; inner portion convex with shallow median furrow;

marginal portion just behind facet nearly horizontally bent out, posteriorly gradually becoming less strongly bent.

Most of the Leptæna Limestone specimens are preserved as casts or the test is only partly or badly preserved. It is ornamented with minute punctæ and rather closely but irregularly placed coarser pits. Terraced lines are only observed on the places where they usually occur, viz. along the anterior margin of the cranidium, on the rostrum, the doublures and the facets.

Dimensions. — The specimens of this species vary remarkably as to size. The individual figured on plate II, figs. 14—17 is of about the ordinary size, but there are several much larger cranidia and pygidia found as well as very small ones. In the largest cranidium which I have seen the distance between the anterior and posterior margin is 68 mm. in some very small ones the corresponding distance is only a few mm.

Remarks. — HOLM's (1882) original description of *Ill. Linnarssoni* was founded only on material from the Leptæna Limestone. He was of the opinion, however, that some specimens from the Chasmops and Trinucleus formations were also referable to the same species and that the small differences which he observed were due only to individual variation (Cf. HOLM, 1886, p. 147). When revising the East Baltic Illænidæ he found, however, that the specimens of *Ill. Linnarssoni* which occurred in the older strata (C_2, C_3, and D) were in some features distinctly unlike those from the younger ones (F_1). In the former the angle between the different portions of the posterior branch of the facial suture is, according to him, quite sharp, not rounded off as in the latter, and the doublure of the pygidium is very wide and convex and its anterior margin is excavated in the middle so as to form a wide backwards convex curve, at the sides of which the edge projects in a pair of short points. Though he had no opportunity to examine the character of the pygidial doublure in the specimens from the Swedish Chasmops Limestone he seems inclined to believe that they were like the contemporaneous East Baltic form, which presumption is evidently correct, as confirmed by an examination of some pygidia from this formation which the present writer has had the occasion to make.

HOLM confines himself temporarily to regarding the two forms as only mutations in time. He thinks that it will perhaps prove necessary to refer them to different species and, since the younger form had already been described from the Leptæna Limestone as *Ill. Linnarssoni,* he considers himself compelled to regard this as the type form and call the older one forma *avus,* although he does not think it correct to regard a younger form as the type form. The fact is, however, that both forms occur in the Leptæna Limestone in Dalarne and, as was to be expected, the type form [which occurs in the East Baltic Lyckholm formation (F_1)] is only found in its upper part, whereas the form which occurs in the lower part corresponds to HOLM's forma *avus.* Since the difference in the doublure of the pygidium, as is also emphasized by HOLM, must be considered to be of rather great importance, and since moreover I have found some further points of difference than those noticed by him, I do not hesitate to refer the two forms to different species.

HOLM, who was not aware of the fact that the Leptæna Limestone in Dalarne is of very different geological age at different localities, has described and figured specimens of both forms as *Ill. Linnarssoni,* but evidently he has not observed the doublure of the pygidium in any of the older ones, but in this respect based his definition of the species solely on the character of the younger form. Since this is the chief character in which the two species differ from each other it is evident that it is the younger one which must keep the name *Ill. Linnarssoni,* all the more so as it is this one which, as is just mentioned, HOLM himself in his work on the East Baltic Illænidæ regards as the type form.

The circumstance that HOLM was not aware of the different ages of the specimens from Dalarne and had not observed the difference in their pygidia evidently made him regard several other points of difference only as individual variations. Both in the Leptæna Limestone specimens of *Ill. avus* and in the East Baltic ones (as far as can be judged from the figures and measurements) the axial part of the body is considerably narrower than in *Ill. Linnarssoni,* and at least in those first mentioned not only is the angle between the different portions of the posterior branch of the facial suture sharper, but the posterior portion is more strongly bent outwards and downwards, so that the angle becomes more acute, about 120°. In *Ill. Linnarssoni* it is about 150°. In the latter, at least in one specimen from the Leptæna Limestone, the angle is, as a matter of fact, also rather sharp when the test is preserved, whereas in the casts it is distinctly rounded.

The *Ill. avus* type seems, however, to have survived for rather a long period, since some of the varieties of this species are also found in boulders of North Baltic Östersjö Limestone and in the upper part of the Leptæna Limestone, and probably also in the Red Trinucleus Shales (Cf. below).

In the upper part of the Leptæna Limestone there occurs still another form, which HOLM has referred to *Ill. Linnarssoni* and which evidently is closely related to this species, the character of the doublure of the pygidium being for instance the same. The outline and convexity both of its cephalon and pygidium is, however, so distinctly different that I have thought it more correct to refer it to a separate species, which I have called *Ill. oviformis.* The three pygidia figured by HOLM, plate IV, figs. 23—27 in his paper of 1882, belong to this form, and his description of *Ill. Linnarssoni* is evidently partly made with reference to it.

Ill. Linnarssoni, as now restricted, is, as is already mentioned, found only in the upper part of the Leptæna Limestone, and it is one of its most common fossils. At Kallholn, for instance, detached parts of its carapace occur in very great abundance and also several entire or nearly entire individuals have been collected at this locality. The hypostoma, however, has never been found attached, but one was found together with a cephalon in such close proximity to its real place that it seems probable that it belongs to the same individual. It is of the same type as the one figured by HOLM, 1882, Pl. VI, fig. 15, and referred by him to this species.

In the Lyckholm formation (F_1) in Estland the species occurs, according to HOLM, in moderate frequency. It seems also to have been found in North Germany in boulders of Lyckholm Limestone, possibly of Leptæna Limestone (Cf. HOLM, 1886, 154). At least the pygidium described and figured by POMPECKI (1890, p. 69, Pl. III, fig. 13) is evidently correctly assigned to this species.

Ill. Linnarssoni is also recorded from the upper part of Etage 4 (BRÖGGER, 1884) and from Etage 5 (KJÆR 1897) in Norway. It is of course impossible, without seeing the specimens in question, to form a decided opinion as to whether they belong to this species. It seems, however, quite likely that it occurs in Etage 5, whereas there is more reason to believe that the specimens found in Etage 4 are referable to *Ill. avus*.

Affinities. — As mentioned above, *Ill. Linnarssoni* belongs to the group of species for which, in case it should be separated from *Illænus* s. str., HOLM (1886, p. 152) proposed the name of *Stenopareia*. All the species referable to this group seem to be very closely allied to each other and are distinguished by the following characters: Eyes and palpebral lobes small, situated at a great distance from the dorsal furrows and far back. Axial furrows well marked, broad (at least in casts). Posterior branches of facial sutures generally with hindmost portions more or less sharply bent outwards or straight. Free cheeks narrow, with rounded angles. Thoracic segments 9. Pygidium without or with only short and weak axial furrows; lateral angles abruptly and strongly truncated; facets long and narrow with rounded or obtuse angles.

HOLM refers the following species to this group: *Ill. Linnarssoni* HOLM, *Ill. Panderi* BARR., *Ill. Bowmani* SALT., *Ill. nexilis* SALT., *Ill. Thomsoni* SALT., *Ill. proles* HOLM, and *Ill. livonicus* HOLM. The thorax of the two latter is not known, but HOLM thinks it probable that since in other respects they show the characters of this group they had also 9 thoracic segments. *Ill. proles*, however, differs from the other members of the group in having comparatively large palpebral lobes and rather differently shaped free cheeks, which makes this presumption, at least as far as this species is concerned, seem rather doubtful.

In addition to those just enumerated the Girvan species *Ill. balclatchiensis* REED and *Ill. shallochensis* REED, described by REED 1904, are referable to this group, and further *Ill. æmulus* SALT., which species SALTER (1867) regarded as a subspecies of *Ill. Bowmani*, and of course *Ill. avus* HOLM and the new species *Ill. oviformis*.

Of the foreign species *Ill. Linnarssoni* (s. str.) seems to agree most closely with *Ill. Bowmani* and with *Ill. shallochensis.* In the latter, however, the pygidial doublure seems to be considerably broader, the posterior branches of the facial sutures are, according to REED, directed straight backwards and without any bend, the posterior border furrow seems to be distinct on the fixed cheeks also when the test is preserved, the occipital furrow is visible in casts, and the posterior edge of the rostrum searcely protrudes in the middle.

It is difficult to get a correct view of the characters of *Ill. Bowmani,* since, as already pointed out by HOLM (1886, p. 153), the species is badly characterized. From SALTER's description and figures it seems, however, as if the doublure of the pygidium was not bent as in *Ill. Linnarssoni* and as if its anterior edge was not protruding in the middle. The posterior as well as the anterior branches are said to be »nearly direct» (SALTER, 1867, p. 185) and the surface of the test seems to be smooth.

Horizons and Localities. This species is found in the upper part of the Leptæna Limestone at Kallholn, Osmundsberg, Boda Klittberg, Unskarsheden, and at Lissberg in Gulleråsen. Probably the specimen (or specimens) recorded by HOLM (1882, p. 109) from Arfvet also belongs to it.

It also occurs in the East Baltic Lyckholm formation and is also found in boulders in North Germany.

In Norway it is probably found in Etage 5.

Illænus oviformis n. sp. Pl. II, figs. 19—24.

1882. *Illænus Linnarssonii,* HOLM, Pl. IV, figs. 23—27.

Specific characters. — Entire body oviform in outline, middle portion flattened, marginal portions sharply bent down; enrolled individuals, seen from the side, also oviform in outline.

Cephalon sub-parabolic, about two fifths the length of the whole body, less than three fifths as long as wide; posterior middle portion flattened, lateral and anterior portions rather abruptly and nearly vertically bent down. In some specimens anterior edge less sharply bent down so as to form a narrow, indistinctly marked border. Anterior margin only slightly arched forwards, a little varying in different specimens. Glabella (also in a rather large specimen) not more than half as wide as distance between eyes. Length and direction of axial furrows, form and situation of eyes and palpebral lobes, and course of posterior branches of facial sutures as in *Ill. Linnarssoni.* Anterior branches of facial sutures gently converging anteriorly, nearly straight as far as to anterior edge of cephalon, where they turn rather abruptly inwards. Free cheek rather flat, more than twice as long as wide; genal angles not so widely rounded as in the species just mentioned.

Thorax of 9 segments. Axis relatively narrower and more convex than in *Ill. Linnarssoni;* inner flat parts of side lobes wider, on first segment fully one third, on last about five eighths the width of axis.

Pygidium sub-triangular in outline, about three fifths as long as wide, flattened above, lateral and especially posterior parts sharply bent down, in some specimens posterior edge even bent somewhat forwards. Axis about one third the width and half the length of pygidium, with slight independent convexity, at least in front, only in some specimens (all of them casts) obscurely defined posteriorly, sub-cylindrical, rounded behind and projecting on front margin. Axial furrows, in casts, very shallow, — on the surface of the test they do not seem to have been impressed at all — converging posteriorly, generally dying out before end of axis. Fulcrum situated relatively far outward, its distance from axis being more than half the width of latter and about equal to the length of the facet. At least in casts very shallow, narrow furrow behind straight portion of anterior edge of side lobe, dying out at fulcrum. Lateral angles strongly truncated and slightly arched outwards as in *Ill. Linnarssoni.* Facets and doublure of the same type as in this species.

Surface of test punctate.

Dimensions. — *Ill. oviformis* does not seem to attain such large dimensions as *Ill. Linnarssoni* and is evidently one of the smaller species of the genus. The specimens found are, however, rather varying in size. In the largest cranidia the distance between the anterior and the posterior margin is 29 mm., in the smallest one the corresponding distance is 10 mm.

Remarks. — Detached parts of the carapace (cranidia, pygidia and one free cheek) of this species have been found in considerable abundance at several localities in the upper part of the Leptæna Limestone. In HOLM's paper of 1882 no special reference is made to the cranidium, but the pygidium is described and figured (Op. cit. Pl. IV, figs. 25—26 and 27; the original of figs. 23—24 is probably referable to the same species, though the facets are unusually long) and assigned to *Ill. Linnarssoni.*

That the different parts really belong to the same species is confirmed by a later find of two enrolled individuals at Kallholn. One of these (Pl. II, figs. 19—20) is nearly perfect, the other, which is much larger, considerably defective.

Affinities. — *Ill. oviformis* is evidently very closely allied to *Ill. Linnarssoni,* and I have been rather doubtful whether to regard it as only a variety of this or to refer it to a separate species. Since, however, it is so well characterized by the different form and curvature of both cranidium and pygidium, by the narrowness of its axial parts, and by its more convex thoracic and better defined pygidial axis, I have come to the conclusion that the second alternative is the more correct one.

Horizons and Localities. — Upper Leptæna Limestone; Kallholn, Osmundsberg, Boda, Östbjörka.

Illænus avus HOLM. Pl. II, figs. 28—35, Pl. XI, figs. 35—37.

1857. *Illænus Rudolphi,* EICHWALD, p. 334.
1860. *Illænus Rudolphi,* EICHWALD, p. 1482, Pl. LIII, figs. 6 a—c.
1882. *Illænus Linnarssonii,* HOLM, p. 103 (pars), Pl. IV, figs. 13—20, Pl. V, figs. 1—5, 7—8.
1886. *Illænus Linnarssonii* forma *avus,* HOLM, p. 150, Pl. X, figs. 10—13.
? 1888. *Illænus Linnarssoni,* WIGAND, p. 76, Pl. IX, figs. 4—5.
1907 a. *Illænus Linnarssoni,* WIMAN, p. 138, Pl. VIII, figs. 12—15.
? 1907 a. *Illænus Linnarssoni,* WIMAN, p. 150.

Remarks. — As already mentioned *Ill. avus* was described by its author as a variety of *Ill. Linnarssoni,* but in consequence of the facts stated above, I have thought it more correct to refer it to a separate species.

HOLM (1886, p. 150) points out the following characters in which it differs from *Ill. Linnarssoni:* Posterior branch of facial suture sharply bent. Doublure of pygidium very wide, convex; its anterior margin in the middle forming a backward directed wide arch, bounded at the sides by a pair of obtuse-angled points, in one specimen [from the Kegel formation (D_2), the only one from this formation in which the pygidial doublure was known] divided by two additional smaller points into three secondary arches.

To judge from the figures and measurements of the type specimens, the axial part of the body is considerably narrower than in *Ill. Linnarssoni*, the glabella also in large specimens being less than half as wide as the distance between the eyes.

The original description was founded on material from the East Baltic Area (formations C_2 and D) only, but HOLM's presumption that the specimens from the Swedish Chasmops Limestone, previously attributed to *Ill. Linnarssoni,* had the same characters, has proved correct. Also the form which occurs in the lower part of the Leptæna Limestone, and which HOLM apparently believed was referable to *Ill. Linnarssoni* evidently belongs to *Ill. avus,* and this species seems to be represented also in the upper part of the Leptæna Limestone and probably also in the Trinucleus Shales of Sweden.

Since HOLM has mentioned only the chief characters in which *Ill. avus* differs from *Ill. Linnarssoni* and I have not myself had an occasion to examine the original East Baltic specimens and all details are not to be seen on the figures, most of the following remarks refer only to the Swedish examples.

The species is very variable in character and it is possible that it will prove suitable to refer some of the forms to separate varieties. One long and one short type can clearly be established, though no entire individual of any of these is found, but there are also intermediate forms. All the types, however, agree in the above characters and in all of them the angle between the different portions of the posterior branch of the facial suture is not only sharper than in *Ill. Linnarssoni*, but also more acute (about 120°).

The cephalon varies greatly in form and convexity, but it never seems to be so regularly arched as in *Ill. Linnarssoni*. At least as a rule the axial furrows on the cranidium extend more than one third the length of the latter. The anterior branches of the facial sutures run straighter than in the species just mentioned, and also their foremost parts are less sharply bent inwards. The lower eyelid, which is comparatively broad, is directed more outwards than in this species and the whole eye lobe is more prominent. The free cheek is flatter, the straight anterior part of its lateral margin very short, and the edge of the curved part behind more or less strongly projecting on it. This last feature is especially prominent on the cephalon figured on Pl. II, figs. 32—33. It is also to be seen on other specimens but seems to be less strongly pronounced on the elongate free cheeks than on the short ones. The doublure is, as usual, very sharply reflexed upon the dorsal part of the cheek along the curved part of the margin, and above the sharp edge there is a fold or groove to receive the thoracic pleuræ and the lateral edge of the pygidium, when the animal enrolls itself. This fold is situated higher up than in *Ill. Linnarssoni*, so that the sharp edge protrudes beneath the ends of the pleuræ in enrolled individuals as in *Ill. Esmarki* SCHLOT. (Cf. HOLM, 1882, pp. 29, 59, Pl. II, figs. 2, 3 and 1886, p. 32, Pl. I, figs. 2, 4). The shortness of the straight part of the margin is evidently connected with the circumstance that, unlike the conditions in *Ill. Linnarssoni*, only a very short part of the edge of the pygidium meets the free cheek when the animal is enrolled.

The hypostoma has never been found in position, but the one from Kullsberg figured by HOLM (1882, Pl. V, figs. 7—8) evidently belongs to this species. A few hypostomata which agree very well with this are also found in North Baltic Östersjö Limestone associated with other parts of the carapace of this species. It is of the same type as that of *Ill. Linnarssoni*, but the middle body is somewhat more convex and more rounded behind, the anterior pair of wings more protruding towards the sides and not reaching so far backwards, and the posterior margin is arched slightly backwards, and as a consequence of this the postero-lateral angles are more widely rounded.

The thorax (which is only preserved in a few individuals of the intermediate type) has a narrower and somewhat more convex axis than the thorax of *Ill. Linnarssoni*.

The pygidium is very variable in shape, but is generally relatively longer than in that species, its length being three fifths to two thirds the width. The axis is narrower, the facets longer and generally directed more backwards. The doublure is, as already mentioned, very wide. Its width is, however, rather different in different types and in some of them it decreases considerably in width anteriorly. It is convex but with at least the lateral parts of the edge bent outwards. The anterior margin is always arched backwards in the middle and the pair of points at the sides of the arch are very distinct. In well preserved specimens, in which it has been possible to lay the edge perfectly bare, there is also seen a pair of mediate points, which, however, are very short and very obtuse-angled. The part of the edge which lies between these points is less strongly bent down than the parts between them and the outer points, which, according to HOLM (1886, p. 148), is also the case in the pygidium from the East Baltic Etage D in which two pair of points have been observed.

The short cranidia (Pl. II, fig. 34—35, Pl. XI, fig. 36) are transversely sub-oval in outline; the length is about two thirds the width in front of the eyes; the posterior part is moderately convex, in the larger specimens more strongly arched from side to side than in the smaller ones; the front part is very suddenly and steeply bent down, the anterior edge even a little backwards, the anterior margin forming a very flattened forward curve. The axial furrows converge slightly but distinctly forward, — more strongly in the large than in the small specimens — but with the anterior ends gently curved outwards. The test is punctate, and along the anterior margin and parallel to it there is a number of continuous terraced lines. Similar though much shorter, more or less transversely arranged and irregularly curved lines are seen on most other parts of the cranidium, but only in such specimens in which the test is exceedingly well preserved.

In the elongate type of cranidium, illustrated on Pl. II, fig. 30, the length is equal or nearly equal to the width, the posterior part parallel-sided, the anterior part parabolic in outline. The posterior and middle part flattened from back to front, in the specimen figured very slightly arched from side to side, in the larger cranidia of this type, as in the large cranidia of the type just described, rather strongly and regularly curved. Anterior and antero-lateral parts very strongly bent down and with a very convex surface. Anterior edge bent slightly backwards and with the margin strongly and rather regularly arched forwards. Axial furrows nearly parallel but with the anterior ends, as usual, turned slightly outwards. At least in casts the posterior border furrows are distinct on the free cheeks, which is not the case in the short cranidia. The surface is ornamented with punctæ, and there are some continuous terraced lines along and parallel to the anterior margin. Whether such lines also occur on the posterior parts of the cranidium it is not possible to decide, since the test is not preserved in any of the specimens of this type which I have seen.

In the short free cheeks the greatest width is on a line with the posterior end of the eye and is equal to about two thirds the greatest length; in the elongate free cheeks it is in front of the eye and less than half the length. In the former the inner portion of the posterior margin is straight, whereas in the latter the genal angle is so widely rounded off that the whole of the posterior margin and the chief part of the lateral margin form one continuous curve (Cf. HOLM, 1882, p. 105, Pl. IV, figs. 18—20). In the short free cheeks the fold or groove on the inside is, as is already mentioned, situated rather high up. In the elongate type the fold is situated nearer the edge.

The form and convexity of the pygidium also vary very much. The relation between the projected length and the width seems to be about the same in all types, but if one takes the length along the surface, those pygidia which are found associated with the short cranidia are relatively considerably shorter than those which presumably belong to the elongate type of cranidia. The former (Pl. XI, fig. 35) are moderately convex, the anterior part rather flattened, the postero-lateral parts gently and rather evenly curved down. The axis is wide, nearly half as wide as the whole pygidium, with a slight independent convexity in front, or sometimes in casts even to the posterior end. There is a pair of marginal depressions, but otherwise the axial furrows are not marked. The straight part of the anterior margin of the side lobe is less than one third the width of the axis and not quite one third the length of the posterior margin of the facet. The facet is directed very strongly backwards and only slightly curved outwards. The doublure decreases only very slightly in width anteriorly; the median furrow is rather broad and deep in front, but grows less distinct posteriorly.

The pygidia (Pl. II, figs. 28—29), which probably belong to the elongate type of cranidia, are parabolic to sub-triangular in outline, flattened above and with the postero-lateral parts nearly vertically bent down. The axis is rather narrow, about one third the width of the whole pygidium, a little more strongly convex than in the type just described, and bounded in front by short shallow posteriorly converging axial furrows, which die out before reaching end of axis. The straight part of the anterior margin of the side lobe about half the width of axis and nearly half the length of the posterior margin of the facet. The facet is relatively strongly arched outwards, and its general direction is not so much backwards as in the short type of pygidia. The doublure decreases distinctly in width anteriorly and there are only faint traces of a median furrow in front.

Besides these extreme types there are also a great number of specimens which in some respects possess intermediate characters. But though there are great variations between these too, I have not found any regular series which connects the short and the elongate type. In none of the cranidia which with regard to their length and form are intermediate between the two extreme types, is the anterior edge bent backwards as in these or the posterior part so much flattened or the anterior one so strongly bent down; they are all more regularly arched. In some of the pygidia which are rather much pointed behind and have a relatively narrow axis the marginal parts are even more gently curved down than in the broadly rounded short type, and the surface of the facet is straighter. The small number of entire individuals that are known show, however, that in forms which have a comparatively long and narrowly rounded cranidium, the pygidium is more pointed behind than in those with a shorter and wider cranidium.

There is no entire individual known of any of the extreme types, but that the different parts must be associated as assumed above might be concluded from their respective shapes. The circumstance that at some localities only the short and broadly rounded cranidia and pygidia are found, confirms this, as far as this type is concerned.

HOLM's type specimen from the East Baltic Kucker formation (C_2) (HOLM, 1886, Pl. X, figs. 10 a—d) apparently belongs to the intermediate form. The cranidium from the Kegel formation (D_2) figured on the same plate (fig. 11) is of a shorter type and resembles the short cranidia from the Leptæna Limestone also in having the axial furrows rather strongly converging anteriorly. The free cheek from the same horizon and locality (Pl. X, fig. 12) is also relatively short and the inner part of its posterior margin is straight.

There are a few more or less well preserved entire individuals as well as detached cranidia and pygidia of this species found at different localities in the Chasmops Limestone in Östergötland. The different specimens vary considerably in shape but can all be said to belong to the intermediate type. The species is apparently also represented in the Chasmops Limestone at Fjecka in Dalarne, since the specimens from this locality as well as those from the Leptæna Limestone at Furudal, which TÖRNQUIST (1884, p. 55) refers to *Ill. Linnarssoni*, evidently belong to *Ill. avus*.

The small pygidia with strongly truncated lateral angles and the small fragmentary cephala found at some localities in the Red Trinucleus Shales, which HOLM (1882, p. 109) regards as a dwarf-form of *Ill. Linnarssoni*, probably belong to *Ill. avus* too, and seem to be referable to the short type.

Detached parts of the carapace (cranidia, free cheeks, rostra, hypostomata and pygidia) referable to this species have also been found in boulders of North Baltic Östersjö Limestone. WIMAN (1907 a, p. 138, Pl. VIII, figs. 12—15) has assigned these to *Ill. Linnarssoni*. He had evidently not seen the pygidial doublure and since he found that they agreed with specimens from the Leptæna Limestone and with the description and figures given by HOLM, and since he did not know that *Ill. avus* is also represented in this limestone and that HOLM's figures and descriptions partly refer to this, he apparently believed that they belonged to the former species s. str., not to HOLM's forma *avus*.

Both the short and the intermediate type is represented. On several of the specimens the test is exceedingly well preserved and its ornamentation seems to be the same in both types. It is punctate, as usual, and terraced lines are seen both on the dorsal side of the pygidia and on the cranidia nearly all over the surface. This suggests that the explanation of the fact that a similar ornamentation has only been observed in the short cranidia from the Leptæna Limestone is that no specimens of other types with really well preserved tests have as yet been found there and it is thus not to be regarded as a feature especially characteristic for that type.

In the short and widely rounded pygidia, which are all very small, the doublure decreases more in width and its surface grows more straight towards the sides than in the pygidia from the Leptæna Limestone, and its anterior margin is not so strongly arched backwards in the middle. I have not had the opportunity to examine the doublure of the pygidia of the intermediate type, but since they, as well as the cranidia of this type, otherwise show the characters typical for *Ill. avus* it seems justifiable to refer them to this species.

The small pygidium from the North Baltic Leptæna Limestone, which has the same form as the small short pygidia from the Östersjö Limestone, and which WIMAN (1901 a, p. 150) has likewise assigned to *Ill. Linnarssoni,* probably also belongs to *Ill. avus.*

There are some cranidia and pygidia found in boulders of Ordovician limestone in Mecklenburg, which WIGAND (1888, p. 76, Pl. XI, figs. 4—5) has referred to *Ill. Linnarssoni.* To judge from his description and figures it seems as if at least some of these belonged to *Ill. avus.* This is also confirmed by the fact that the specimens occur in »Backstein» Limestone and in a limestone which he considers to be Ortoceras Limestone, but which might be Chasmops Limestone. It appears as if both the short and the intermediate type were represented in these boulders and possibly the long narrow cranidium mentioned by WIGAND is referable to the elongate type.

HOLM (1886, p. 154) also mentions several finds of specimens of *Ill. Linnarssoni* (s. lat.) in boulders of Chasmops and »Backstein» Limestone at different localities in North Germany and presumably these are referable to *Ill. avus.*

Probably the specimens recorded from Etage 4 in Norway also belong to this species, as already pointed out above (p. 122).

In the lower part of the Leptæna Limestone in Dalarne this species occurs rather abundantly and is collected at most localities where this is exposed. There is one entire individual (figured by HOLM, 1882, Pl.

V, figs. 1—4) from Furudal in TÖRNQUIST's collection in the Lund Museum, and two entire cephala, now in the Upsala Museum, one of them with a few thoracic segments attached, have been collected by the present writer at Kullsberg. The species is also represented at some localities, e. g. at Osmundsberg, where there is reason to believe that the Leptæna Limestone in which it is found is of relatively young geological age.

Most of the specimens found are of the intermediate type, but the short type also occurs in moderate frequency, whereas the elongate type seems to be rare. It is found, however, both at Kullsberg and in the solid limestone at Amtjärn.

At Amtjärn the species occurs not only in the solid limestone which forms the Amtjärn hill but also, and especially abundantly, in the shales interstratifying the thin bands of limestone which underlie this and are exposed in the quarry at the south-west end of the hill.

The cranidia and pygidia found at Skattungbyn and Osmundsberg are all of the short type, but the free cheeks found associated with these at the latter locality are rather elongate.

The occurrence at Osmundsberg[1] is of special interest inasmuch as it shows that this type of *Ill. avus* still survived during the time when the upper part of the Leptæna Limestone was deposited and consequently attained an unusually long vertical range. The cranidia and pygidia from this locality agree very closely with those of this type found in the lower part of the Leptæna Limestone. The only difference is that some of the former are considerably larger than any of the latter. This suggests that the form varied in course of time inasmuch as it attained greater dimensions.

The specimens collected at Skattungbyn are also comparatively large and it is not improbable that the Leptæna Limestone which occurs here is of the same age as at Osmundsberg, but this question cannot be settled until its fauna is better known.

The species has likewise been found at Östbjörka, from where it is represented in the Upsala Museum by a pygidium of the intermediate type and by a short free cheek. Other fossils from Östbjörka prove that here also it is the upper part of the Leptæna Limestone which is most often exposed, or at least that it is in this that most collections have been made. Since, however, Leptæna Limestone has been exposed at several different places within this village and the limestone does not seem to form one continuous mass, it appears probable that the lower

[1] The Osmundsberg hill seems to consist of one continuous mass of limestone, and though its different parts might be of somewhat different ages at different places it appears as if the whole of it belonged to the upper part of the Leptæna Limestone. Of the great number of fossils collected here, the majority belong to species which form part of the fauna of the Upper Leptæna Limestone at other localities, e. g. at Kallholn, and some of these were found associated with specimens of *Ill. avus*.

part of it is also represented and that the specimens in question as well as the specimens of *Ill. fallax* and *Ill. gigas* collected at Östbjörka were found in this.

In the young Leptæna Limestone which forms the Lissberg hill in the village of Gulleråsen there also occurs a form which might be assigned to *Ill. avus*. It differs, however, in so many respects from all the types described above that it must be regarded as a distinct variety (var. *lissbergensis*) of the species (see below).

Dimensions. — *Ill. avus* seems on the whole to have been a smaller form than *Ill. Linnarssoni* though the specimens are of very different size. In HOLM's type specimen from the Kucker formation the projected length of the cephalon is said to be 36,5 mm. and that of the pygidium 28 mm. The known Swedish specimens both from the Chasmops and from the Leptæna Limestone, which are of the same — intermediate — type, are considerably smaller; in the largest cranidia the distance between the anterior and the posterior margin is about 22 mm. and the width in front of the eyes 27,5 mm.

The specimens of the short type found in the lower part of the Leptæna Limestone seem to have about the same average size as those of the intermediate type occurring in the same beds, whereas in the largest cranidium found at Osmundsberg the distance between the anterior and posterior margins is 31 mm. and the width in front of the eyes 34 mm. In the largest entire pygidium from this locality the distance from the anterior margin to the posterior end is 21 mm. and the greatest width 29 mm. and in another fragmentary pygidium the greatest width seems to have been nearly 40 mm. There are also some very small cranidia found at Osmundsberg, in the smallest of which the distance between the anterior and posterior margins is only 2,5 mm.

In the elongate cranidium from Amtjärn figured on plate II (fig. 30) the corresponding distance is 18 mm. and the width in front of the eyes 19,5 mm. The large cranidium of this type from Amtjärn, mentioned above, is, however, of much larger dimensions than any of the cranidia of the other types found in the lower part of the Leptæna Limestone, the distance between its anterior and posterior margins being 37 mm., and the width in front of the eyes 40 mm. The pygidium figured on plate II, figs. 28—29, which I believe belongs to this form, is also considerably larger than any of the pygidia of the short or the intermediate type found in the same part of the Leptæna Limestone or in the Chasmops Limestone.

Affinities. — It is evident from what is stated above that *Ill. avus* is closely allied to *Ill. Linnarssoni* HOLM and to *Ill. Bowmani* SALT. The reasons why it cannot be referred to the former of these two species have already been pointed out and need not be repeated here.

It cannot be united with *Ill. Bowmani* either, since in this species, according to SALTER (1867, p. 185, Pl. XXVIII, figs. 7—10), beside other dissimilarities, the glabella is wider, the facets of the pygidium much shorter and its doublure considerably narrower. The cranidia of *Ill. Bowmani* var. *brevicapitatus* REED (REED, 1896, p. 412, Pl. XX, fig. 4) and of *Ill. Bowmani* var. *longicapitatus* REED (op. cit. p. 412, Pl. XX, fig. 5) from the Keisley Limestone seem to correspond more or less with the respective short and elongate type of *Ill. avus,* but this correspondence need not prove any specially close relationship, since it appears rather natural that two nearly allied species should in some respects vary in the same directions.

The species seems on the whole to have more points of resemblance with the two Girvan species *Ill. balclatchiensis* REED (REED, 1904, p. 56, Pl. VIII, figs. 12—16) and *Ill. shallochensis* REED (op. cit. p. 68, Pl. X, figs. 2—5). REED has also compared both these species with *Ill. Linnarssoni* (s. lat.) and found that the similarity between this and the species first mentioned is especially great. Since he emphasizes the likeness in the truncation of the lateral angles and the doublure of the pygidia, it is evident that in this case he has chiefly taken into consideration the characteristics of *Ill. avus.* In *Ill. balclatchiensis,* however, the anterior ends of the axial furrows do not seem to be bent outwards, the eyes appear to be situated farther forward than in *Ill. avus,* and the course of the posterior branches of the facial sutures is different. In the pygidium the axis is more convex, the axial furrows more parallel and longer — in casts even united behind the axis — and there is a postaxial groove seen in casts.

In *Ill. shallochensis* the axial part of the cephalon and pygidium seems to be wider than in *Ill. avus,* the posterior branches of the facial sutures are said to be straight and vertical to the posterior margin, the border furrows are distinctly marked on the fixed cheeks, the posterior margin of the rostrum protrudes only very slightly in the middle and the outbent marginal part of the pygidial doublure seems to be comparatively wide.

Horizons and Localities. — *Ill. avus* occurs both in the lower and in the upper part of the Leptæna Limestone in Dalarne. It is found at Kullsberg, Amtjärn, Sinksjön, Furudal, Östbjörka, Skattungbyn, and Osmundsberg (at the two latter localities only the short type).

It is also found in the Chasmops Limestone at several localities in Östergötland, in Dalarne, and probably in Öland (Cf. HOLM, 1886, p. 154), in the Red Trinucleus Shales in Östergötland, and in boulders of North Baltic Östersjö and Leptæna Limestone.

In the East Baltic Area it occurs, according to HOLM (1886) and SCHMIDT (1901), in the Kucker (C_2), Itfer (C_3), Kegel (D_2), Wasselem (D_3), and Wesenberg (E) formations.

In Norway it is probably found in Etage 4. (Cf. above).

Further it seems to have been found in boulders of »Backstein» and Chasmops Limestone at several localities in North Germany.

Illænus avus var. lissbergensis n. var. Pl. II. figs. 25—27.

Remarks. — This form, which occurs at Lissberg in the village of Gulleråsen, differs rather much from all the types of *Ill. avus* described above, though it agrees with them in its chief characters, and has the most points of resemblance with the elongate type. It is represented by a considerable number of detached cranidia and pygidia, a few free cheeks and two hypostomata in the Museum of the Geological Survey. All of the specimens seem to have been found in the same piece of rock.

The cranidia are very elongate, generally about as wide as long, but the relation between length and width varies slightly in the different specimens. They are moderately and rather evenly convex or in the shorter, especially in the small, specimens somewhat flattened above. The outline forms a figure in which the posterior part is nearly parallel-sided, the anterior part either very regularly rounded or else slightly parabolic. The anterior margin is strongly arched forwards, though only gently curved in the middle. The axial furrows converge very slightly anteriorly, their foremost ends curved outwards as usual. The posterior border furrow on the fixed cheeks is very distinctly marked in casts. The free cheeks are of the elongate type with very widely rounded lateral angles. The hypostomata are comparatively short and wide.

The pygidia are very low, triangular in outline, about five sevenths as long as wide, flattened above and with the postero-lateral edge more or less steeply bent down. The axis is narrow, about one third the width of the pygidium; its anterior part with slight independent convexity and bounded by short, shallow, backwards slightly converging axial furrows. The straight anterior part of the side lobe is about three fifths the width of the axis and four fifths the length of the posterior margin of the facet, which is thus considerably shorter than in any of the types of *Ill. avus* described above. The doublure is comparatively somewhat narrower than in any of the types just mentioned, and it has a very indistinctly marked middle furrow.

Other fossils found at Lissberg indicate that the limestone here belongs to the upper part of the Leptæna Limestone and none of the other types of *Ill. avus* is found at this locality. It is possible that the form in question here ought to be referred to a separate species, but until the other forms of *Ill. avus* are better known it seems more advisable to regard it only as a variety of this species, though it undoubtedly deserves a distinctive name. The designation *Ill. avus* var. *lissbergensis* may be accordingly suggested.

Dimensions. — Among the known specimens of this form there are two rather large cranidia nearly of the same size. In both the width in front of the eyes is 30 mm., in the one the distance between the anterior and posterior margin is 29 mm., in the other 30 mm. The other cranidia are considerably smaller, most of them as well as most of the pygidia smaller than those figured (Pl. II, figs. 25 and 27). In the smallest cranidium the distance between the anterior and posterior margins is only about 4,5 mm. and the width in front of the eyes 5 mm.

Horizon and Locality. — Upper Leptæna Limestone; Lissberg in Gulleråsen.

Illænus cf. **parvulus** HOLM. Pl. II, figs. 6—7.

Description. — Cephalon about three fourths as long as wide, very strongly convex; front part of cranidium and free cheeks nearly vertically bent down. Glabella strongly raised, wide, between the middle of the eyes occupying more than three fourths the width of cranidium, gently decreasing in width anteriorly and more distinctly so posteriorly. Axial furrows shallow, deepening posteriorly, extending nearly as far forward as the anterior ends of the eyes, the hinder two thirds diverging anteriorly, the front parts gently curved inwards. Fixed cheeks narrow. Palpebral lobes long and narrow, moderately projecting laterally, situated at less than half their own length from posterior margin of cephalon, their distance from anterior margin about equal to their length. Posterior branch of facial suture nearly straight, directed backwards and slightly outwards. Anterior branch gently outwards concave. Free cheeks wide, largest width, behind the eye, about equal to middle length, irregularly pentagonal in outline; genal angles well rounded. Eyes rather large, crescentiform, with narrow (low) lower eyelids set off by shallow furrows. Anterior edge of cranidium and antero-lateral edge of free cheeks slightly protruding, forming a fold to receive edge of pygidium when the animal is enrolled. Rostrum fusiform, posterior edge hardly protruding in the middle.

Remarks. — In his paper of 1884 (p. 55) TÖRNQUIST mentions the occurrence of *Illænus parvulus* HOLM in the Leptæna Limestone at Osmundsberg. I have not been able to find the material on which his designation was founded. It seems probable, however, that it belonged to the same form as the specimens from the same formation and locality on which the above description is founded, namely a cephalon in the Lund Museum (collected by ISBERG, 1913) and a cranidium in the State Museum of Natural History, Stockholm.

The cephalon of this form is comparatively narrower and higher than in the type form of *Ill. parvulus,* which belongs to the fauna of the Chasmops Limestone. The cranidium is considerably more convex both from side to side and from back to front, and its anterior margin more strongly arched forwards; the palpebral lobes are more inclined towards the sides; the free cheeks are wider (higher), their greatest width being about equal to the middle length. The eyes are situated at about their own length from the anterior margin of the cephalon; in *Ill. parvulus* only at about two thirds their own length.

The form from the Leptæna Limestone seems also to attain larger dimensions than the Chasmops Limestone form. In the largest known cephalon of the latter, the distance between the anterior and the posterior margin is 4 mm. and the width 5 mm. In the entire cephalon from Osmundsberg the width is nearly 6 mm., the distance between the anterior and the posterior margins 5 mm., and in the detached cranidium from the same locality the corresponding distance is 6,25 mm.

On account of the differences mentioned above, it is evident that this form cannot be referred to the type form of *Ill. parvulus.* The different ages of the formations in which the two forms occur also contradict this assumption. Until more material of the Leptæna Limestone form is available it cannot, however, be decided whether it ought to be regarded as a younger variety of this or be referred to a separate species.

The cephalon from the North Baltic Östersjö Limestone, which WIMAN (1907 a, p. 138, Pl. VIII, figs. 20—22) with some hesitation has referred to *Ill. parvulus,* resembles the form from Osmundsberg with regard to size, but it is considerably wider and lower than this, and the course of the posterior branches of the facial sutures is different.

Horizon and Locality. — Upper Leptæna Limestone; Osmundsberg.

Illænus sp. ind. a.

1882. *Illænus* sp. ind., HOLM, Pl. III, figs. 20—21.
? 1882. *Illænus* sp. ind., HOLM, Pl. III, figs. 18—19.

Remarks. — In TÖRNQUIST's collection in the Lund Museum there is a nearly entire though very badly preserved and broken individual from Amtjärn (figured by HOLM, 1882, Pl. III, figs. 20—21), and in the same piece of rock a pygidium with 9 thoracic segments attached (ibid. Pl. III. figs. 18—19), which seems to belong to the same form.

On account of the bad condition of the specimens the characters of the form are difficult to define, but it seems to be very closely related to the new species *Ill. dalecarlicus* (see p. 114 above and Pl. II, figs. 10—13) and to *Ill. angustifrons* HOLM [HOLM, 1886, p. 130, Pl. IX, figs. 1—3 (the type form), Pl. VIII, figs. 14—22 (var. *depressa*)]. The axial furrows on the cephalon do not, however, seem to reach as far forward as in either of these, and the eyes are situated a little more forward. The anterior margin of the cranidium is more strongly arched forwards than in *Ill. dalecarlicus* and in *Ill. angustifrons* var. *depressa*, but not so strongly as in the type form of the latter species. The free cheeks are more strongly and suddenly bent down than in *Ill. dalecarlicus* and in the type form of *Ill. angustifrons* (of var. depressa only detached parts of the cephalon and the pygidium are known), and consequently the outline of the cephalon is more semioval. The outer parts of the side lobes of the thorax are also more strongly bent down. The rostrum is rather like that of *Ill. dalecarlicus* in shape, but it is comparatively much larger and slightly longer (from back to front) in relation to the width between the lateral extremities.

The pygidium of the entire individual seems to be of about the same form as that of *Ill. dalecarlicus,* and probably the posterior part of the edge was flattened out to form a concave border (only the doublure of this part is preserved), whereas the anterior part is, contrary to the case in this species, rather steeply bent down. The pygidium of the other specimen is short and broad and very widely rounded behind, and only the posterior part of the edge forms a very narrow, flattened border.

The ornamentation of all parts of the carapace appears to be similar to that of *Ill. dalecarlicus.* On the entire individual it is only to be seen on certain places, but on the other specimen it is very distinct nearly everywhere (Cf. HOLM, op. cit. Pl. III, fig. 19).

Horizon and Locality. — Lower Leptæna Limestone; Amtjärn.

Illænus sp. ind. b. Pl. II, fig. 9.

Description. — Two hypostomata in the Upsala Museum, one from Sätra, the other from Kullsberg, exhibit the following characters: — Width behind anterior wings five sevenths the length; very gently tapering posteriorly and widely rounded behind. Anterior margin gently arched forwards; lateral margins continuous with posterior margin. Anterior lobe of central body strongly raised, compressed from the sides and slightly keeled in the middle, rounded, slightly tapering posteriorly, somewhat longer than width across middle. Posterior lobe gently convex, crescentiform, with pair of small, low, oval maculæ at anterior edge. Median furrow rather shallow, though quite distinct. Lateral border furrows from base of anterior wings to median furrow deeply impressed; their posterior parts shallow and continuous with similarly shallow posterior border furrow. Anterior border narrow (from back to front), flat, as usual continuous with anterior wings. Lateral and posterior borders narrow, raised. Anterior pair of wings extending about three eighths the length of the hypostoma, narrow, slightly inclined towards the sides; their lateral edges are not very well preserved on either of the specimens, but they seem to have been cut off squarely. Posterior pair of wings small, triangular.

Remarks. — The hypostoma seems to be rather like that of *Ill. fallax* HOLM, but it is somewhat more elongate, its posterior part (behind the anterior wings) is more parallel-sided and more widely rounded behind, the anterior wings do not reach so far backwards, and the anterior margin is more evenly arched forwards.

Horizon and Localities. — Lower Leptæna Limestone; Kullsberg, Sätra.

Illænus sp. ind. c.

1882. *Illænus* sp. ind., HOLM Pl. III, fig. 22.

Remarks. — The hypostoma figured by HOLM, 1882, Pl. III, fig. 22 is rather unlike other known *Illænus* hypostomata, though it is evidently referable to this genus. It is characterized by the following features: Width behind anterior wings about three fourths the length; very slightly tapering posteriorly and widely rounded behind. Anterior margin gently arched backwards. Anterior lobe of central body short, nearly hemispherical, situated uncommonly far backward. Posterior lobe very slightly raised, of the usual shape but comparatively large; maculæ not observed. Anterior border wide (from back to front), flat, as usual continuous with anterior pair of wings. Lateral and posterior borders badly preserved but seem to have been very narrow. Anterior pair of wings flat, extending about half the length of hypostoma, their lateral margins converging anteriorly

Horizon and Locality: Upper Leptæna Limestone; Osmundsberg.

Genus **Bumastus** MURCHISON.

Bumastus nudus ANGELIN. Pl. II, figs. 1—5.

1854. *Bronteus? nudus,* ANGELIN, p. 90, Pl. XLI, fig. 19—20.
1898. *Illænus (Bumastus) nudus,* HOLM, p. 135, Pl. V, figs. 1—5.

Specific characters. — Cranidium about as long as width between eye lobes, rather weakly or moderately convex; anterior edge regularly arched forwards, very slightly produced to form a narrow, ill-defined border (in casts not or hardly discernible). Glabella gently convex, very long, being in length about seven eighths that of cranidium, strongly contracted between the eye lobes but widening again at front to more than its basal width. In casts a narrow (from back to front) occipital band is seen and in front of this a small median tubercle. Axial furrows strongly concave outwards and with the anterior and posterior portions meeting at obtuse angles; in the only testiferous specimen known rather broad and shallow, long, reaching nearly to anterior margin and terminating in small faintly defined pits; in casts their posterior portions quite strongly marked, then widening at angles to form small, rather deep, oval impressions, growing more shallow and narrower anteriorly and dying out before reaching the terminating pits, which are generally quite distinctly marked (See HOLM, 1898, Pl. V, figs. 1, 2). Free cheeks inside the eyes generally a little more than half as wide as the glabella, gently sloping towards the sides and a little more strongly towards the back and front; slightly impressed posterior border furrow seen in casts. Palpebral lobes rather small, moderately projecting laterally, their distance from the posterior margin about half their distance from the anterior one and a little less than their own length. Posterior branch of facial suture at first running nearly straight backwards, but with the posterior portion turning rather strongly outwards to meet posterior margin of cranidium at acute angle; anterior branch slightly outwards convex. Free cheek weakly convex, its width about three fourths its middle length; genal angle bluntly pointed; lateral margin slightly arched outwards; posterior margin nearly straight.

Hypostoma sub-triangular in outline, width behind anterior wings nearly equal to the length, tapering anteriorly and rather narrowly rounded behind. Anterior margin rather strongly arched forwards; lateral margins continuous with posterior margin. Anterior lobe of central body elongate-oval, reaching to anterior margin, very strongly raised, compressed from the sides. Posterior lobe small, depressed, of the usual shape; with pair of very prominent, oval maculæ. Median furrow only impressed in front of maculæ. Lateral border furrows from base of anterior wings to maculæ broad and deep; their posterior portions narrow and shallow. Lateral and posterior borders narrow, raised. Anterior pair of wings triangular in outline, rather small, gently sloping backwards and somewhat outwards.

Pygidium semioval, a little longer than wide, moderately and rather evenly convex, becoming concave near margin to form an ill-defined concave border, on small specimens very weakly marked at the sides and dying out posteriorly, on larger ones more distinct and continuing round end of pygidium; antero-lateral edges rather suddenly bent downwards and continuous with lateral portions of facets; sometimes in casts a very slight median longitudinal ridge is seen running from near centre to posterior extremity. Axis only traceable in front, where it is strongly raised over the straight parts of the side lobes and projecting on front margin, very wide, nearly three fifths the width of pygidium, with narrow (from back to front), depressed articulating band at anterior edge. Straight anterior parts of side lobes very narrow, less than one tenth the width of axis. Inner portion of fulcrum prominent, with deep, broad furrow behind; lateral portion very weak. Facet rather small; inner portion rather suddenly bent down; lateral portion very indistinctly set off with slightly concave surface; anterior margin gently arched backwards; lateral angles slightly pointed. Doublure narrow, gently decreasing in width anteriorly to about three fifths its basal width, strongly concave with its inner portion bent upwards nearly vertically.

Surface ornamented with rather closely but irregularly placed punctæ and the usual terraced lines along the anterior margin of the cranidium and on the doublure of the pygidium.

Dimensions. — Among the known specimens of this species there is one cranidium in which the distance between the anterior and posterior margins is 30 mm. and the width in front of the eye lobes 32 mm.; the other cranidia are considerably smaller, most of them smaller than the one figured in this paper (Pl. II. fig. 1); in the smallest ones the distance between the margins is only about 6 mm. In the largest pygidium which I have seen the width is 29 mm. and the distance between the anterior margin and the posterior end 25,5 mm. ANGELIN's figure of the pygidium of *Bronteus? nudus* (ANGELIN, 1854, Pl. XLI, fig. 20) is of considerably larger dimensions, but it is possible that it is enlarged, although it is said to be of natural size. His figures of the cranidium (figs. 19, 19a) are also rather large.

Remarks. — In the 2d part of Palæontologia Scandinavica (1854) ANGELIN figures on Pl. XLI, figs. 19, 19a and 20 under the name of *Bronteus? nudus* a cranidium and a pygidium of a trilobite from the Regio Harparum in Dalarne, i. e. the Leptæna Limestone. The type specimens are not to be found, and the accompanying description (p. 90) is, as usual, very brief. In the Museum of the Geological Survey, Stockholm there are a considerable number of cranidia and pygidia and a few free cheeks from Lissberg in Gulleråsen, collected by von SCHMALENSÉE in the summer of 1883, which HOLM (1898) has described and referred to this species, which as he points out does not belong to the genus *Bronteus* but to *Bumastus*. The pygidia agree rather well with ANGELIN's figure, whereas his figures of the cranidium differ in some characters from the cranidia from Lissberg, especially the front part, but it seems as if this part had not been preserved on the specimen, but was supplemented in the figures (Cf. HOLM, op. cit., p. 136).

There is also a hypostoma from Lissberg found together with the other parts of the carapace. It is of the common *Bumastus* type and evidently belongs to the same species.

Further there is a cranidium from Osmundsberg in the Upsala Museum, which is referable to this species, although it is more gently convex than the cranidia from Lissberg, and the glabella is not so strongly contracted between the eyes. In this the test is preserved, which is not the case in any of the specimens from Lissberg. It seems rather probable that ANGELIN's type specimens were also found at Osmundsberg.

Affinities. — *Bum. nudus* does not seem to be particularly closely related to any other known species. As already mentioned (p. 99), it resembles *Ill. dalecarlicus* and *Ill. angustifrons* in the general appearance of the cranidium. The anterior edge is, however, produced into a liplike border or is sharp (in casts), not smoothly rounded as in these, the axial furrows extend farther forwards and terminate in pit-like depressions. The latter feature is characteristic of most Bumastids, but, as far as I know, is nót found in any species of *Illænus* (s. str.).

The pygidium agrees with that of *Bum. Macallumi* SALT. (SALTER, 1867, p. 210, Pl. XXVII. fig. 1, Pl. XXX, figs. 2, 3; REED, 1904, p. 65, Pl. IX, figs. 8—9) in having a narrow, straight inner part on the side lobe (not generally marked in the Bumastids) and a strong postfulcral furrow, but its shape and convexity are different and the cranidia of the two species are very unlike each other.

Horizon and Localities. — Upper Leptæna Limestone; Lissberg in Gulleråsen, Osmundsberg.

Family **Bronteidæ** ANGELIN.

Genus **Bronteus** GOLDFUSS.

Bronteus laticauda WAHLENBERG.

1818. *Entomostracites laticauda,* WAHLENBERG, p. 28 (pars), Pl. II, fig. 8 (non fig. 7).
1822. *Asaphus laticauda,* BRONGNIART, p. 24 (pars), Pl. III, fig. 8 (excl. cephalon).
1826. *Asaphus (Illænus) laticauda,* DALMAN, p. 251 (pars).
1837. *Illænus laticauda,* HISINGER, p 17 (pars), Pl. III, fig. 6 (excl. cephalon).
1845. *Bronteus laticauda,* BEYRICH, p. 42, Pl. figs. 8 - 9.
1854. *Bronteus laticauda,* ANGELIN, p. 57, Pl. XXXIII, fig. 2.
1857. *Bronteus insularis,* EICHWALD, p. 336.
1858. *Bronteus hibernicus,* SCHMIDT, p. 189.
1859. *Bronteus laticauda,* NIESZKOWSKI, p. 370.
1861. *Bronteus insularis,* EICHWALD, p. 1492, Pl. LIII, fig. 9.
1878. *Bronteus laticauda,* ANGELIN (LINDSTRÖM ed.), p. 57, Pl. XXXIII, figs. 1 a– 2.
1884. *Bronteus laticauda,* TÖRNQUIST, p. 52.
1894. *Bronteus laticauda,* SCHMIDT, p. 34, Pl. III, figs. 9—11.
1901. *Bronteus laticauda,* LINDSTRÖM, p. 44, Pl. II, figs. 6—13.

Specific Characters. — Cephalon very wide, nearly semicircular, flattened, with genal angles broadly produced into relatively long, tapering, pointed spines; depressed border surrounding cephalon and extending to tip of spines; border in front of glabella rather different in different specimens, in some narrow (from back to front), in others relatively wide, sometimes almost flat at least in the middle and set off by shallow furrow, sometimes slightly concave and not distinctly bounded behind, outside frontal lobe considerably increasing in width and always distinctly concave, but growing narrower and less concave again towards tip of spines. Cranidium with narrow anterior edge steeply bent down, and gently arched. Glabella weakly convex, consisting of a long neck portion, nearly two thirds the length of the whole glabella, and a short, expanded anterior portion, the frontal lobe, more than twice the width of neck at base and projecting laterally so as to overhang the cheeks. Frontal lobe very slightly convex, with indistinctly defined, obtusely pointed lateral extremities and with anterior end gently arched forwards, but in most specimens with a slight impression in the centre; width of frontal lobe about equal to one and a half times the length of the whole glabella. Neck slightly tapering from occipital furrow to 2d pair of lateral glabellar furrows, anteriorly increasing in width again, keeled in the middle and with the highest point in the median line just in front of occipital furrow, the short slope towards the latter being rather steep, the slope towards frontal lobe very gentle. 3 pairs of lateral glabellar furrows present, with their inner ends placed about equal distances apart. The two anterior pairs directed inwards and slightly forwards. Front pair situated at base of anterior expanded portion of glabella, very short, extending inwards less than one fourth the width of glabella; its inner portions forming distinctly impressed circular pits; its lateral portions very shallow. 2d pair extending nearly one third across glabella, consisting of obtusely defined, elongated pits continued outwards by faint furrows. 3d pair represented by two isolated, very indistinctly marked, rounded impressions, not reaching as far inwards as 2d pair and situated somewhat nearer to it than to occipital furrow. Axial furrows outside neck of glabella strong and deep, but very shallow in front, at first slightly converging anteriorly to 2d pair of lateral glabellar furrows, then somewhat more strongly diverging to 1st pair and with the anterior parts strongly curved outwards. Occipital furrow strong and deep but decreasing in depth towards the sides and not reaching axial furrows, very slightly arched forwards in the middle. Occipital ring flattened, gently arched from side to side and with straight posterior margin.

Fixed cheeks in front and inside palpebral lobes rather narrow, rising up on each side of glabella to eye lobes situated at a distance from axial furrows less than half the width of the glabella and nearly at the same level as it. Palpebral lobes very large and prominent, sub-elliptical in outline, but with length only a little greater than width, situated far back, less than their own length from posterior margin of cephalon, surface flattened or gently concave from back to front. A strongly curved furrow on each side marks off a small sub-circular to sub-elliptical area at axial furrow inside palpebral lobe. Another pair of furrows starting at axial furrows at base of frontal lobe runs in a gentle curve nearly parallel to anterior margin to facial sutures and is continued on free cheeks. Posterior wing of fixed cheek extended far outwards with narrow (from back to front) depressed articulating band along its hind border continued a little more than two thirds the way out; posterior margin directed nearly straight outwards for about two thirds its length, then curving slightly backwards but with the end directed more straight outwards again; posterior border furrow shallow but quite distinctly impressed, beginning at axial furrow just behind the small sub-circular area mentioned above, and running obliquely backwards in a gentle curve to posterior branch of facial suture and then outwards about halfway along this. Posterior branch of facial suture long, at first directed outwards and very slightly backwards, then curving more strongly backwards and cutting posterior margin of cephalon at very acute angle nearly halfway out to genal angle. Anterior branch only a very little longer than posterior one, running in a gentle curve obliquely outwards from eye to antero-lateral margin with a general inclination of about 60° to posterior margin of cephalon.

Free cheek sub-triangular and transversely elongated in shape, produced backwards into a tapering, acutely pointed genal angle and with the lateral and posterior margins gently outwards and forwards convex; inner portion of cheek slightly swollen, rising up to eye and separated by shallow groove from depressed convex median portion, sloping down to rather wide concave border not marked off by any distinct furrow; point flattened. Eye very strongly rounded, but comparatively low and narrow. Doublure of free cheek extending as far inwards as to inner swollen portion of cheek and continued rather far forwards underneath anterior portion of cranidium, very strongly concave (convex when seen from the under side). Rostrum not known.

Hypostoma nearly as long as width across anterior pair of wings, slightly tapering posteriorly; anterior margin with somewhat flattened curvature and very slightly and obtusely angulated in the middle; antero-lateral angles rounded; lateral margins slightly converging posteriorly and continuous with gently backwards convex posterior margin. Antero-lateral portions of edge somewhat depressed, but not separated from middle body by any furrow; lateral and posterior edges flattened, forming a continuous border, gently bent up at the sides, steeply behind, marked off by shallow continuous furrow ending at each side inside anterior pair of wings; middle furrows short, oblique, deep in front of maculæ, but shallow towards the sides, not united across middle of body. Central body extending to anterior margin of hypostoma; anterior lobe more than two thirds the length of whole body, rounded, strongly convex and slightly compressed from the sides; posterior lobe crescentiform, depressed-convex, with pair of prominent, large, pointed-oval, slightly oblique maculæ. Anterior pair of wings small, pointed, sub-triangular in shape, nearly vertically inclined. Posterior pair of wings bent obliquely inwards, broadly triangular.

Thorax with gently raised axis of about uniform width (only a portion of the thorax is known as yet) and slightly narrower than the pleuræ. Pleuræ unfurrowed, flattened; their inner portions horizontal, with narrow, flattened anterior and posterior articulating borders; their lateral portions very slightly bent down with the ends pointed and directed backwards.

Pygidium semielliptical in outline with the lateral angles very slightly rounded, about three fourths as long as wide; inner anterior portion very slightly convex; marginal portion flattened or, generally, flattened behind, gently concave at the sides. Anterior margin nearly straight or gently arched backwards outside very weak fulcrum, which latter is situated about halfway out. Anterior edge bent down or very slighly depressed but not forming any distinct articulating band. Axis short, sub-conical, rounded behind, weakly convex, broader than long, slightly more than one fourth the length of pygidium and less than one fourth its width; one anterior axial ring (or half ring) set off by shallow furrow, dying out before reaching axial furrows; posterior part of axis unfurrowed. Axial furrows very faint, generally slightly inwards concave, converging posteriorly and not impressed behind end of axis. Side lobes apparently composed of 7 pairs of pleuræ. 6 anterior pairs simple, radiating from the sides of the axis, gently raised, broadening and decreasing in height towards their outer extremities, flattened near margin, not regularly rounded but highest near their inner posterior edge — which feature is not so conspiciuous at first but grows more distinct as they become broader and flatter — and separated from each other and from 7th pair by rather narrow, shallow but distinct, gently curved interpleural furrows, rounded at bottom, generally dying out near margin, and in most specimens rather faint near axis. 7th pair, fused, forming a broad, gently raised postaxial piece decreasing in height towards the margin, at first gently tapering posteriorly but soon broadening again to considerably more than its frontal width; anterior portion without any trace of an interpleural furrow; posterior portion with faint median furrow of varying length, generally beginning about halfway up postaxial piece and dying out near margin, in some specimens not discernible at all, sometimes continued forwards by faint ridge or keel — representing the »high» inner edges of fused pleuræ — which soon becomes obsolete. Doublure very wide, increasing in width posteriorly, nearly two thirds the length of pygidium, inner portion gently convex or, in some specimens, flattened, with weak median groove; marginal portion wide, slightly concave all round or concave in front, flattened behind, marked by narrow, slightly raised, radiating ridges (furrows on the underside, i. e. the real surface of the doublure) lying underneath the highest portions of the dorsal parts of the pleuræ, dying out near margin and separated by broad, shallow grooves. The ridges are generally continued on the inner portion of the doublure, where they increase considerably in width but are always very weak.

Test of nearly all parts of the carapace ornamented by fine, irregular terraced lines. On the inner part of the cephalon the lines are rather strongly undulating and concentric to the highest portions, on the middle parts of the free cheeks gently curved with the convexity directed inwards and forwards, and on the border and doublure of the cephalon nearly parallel to the margin. On the hypostoma they are concentric to the lateral and posterior margins, meeting anterior margin at more or less acute angle. On the thorax they arch over the axis with the convexity of the curve forwards; on the pleuræ the curve is reversed. On the dorsal surface of the pygidium the lines are rather coarse; on the axis arched forward, on the side lobes very strongly undulating, incrossing the pleuræ and generally interrupted in the furrows; their general direction is not parallel to the margin but more transverse. On the doublure of the pygidium, on the other hand, they are nearly parallel to the margin and continuous all round, though generally rather indistinctly marked on the highest edges of the ridges.

Dimensions. — *Br. laticauda* seems to attain rather large dimensions but does not belong to the largest species of the genus. The specimens vary, however, considerably in size. The smallest pygidium from the Leptæna Limestone which I have seen is only 13 mm long, while the largest one measures 84 mm. In the cranidia from the same formation the length varies between 13 and 31 mm.

Remarks. — This species is one of the fossils most frequently met with in the Upper Leptæna Limestone, although no entire individual is known as yet either from this formation or from other formations in which it occurs.

Among the specimens from Osmundsberg in WAHLENBERG's collection in the Upsala Museum there are three pygidia from which WAHLENBERG's original figure of the species (1818, Pl. II, fig. 8) probably was drawn.

ANGELIN's restoration of the entire individual (1854, Pl. XXXIII, fig. 2) is in some respects incorrect, especially as regards the outline of the cephalon and the shape and direction of the free cheeks [Cf. the restored figure of a cephalon on Pl. III (fig. 8) below]. On the thorax the side lobes are too wide in comparison with the axis, and the latter ought to be more parallel-sided.

BEYRICH (1845, p. 34) has suggested an interpretation of the structure of the Bronteid pygidium, according to which all the furrows on the side lobes would not be of the same nature. Only the 2d, 4th etc. furrows would be real interpleural furrows, the 1st, 3d etc. pleural furrows, each pleura accordingly consisting of two separated bands. BARRANDE (1852, p. 837) did not accept this hypothesis but considers that each of the lateral ridges represents a pleura, since this is the case in other genera with ridged pleuræ (on the thorax).

Even if one does not consider that the difference between the ridged and the furrowed pleuræ has a specially great morphological significance, one must agree with the author last mentioned that it does not seem probable that a form in which the thoracic pleuræ are unfurrowed would have so distinctly marked pleural furrows on the pygidium. Moreover a comparison between the Bronteid pygidium and the more primitive pygidium of *Bronteopsis scotica* SALT. (REED, 1904, p. 94, Pl. XIII, figs. 5—13), a species apparently very closely related with *Bronteus,* favours BARRANDE's opinion.

While on the strongly reduced axis of the former the evidences of segmentation have entirely disappeared, or only exceptionally (e. g. *Bronteus planus* CORD., *Bronteus simulans* BARR.) a few rings are faintly indicated, the considerably longer axis of *Bronteopsis scotica* is fairly distinctly segmented. REED (Op. cit,, p. 95) states that the latter is composed of 5—7 rings and a terminal pointed piece. To judge from the figures there seem as a rule to be 6 rings (when the articulating half ring is not counted as a separate ring), though sometimes the posterior ones might be very indistinctly marked. On the side lobes there are 6 narrow, slightly raised ridges on each side, corresponding to the axial rings and apparently each of them representing a pleura. The pleuræ are separated by rather broad furrows and between the 6th pair there is a comparatively wide postaxial smooth portion traversed down its centre by a single median narrow ridge, probably representing the completely fused 7th pair of pleuræ.

Affinities. — SCHMIDT (1894, p. 34) was of the opinion that the defective pygidium described and figured by PORTLOCK (1843, p. 270, Pl. V, fig. 8 a—b) as *Br. hibernicus* PORTL. probably is referable to *Br. laticauda,* but whether this is really the case it is not possible to decide from the figures available. Anyhow, the two species seem to be very closely allied to each other. Together with the other known Ordovician species, *Br. craigensis* REED (REED, 1904, p. 89, Pl. XII, figs. 12, 13), *Br. Grayi* REED (REED, 1904, p. 90, Pl. XII, fig. 14) and *Br. lunatus* BILL. (BILLINGS, 1863, p. 188, fig. 187) they form a group which differs from the Silurian and Devonian members of the genus in having a pygidium with only 6 pleuræ on each side of the fused median pair. Possibly this group ought to be separated from *Bronteus* s. lat. and be referred to a separate genus or sub-genus, but since except in the case of *Br. laticauda* and *Br. lunatus* only the pygidia of these species are known as yet, this question has better be postponed until more material is available.

The pygidium of *B. lunatus* is very similar to that of *Br. laticauda* but seems to have a somewhat longer axis (Cf. WELLER, 1903, Pl. XV, figs. 14—16) and the cephala of the two species are rather unlike each other. In that of the former the anterior portion of the glabella is not so strongly and suddenly expanded towards the sides as in that of the latter, the neck is shorter, only extending to the 2d pair of lateral glabellar furrows, the free cheeks are longer and wider, and the anterior branches of the facial sutures turn rather strongly inwards before reaching the anterior margin.

Br. Grayi differs in having a much longer and wider pygidial axis with two well marked furrows on its anterior end.

In *Br. craigensis* the axis seems, to judge from the figures, to be shorter and wider than in *Br. laticauda* and the whole pygidium to be more convex; the 6th pair of pleuræ are, according to REED, very indistinctly defined, whereas they are quite distinctly marked in the species last mentioned, and the 7th pair completely fused, without trace of an interpleural furrow.

Horizons and Localities. — The species is found in the Upper Leptæna Limestone in Dalarne at Osmundsberg, Kallholm, Boda, Unskarsheden, Westanå, Klittberg and, according to BEYRICH, at Dalbyn.

It further occurs in the Lyckholm Formation (F_1) in Estland and, according to KJÆR (1897), in Etage 5a in Ringerike in Norway.

Family **Holotrachelidæ** n. fam.

Cephalon large, convex, surrounded by distinct border. Glabella tumid, nearly smooth. Free cheeks large and separate. Facial sutures cutting the posterior margin of the cephalon well within the genal angles. Eyes prominent and placed rather far forward. Thorax with distinctly furrowed pleuræ. Pygidium small with free ending pleuræ.

Genus **Holotrachelus** LINNARSSON.

Complete body oviform in outline. Cephalon strongly convex with rounded lateral angles. Glabella well defined, long, rather strongly convex, narrower and rounded in front, separated from anterior border by short preglabellar field; lateral glabellar furrows and occipital furrow obsolescent. Cheeks broad. Eyes prominent, placed near the glabella and far forward. Hypostoma rather hour-glass shaped. Thorax with convex axis, wider than side lobes; axial furrows hardly impressed; segments 8 with furrowed pleuræ. Pygidium with gently convex axis, composed of 3 rings and a terminal piece; side lobes with 4 pairs of flattened pleuræ with free outer portions placed close to each other and with truncate ends.

Holotrachelus punctillosus TÖRNQUIST. Pl. III, figs. 16—25, text-fig. 16.

1818. *Entomostracites laticauda,* WAHLENBERG, p. 28 (pars) Pl. II, fig. 7 (non. fig. 8).
1822. *Asaphus laticauda,* BRONGNIART, p. 24 (pars), Pl. III, fig. 8 (excl. pygidium).
1826. *Asaphus (Illænus) laticauda,* DALMAN. p. 251 (pars).
1837. *Illænus laticauda,* HISINGER, p. 17 (pars), Pl. III, fig. 6 (excl. pygidium).
1854. *Chirurus conformis,* ANGELIN, p. 90, Pl. XLI, fig. 15.*
1884. *Homalonotus punctillosus,* TÖRNQUIST, p. 44, Pl. I, figs. 46, 47. Pl. II, figs. 1, 2.
1896. *Homalonotus? punctillosus,* REED, p. 411.
1898. *Illænus punctillosus,* HOLM, p. 138, Pl. VI, fig. 1.
1919. *Illænus (Holotrachelus) punctillosus,* TÖRNQUIST, p. 502.

Specific Characters. — Complete body oviform in outline, about twice as long as wide. Cephalon considerably larger than pygidium.

Cephalon semioval with broadly rounded genal angles, about two thirds as long as wide, very strongly convex, bent down nearly vertically in front and at the sides, and surrounded by flattened or slightly rounded marginal border set off by strong furrow. Border in front of glabella relatively narrow (from back to front), its surface sloping rather strongly forwards, gradually growing wider and more steeply inclined towards the sides, widest at genal angles, behind fixed cheeks rapidly decreasing in width again; edge of border sharp. Anterior margin arched forwards and gently upwards in the middle. Axial furrows narrow and rather shallow, deepening posteriorly, arching outwards at first from base, then bending inwards with slight convergence and united in front of glabella by shallow, forwards convex preglabellar furrow.

Glabella convex, bent down nearly vertically in front, generally slightly compressed from the sides but in some large specimens (e. g. the specimen figured on Pl. III, figs. 16—18) somewhat flattened on top. Outline of glabella + occipital segment broadly sub-ovate. 4 pairs of very weak lateral glabellar furrows are traceable in a few specimens, though in most some or all of them are indistinguishable; 3 anterior pairs short, extending about half-way from axial furrows to median line of glabella; frontal pair starting in axial furrows opposite anterior extremities of eyes, obliquely directed inwards and forwards; 2d and 3d pairs directed nearly straight inwards; 2d pair — probably homologous to 1st pair of most trilobites — situated a little in front of a line joining the middle of the eyes, 3d pair opposite posterior extremities of eyes; basal pair starting at extremities of median portion of occipital furrow, at first running obliquely forwards and outwards and then nearly straight outwards to axial furrows. The inner portions of the basal furrows are distinguishable in a comparatively large number of specimens, the frontal furrows are also rather often present, the 2d pair and the outer portions of the basal pair more seldom, and the 3d pair is only detected in a very few specimens.

Occipital furrow not always distinguishable, but generally represented in casts, more seldom on the surface of the test, by pair of weak and short, nearly transverse lateral portions placed close to posterior margin of cephalon. In casts a straight median portion is also sometimes visible and it is likewise indicated at least in one testiferous specimen. It is situated considerably more forward than the lateral portions and is somewhat shorter than the distance between their inner extremities. Only in a very few specimens is a connection between the different portions indicated. Occipital ring flattened, strongly arched from side to side, with minute median tubercle (not discernible in all specimens) near anterior margin; middle portion relatively wide (from back to front); lateral portions narrow; posterior margin arched gently backwards.

Cheeks broad, their anterior slope nearly vertical from the eyes, their lateral slope somewhat less abrupt. Fixed cheeks narrow in front of and inside palpebral lobes, rapidly increasing in width posteriorly, united in front of glabella by short, slightly convex and nearly vertically inclined preglabellar field; palpebral lobes sloping downwards laterally, gently arched from back to front, narrow and rather short, placed near the glabella and far forward. Posterior branches of facial sutures running in slight sigmoidal curves backwards and outwards from eyes to posterior border furrows, where they curve more strongly backwards and then inwards to cut posterior margin of cephalon at obtuse angles; anterior branches somewhat shorter than posterior ones, nearly straight, slightly converging anteriorly, but bending rather abruptly inwards near margin. Free cheek rather elongate, greatest width just behind eye scarcely more than half the length; lateral and posterior margins rounded, forming a continuous curve with the strongest curvature at genal angle; posterior as well as anterior extremity acutely pointed and curving inwards; eyes rather small but very prominent, nearly half as high as long, sub-crescentiform in outline, convex vertically and longitudinally; doublures of free cheeks continued forwards and inwards underneath anterior portion of cranidium and behind antero-lateral portions of rostrum, nearly meeting in front.

Fig. 16. *Holotrachelus punctillosus* TÖRNQUIST. Inferior surface of cephalon showing rostrum etc. × 1 1/3. Kallholn. Upsala Museum.

Rostrum measuring from side to side on front edge about two and a half times as much as from back to front across middle, very rapidly decreasing in width along its first two thirds from the rostral furrow, thence becoming nearly parallel-sided, its posterior third forming a very narrow, band-like portion separating the inner extremities of the doublures of the free cheeks; anterior margin gently arched upwards and very slightly forwards.

Hypostoma hour-glass shaped, its waist scarcely more than half the width of its anterior end (across the anterior pair of wings) and about four fifths that of its posterior portion, about twice as long as wide at waist; anterior end with somewhat flattened curvature; posterior portion slightly inclined a little behind middle furrow; posterior end strongly rounded and produced in the middle into short point. Anterior lobe of middle body about twice as long as posterior lobe, moderately elevated, slightly compressed from the sides, broadest in front, where it is as wide as long, narrowing and decreasing in height posteriorly; anterior and posterior extremities broadly rounded. Middle furrow weak, scarcely impressed in the middle, deepening laterally. Posterior lobe of body forming about three fourths of a circle or ellipse; its anterior end arched backwards; its surface rising up from all sides, at first not so strongly but then very steeply to form a high, prominent, sub-conical boss, which points a little backwards owing to the inclination of the posterior part of the hypostoma. Anterior border very narrow (from back to front), without thickened rim, almost entirely occupied by a rather shallow furrow dying out laterally, where the border becomes confluent with the anterior pair of wings. Anterior wings triangular, extending about half the length of anterior lobe of body, rather strongly but not suddenly inclined, their surfaces being slightly convex transversely. Border surrounding hypostoma behind anterior wings narrow with thickened rim; its lateral portions rising gradually in their backward course to anterior extremities of posterior wings, where they terminate in sharply pointed tips, the posterior portion of the border being only very slightly raised and the descent nearly vertical; posterior portion of border narrower than lateral portions, but widening a little at middle and here provided with small triangular tubercle projecting on margin. Posterior wings inclined almost vertically, relatively large, generally extending along middle two thirds of posterior lobe of body, but in some specimens somewhat shorter and placed a little more backward, about as high as long, rather hour-glass shaped with upper and lower margins sub-parallel or slightly converging anteriorly. Lateral furrows generally not impressed outside anterior portion of anterior lobe of body, strong and sharp outside its posterior portion, thence becoming weaker and terminating in very indistinctly marked pits at base of posterior wings, where they meet the rather shallow posterior furrow.

Thorax composed of 8 segments, slightly increasing in width to 4th or 5th segment, thence decreasing slowly to pygidium. Axis strongly convex, very wide, nearly half the width of thorax, broadest in front, narrowing slightly to 3d axial ring, 3d to 5th ring of nearly uniform width, posterior portion of axis gradually tapering to pygidium. Axial rings with distinctly set off articulating half-rings. Axial furrows broad but very weak. Pleuræ straight, extended horizontally as far out as fulcrum, which is rather strong and is situated nearly half-way out. Outer portion of pleuræ on 1st segment rather slightly bent downwards and more strongly backwards, in the following 5 successively more strongly bent downwards and less strongly backwards, in the 2 last ones the conditions being the reverse. In the 2 anterior pairs of pleuræ the outer portions taper rapidly to acute backwardly directed points; outer portions of following pairs progressively more and more gently narrowing laterally — in the last pair nearly parallel-sided — their tips somewhat obliquely truncated and with the hinder ends produced into short points, which gradually decrease in length and become less and less acute towards the pygidium. Posterior edge of pleuræ just outside fulcrum slightly arched backwards and overlapping adjacent portions of following pleuræ in enrolled individuals. Facets very narrow, their greatest width being about one seventh the length (from side to side), tapering laterally to mere points, rather sharply bent down, with concave surface and with the lower margin slightly arched upwards and backwards just outside fulcrum, its lateral portion being arched downwards and somewhat forwards. Each pleura with strong, broad diagonal furrow, narrowing laterally and becoming obsolete before reaching extremity of pleura.

Pygidium sub-semicircular in outline, about twice as wide as long. Axis about three fourths the length of pygidium, its width in front about two fifths total width of latter, gently convex anteriorly, rapidly decreasing in height and narrowing posteriorly, consisting of 3 rings and a terminal piece, the extremity of which is very indistinctly defined but seems generally to be continued by short, low, pointed terminal appendage reaching back to posterior end of fused portion of last pair of pleuræ and, at least in some specimens, longitudinally divided by sharp, narrow interpleural furrow. First axial ring with slightly raised articulating half-ring set off by distinct furrow; middle portions of anterior edges of following rings also slightly raised, evidently representing rudimentary articulating half-rings.[1] Ring furrows[2] in front of »articulating half-rings» sharp but exceedingly narrow; 1st and 2d furrows gently arched forwards; 3d furrow more strongly arched. Axial furrows very weak, posteriorly not impressed at all. Side lobes with a flattened area in front, adjacent to axial furrows, which tapers posteriorly and becomes obsolete at about the level of 2d axial ring furrow, outside and behind this flattened area the surface slopes gently to the margin; consisting of 4 pair of pleuræ with attached inner portions, separated by very fine, sharp interpleural furrows, and apparently free outer portions in close contact, with truncate, slightly oblique ends; 1st and 2d pairs of pleuræ similar to posterior thoracic pleuræ, but with the inner flat portions narrower, especially posteriorly, and the outer portions bent more strongly back and very slightly downwards and with weaker, somewhat more oblique and comparatively shorter pleural furrows. 3d pair directed still more strongly backwards with nearly straight posterior (inner) margins, the anterior margins slightly curved — but not angulated — adjacent to axial furrows; pleural furrows very weak, directed straight backwards. Posterior pair of pleuræ sub-parallel; pleural furrows represented by faint grooves bounding the sides of postaxial ridge.

Test of all parts ornamented with minute closely set punctæ; terraced lines only occur along the antero-lateral edge of the cephalic border, on the doublures and on the facets.

Dimensions. — The specimens of this species vary very much in size. Large, medium, and small examples seem to be about equally common. The total length of the individual figured on Pl. III, figs. 16—18 seems to have been about 71 mm; the distance between the anterior and posterior margins of its cephalon is 30 mm. In the largest cranidium

[1] Similar rudiments of articulating half-rings are seen on the pygidium of several other trilobites too, e. g. among the Phacopidæ and the Cheiruridæ.

[2] The ring furrows here do not correspond to the furrows which mark off the articulating half-rings on the thoracic segments, as they do, at least partly, in most other trilobites.

which I know of the corresponding distance is 48 mm, in the smallest one only 4 mm.

Remarks. — There has been much uncertainity and confusion about the generic position and affinities of this interesting species chiefly owing to the imperfect knowledge of its real appearance.

A cranidium from Osmundsberg was described and figured already by WAHLENBERG 1818 together with a pygidium from the same locality, which WAHLENBERG referred to the same species and on which he based the specific name, *Entomostracites laticauda.*

BRONGNIART (1822), DALMAN (1826), and HISINGER (1837) accepted this bi-composite species, but the former referred it to *Asaphus,* the two latter to *Illænus,* DALMAN giving it as *Asaphus (Illænus) laticauda,* HISINGER as *Illænus laticauda.*

BEYRICH (1845) was the first to point out that the cranidium and the pygidium in question did not belong to the same species and that the latter must belong to a species of the genus *Bronteus*, established by GOLDFUSS 1839. (He also for the first time described and figured the cranidium, which really belongs to this pygidium).

The cranidium of our species was described and figured again in 1884 by TÖRNQUIST, who referred it to the genus *Homalonotus,* naming the species *Hom. punctillosus.*

In the Museum of the Geological Survey, Stockholm there is, however, a small cranidium of the species from Boda collected by LINNARSSON in 1870 and labelled by him *Holotrachelus punctatus* n. g. & sp. and further three other cranidia collected at the same locality by TÖRNQUIST in 1876 labelled by the same hand with the same specific name. This shows that evidently several years before TÖRNQUIST's work was published LINNARSSON had paid attention to the species and regarded it as a representative of a new genus.

In 1896 REED reported the species from the Keisley Limestone in England and from the Chair of Kildare in Ireland and expressed a doubt as to whether it was correctly placed in the genus *Homalonotus* and also suggested that it might subsequently have to be referred to *Bathyurus* BILL. or to *Bathyurellus* BILL.

In 1898 HOLM described and figured the free cheek and called attention to some features in which the cephalon agreed with the *Illænus* type in general and especially to the many and important points of resemblance between the cranidium and that described as *Ill. calvus* BARR. (BARRANDE, 1872, p. 71, Pl. VI, figs. 11, 12). Since there seemed to be reasons for supposing that the pygidium too was of the *Illænus* type he came to the conclusion that until more complete, decisive specimens were found there were more grounds for referring the species to *Illænus* than to *Homalonotus* and that it probably ought to be regarded as a representative of a distinct sub-genus, to which in this case *Ill. calvus* too had to be referred. Provided that his presumption should prove correct he suggested that LINNARSSON's name *Holotrachelus* should be adopted as the name for this sub-genus.

In a recently (1919) published paper TÖRNQUIST accepts HOLM's proposal and uses the name *Illænus (Holotrachelus) punctillosus* in lists of species.

To none of these authors was any part of the carapace known except the cranidium and the free cheeks, or at least they were not recognized as belonging to the same species. The good material now available, among which there are two nearly complete individuals from Kallholn, has enabled me to give the above description of the different parts and proves that the species cannot be associated with any of the genera proposed but must be acknowledged to mark a distinct genus.

The specimen figured by ANGELIN (1854, Pl. XLI, fig. 15*) as the pygidium of *Cheirurus conformis* ANG.[1] is found to belong to our species and consists of a pygidium with one thoracic segment attached. It is not described in the text, nor is there any statement as to where it is found. In MARKLIN's collection in the Upsala Museum there is, however, a specimen (figured in fig. 20, Pl. III, below) from which ANGELIN's figure apparently was drawn. It is not known at which locality this specimen was found, but the rock is typical Upper Leptæna Limestone — in the same small specimen of limestone there are also a cranidium belonging to the same species and two fragmentary pygidia of *Bronteus laticauda* — and it seems probable that it comes from Osmundsberg, since most of the old collections of fossils from this limestone were made there.

The hypostoma has not been found attached, but when the matrix was removed underneath the cephalon of the entire individual figured below a hypostoma of the type described was discovered, which, though not in actual position, seems to belong to this individual. A similar hypostoma has been discovered underneath another entire cephalon and several others with identical characters have been found associated with detached cranidia of the species.

Cranidia of the species occur very abundantly in the Upper Leptæna Limestone at several localities. Free cheeks and hypostomata are also rather frequently found and several detached thoracic segments have been collected, whereas only a very few pygidia are known.

The circumstance that the pygidium is so seldom preserved is evidently due to a great extent to the strange fact that its different segments are not so firmly coalesced as in other trilobites. Consequently it must have been very easily broken along the lines of fusion after the death of the animal or in the moulted tests, and the fragile segments

[1] In the letterpress (Op. cit. p. 90) there is no asterisk to the number 15, but this is the case everywhere in this work of ANGELIN's where the number of the figure (on the plate) has an asterisk, and there can be no doubt as to which figure is meant.

WESTERGÅRD (1910, p. 21) has already pointed out that this specimen is presumably not the pygidium of *Cheirurus conformis*.

easily destroyed. A few detached pygidial segments are really known and in the pygidium figured on plate III, fig. 21 the 4 segments have got loose from each other, though they are only very slightly displaced. It seems to be beyond doubt, however, that they were originally fused and really all belong to the pygidium. That the pygidium is composed of 4 segments is moreover proved by other specimens, e. g. the two entire individuals from Kallholn, in which the line of demarcation between it and the thorax is quite distinctly seen.

As is well known, in most trilobites that were capable of being rolled up completely the outer portions of the thoracic pleuræ either decrease very considerably in size laterally and terminate in more or less acutely pointed tips or else, when they are of about uniform width all the way out (or increase in width towards the tips), their anterior surfaces are provided with large facets, which increase in size towards the rounded or obtuse extremities. In *Holotrachelus punctillosus*, on the other hand, the outer portions of the thoracic pleuræ, except on the anterior segments, taper only very slightly and the facets on their anterior edges are very narrow, especially near the blunt extremities. Consequently the lateral margins of the thorax could only be comparatively slightly shortened when the animal contracted itself, but it seems nevertheless to have been capable of rolling itself up into a complete ball. This was evidently possible on account of the relatively small size of the pygidium and the length and strong convexity of the cephalon. The cephalic border thus has an unusually great extension and when the animal was enrolled there was enough room for the margin of the thorax to be applied along a very long portion of it. No completely enrolled specimen is found as yet, but the two known entire individuals are both partly rolled up. In the one figured below the anterior part of the body is strongly contracted (as is seen from the figures) and in the other the thorax seems to be contracted nearly as much as was possible, whereas the cephalon is only very slightly bent down.

Affinities. — The true relations of this genus are still difficult to decide. On account of its many peculiar characters it is evident that it cannot be placed either with the Illænidæ, the Homalonotidæ, the Bathyuridæ or with any other known genus at all but must be referred to a distinct family. As is already mentioned above, HOLM has compared the cranidium with the cranidium described and figured by BARRANDE (1872, p. 71, Pl. VI, figs. 11, 12) as *Illænus calvus* BARR. and it is true that there are some striking similarities. The latter differs from all other Illænids and resembles *Hol. punctillosus* in having a distinct anterior border and the glabella defined in front (this latter feature is not seen in BARRANDE's figures, but it is mentioned in the text). The eye lobes are placed farther forward than in the Illænids in general but not so far forward as in *Hol. punctillosus*. Further it differs from this species in the shape of the fixed cheeks, the course of the facial sutures, — the posterior portions of which are, for instance, not so strongly curved — in the curvature of the anterior margin, which is rather strongly arched forwards, and in having the posterior border furrows on the fixed cheeks very weakly marked. It is open to doubt whether this cranidium is correctly placed in the genus *Illænus,* but since no other portion of the species is known it is impossible to decide its true generic position. It is not unthinkable, however, that it may subsequently have to be referred to *Holotrachelus.*

Horizons and Localities. — The species is found in the Upper Leptæna Limestone at Osmundsberg, Kallholn, Boda, Östbjörka, Unskarsheden, Dalbyn, and Gulleråsen (from the latter locality it is represented only by a hypostoma in the Museum of the Geological Survey, Stockholm).

Further it is recorded from the Keisley Limestone in England and from the Chair of Kildare in Ireland.

It is apparently represented in the North Baltic Östersjö Limestone too, but the only evidence is a single hypostoma in the Upsala Museum.

Family **Calymenidæ** MILNE-EDWARDS.

Genus **Pharostoma** CORDA.

Distinguishing Characters of the Species.

Glabella as long as, or longer than width at base. Preglabellar field short, from one sixth to one fourth the length of glabella. Anterior border flattened. Pygidium about three fifths as long as wide, rounded behind; axis with 5 distinct axial rings; side lobes marked by 5 pairs of strong pleural furrows and between these weak interpleural furrows *Ph. Leptænarum* TQT.

Glabella shorter than width at base. Preglabellar field long, from one third to more than half the length of glabella. Anterior border strongly bent upwards. Pygidium about three fourths as long as wide; axis with 11 to 13 axial rings; side lobes marked by 11 or 12 pleural furrows; interpleural furrows obsolete *Ph. foveolatus* TQT.

Pharostoma Leptænarum TÖRNQUIST. Pl. IV, figs. 1—9.

1884. *Calymene Leptænarum,* TÖRNQUIST, p. 41, Pl. I, fig. 44.

Specific Characters. — Cranidium about four sevenths as long as wide — in young individuals relatively somewhat longer — broadly rounded in front. Glabella rather strongly convex, elevated above the cheeks, about as long as or (in young individuals) somewhat longer than width at base, tapering anteriorly, the width across frontal lobe being in the adult about five eighths that at base, broadly rounded in front. Frontal lobe occupying rather less than one third the length of glabella, transversally sub-semielliptical in outline; anterior pair of lateral lobes very small, sub-triangular, scarcely separated from frontal lobe; 2d pair considerably larger, sub-oval; basal pair large, nearly half as long as the whole glabella and occupying about one third its width at base, rounded sub-triangular in outline; central lobe of glabella distinctly tapering posteriorly, strongly elevated above lateral lobes. Anterior pair of lateral glabellar furrows very short and weak (in some specimens not recognizable at all) occupying only the lateral slopes of glabella, nearly straight and directed slightly backwards; 2d pair strongly marked, originating in axial furrows nearly at the same places as anterior pair, directed obliquely inwards and backwards, and connected to basal pairs by shallow grooves, central portion of glabella between their inner extremities occupying rather more than half the width of glabella; basal pair with short, narrow outer portions, nearly parallel to 2d pair of furrows; inner portions much broader and deeper, slightly bifurcate, the smaller branch turning forwards, the stronger branch nearly straight backwards towards occipital furrow, with which it is connected by a faint groove; between the two divisions of the furrow there is a slight node upon the side of the glabella.

Axial furrows deep and narrow, converging anteriorly, strongly bent inwards at base and more slightly at 2 lateral glabellar furrows, where there is a buttress formed by the inner extremity of the eye-ridge; just in front of this the furrows become somewhat wider and deeper so as to end in small rounded pits, where they meet the narrow, sharp preglabellar furrow. Outside the basal pair of glabellar lobes there is a small sub-semicordate depressed area on each side, which gives the impression of being an expansion of the axial furrow, but it is not situated at the same level as this but on its outer wall, on the steep inner slope of the fixed cheek. Occipital furrow well marked, narrow, rather shallow behind central lobe of glabella and nearly straight in a horizontal direction, becoming more deeply impressed and arched backwards behind basal glabellar lobes. Occipital ring flattened from back to front, strongly arched from side to side, broadest (longitudinally) in the centre, becoming narrower at back of basal glabellar lobes; its posterior margin gently arched backwards. Preglabellar field short, from one sixth to one fourth the length of glabella, gently convex, descending to border, not marked off laterally by furrows but confluent with anterior portion of fixed cheeks. Anterior border narrow (longitudinally), flattened; edge of border with a fringe of forward directed spines; one placed in the median line of the body and one on each side in a line with the lateral extremity of the frontal lobe of the glabella being somewhat stouter than the others, of which there seem to be 1 or 2 on each side between the median and the stouter lateral spine and 2 or possibly 3 outside the latter. The true character of the spines is only seen when the test on the edge of the border is preserved;[1] in casts the apparently hollow bases of the stouter spines are represented by small triangular points, the bases of the more slender spines by minute tubercles scarcely projecting on the margin.

Fixed cheeks broad, their width at posterior margin two thirds to three fourths that of glabella at base, strongly convex. Palpebral lobes very small, not projecting laterally, strongly elevated, placed far forward, their posterior extremities situated opposite the middle of 2d lateral glabellar lobes, continued by indistinctly marked, rather broad (in a longitudinal direction) but very low eye ridges, which are directed straight inwards or somewhat forwards, slightly broadening towards the axial furrows and bounded in front and behind by shallow furrows, of which especially the anterior one is very weak; inner extremities of ridges rounded or obtusely pointed, projecting on inner margin of cheek into axial furrows. Posterior borders of cheeks rather strongly raised, narrow near axial furrows, considerably broadening laterally; inner portions directed nearly straight outwards; outer portions outwards, downwards and somewhat backwards, at genal angles confluent with very narrow inner posterior portions of lateral borders; border furrows strong. Anterior branches of facial sutures short, nearly straight, very slightly converging anteriorly; posterior branches long, running in even convex curves outwards, downwards and backwards, longitudinally cutting the posterior portions of lateral borders.

Thorax (only partly known) with convex axis. Axial rings arched slightly forwards in the middle, with weak lateral nodes. Pleuræ horizontal to weak, remote fulcrum, then curving abruptly to lateral margin; extremities slightly pointed; surface of pleuræ marked by strong, nearly median furrows becoming obsolete before reaching extremities.

Pygidium parabolic to semioval in outline, generally a little more than half as long as wide; anterior margin arched forwards in middle — in front of axis — and gently recurved at sides. Axis strongly convex, narrow, width at anterior margin not quite one third that of whole pygidium, gently tapering posteriorly, with obtusely rounded extremity not reaching posterior margin; composed of 5 to 6 axial rings, of which the posterior one is very indistinctly defined behind, and a short terminal piece. Axial furrows strong, connected by shallow groove behind extremity of axis. Side lobes slightly flattened adjacent to axial furrows, then sloping rather gently with convex surface to near margin, where the slope becomes steeper, the marginal portion being curved down nearly vertically with the edge slightly incurved; with pair of half ribs on anterior edge followed by 5 pairs of gently raised regular ribs, defined by

[1] This is the case in one small, otherwise somewhat defective, cranidium from Kallholn in the Lund Museum, but not in any of the other cranidia which have come under my notice.

strong pleural furrows extending from axial furrows to steeply inclined marginal portion of pygidium. Ribs, as usual, formed by posterior and anterior bands of adjacent pleuræ, which are nearly completely fused, the interpleural furrows being very faintly impressed and becoming obsolete before reaching margin; posterior pair of ribs very short, sub-parallel, separated by short and rather wide, slightly swollen, unfurrowed postaxial piece; edge of pygidium very slightly arched upwards in centre, furnished with 7 pairs of minute points (not discernible in all specimens) directed straight downwards or slightly inwards. These points, of which the two posterior ones are placed close to each other, probably represent the outermost tips of the pleuræ. Thus it seems as if the pygidium was composed of 7 segments and the unfurrowed postaxial piece formed by the posterior bands of the 6th pair of pleuræ and the whole of the last pair.

Surface of test of all parts ornamented with rounded, small tubercles of different sizes, placed close together.

Dimensions. — In the largest known cranidium the distance between the anterior and the posterior margins is 6,5 mm; in the largest of those figured below the corresponding distance is not quite 6 mm and the aproximate width at posterior margin 10,5 mm. In the largest known pygidia the length, exclusive of the articulating half-ring, is not quite 4 mm. and the greatest width about 7 mm.

Remarks. — When TÖRNQUIST founded this species only some cranidia and a few fragments of thoracic segments from the Upper Leptæna Limestone at Boda were known to him. The latter are only mentioned and his description and figure of the cranidium are somewhat incomplete, since all the features cannot be seen on his specimens. Several other cranidia and about a dozen pygidia — one of the latter with 11 fragmentary thoracic segments attached — which evidently belong to this species are now available from the Upper Leptæna Limestone at other localities and have enabled me to give the above more complete diagnosis of the species.

Among the cranidia there are several very small ones (the smallest ones having a length of about 2 mm), evidently belonging to young individuals. These are relatively somewhat longer than the larger cranidia and their glabella is more cylindrical — in the smallest ones scarcely widening posteriorly — and more strongly convex and has comparatively narrow lateral lobes. The same difference between the young and the adult is also found in other Calymenidæ, e. g. in *Calymene tuberculosa* SALT. (Cf. SALTER, 1849, Pl. VIII and text p. 2, 1865, p. 92) and *Calymene senaria* CONR. (Cf. RUEDEMANN, 1913, p. 120, Pl. IX, figs. 6—10).

In a specimen of Leptæna Limestone from Kallholn in the Upsala Museum the writer has detected a larva (Pl. IV, fig. 9) in the 1st nepionic stage (with one thoracic segment) which is evidently referable to this species. The whole animal is 0,95 mm long. The cephalon occupies more than half the length, is about two thirds as long as wide, semielliptical in outline, very strongly convex, and surrounded by a narrow, flattened border, which seems to have been prolonged into genal spines, although these are broken off on the specimen. The glabella is narrow, considerably longer than wide, sub-cylindrical, rounded in front and very strongly convex. Two pairs of lateral glabellar lobes are distinctly to be seen; these, however, are very narrow, the lateral furrows being nearly confined to the lateral slopes of the glabella (in the figure the basal pairs are too long). The eyes are situated a little farther away from the glabella and perhaps somewhat more forward than in the adult (in the figure they are too large and a little too near the glabella and the posterior margin) and the eye ridges are a little more strongly raised. The line of demarcation between the thoracic segment and the pygidium is very distinct. The axis of the pygidium is relatively wide in front but decreases very abruptly in width posteriorly, so that the apex appears to be pointed; it consists of 3 axial rings and a very short terminal piece. 3 pairs of pleuræ are distinctly seen on the side lobes, and between the last 2 pleuræ there is a rather wide median portion, which is rather badly preserved on the specimen, so that it is impossible to see whether it was originally unfurrowed or not. The interpleural furrows are sharp, rather narrow near the axial furrows, increasing in width and deepening laterally. The pleural furrows are strong, but do not extend so far outward as in the adult. At least the anterior 2 pairs of pleuræ are more like the thoracic pleuræ than is the case in the adult, and the pygidium seems to be composed of a smaller number of segments, which indicates that the formation of the pygidium was incomplete at this stage.

No free cheeks referable to this species have been found (except those of the larva), but the width of the distal portions of the posterior borders — on the fixed cheeks — indicates that they had genal spines. Further it seems probable that the edge of the lateral border was spinose as in other species of *Pharostoma*. The spinosity of the frontal border appears to favour this assumption, but it must be pointed out that the spines which occur on the lateral border in other species of the genus are placed on its lower inner edge, which meets the lower edge of the rostrum and not the edge of the anterior border. In BEYRICH's (1846, Pl. II, fig. 6 b) outline drawing of the cranidium of *Phar. pulchra* BARR. there are really some spines on the rostrum, though very near its anterior margin. This figure seems, however, to be more or less constructed and it is possible that the spines are incorrectly placed. In one of BARRANDE's (1852, Pl. XIX, fig. 5) figures of this species the spines seem to be situated on the incurved edge of the anterior border in front of the rostral furrow. The only other one of his figures (Op. cit, Pl. XIX, fig. 3) in which the anterior spines are indicated shows clearly that they are placed on the lower side of the cephalon, but whether on the edge of the anterior border or on the rostrum it is impossible to see. On the species of *Pharostoma* described by SCHMIDT (1894) spines seem only to have been observed on the free cheeks, not in front.

There is one pygidium (Pl. IV, fig. 3) from Arfvet in the Upsala Museum which differs from the typical pygidia of the species by its comparatively very slightly convex, and consequently relatively very wide, side lobes. The specimen is well preserved and does not seem to have been pressed, but it appears probable that this difference is only due to individual variation, since otherwise it shows the characters of the species and occurs in close association with a portion of a typical cranidium.

Affinities. — SCHMIDT's (1894, p. 25) assumption that this species as well as the cranidium described by TÖRNQUIST as *Calymene foveolata* were referable to *Pharostoma,* has proved correct as far as can be judged from the material now available. Of the two species the one now in question seems to agree most closely with the previously described members of the genus and it is difficult to decide to which of them it is most closely allied.

The shape of the glabellar lobes recalls *Ph. pulchra* BARR. (BARRANDE, 1852, p. 575, Pl. XIX, figs. 1—9) but it differs from this species by the narrowness of the glabella at the base, the flattened frontal border, the shape of the pygidial axis and the direction of the ribs on the pygidium, which are turned less abruptly backwards.

The pygidium seems to be rather like that of *Ph. pediloba* RÖMER (SCHMIDT, 1894, p. 26, Pl. II, figs. 12—16), but in the shape of the glabella and especially in the shape of the posterior glabellar lobes it differs from this as well as from the other East Baltic species of *Pharostoma.*

In the shape of the glabella and the glabellar lobes and in the possession of eye ridges it resembles the glabella from the Trinucleus Shales in Skåne described and figured by OLIN (1906, p. 58, Pl. II, fig. 15) as *Calymene pulchra,*[1] but in this the anterior border is very strongly bent upwards and straight, the eyes are situated on the same level as the glabella, and the course of the posterior branches of the facial sutures is quite different.

Horizon and Localities. — Upper Leptæna Limestone; Kallholn, Osmundsberg, Boda, Arfvet, Lissberg.

[1] As far as can be judged from the figures and descriptions, this form differs rather much from *Ph. pulchra,* especially in the shape of the glabella and the course of the posterior branches of the facial sutures, and does not seem to belong to this species. Probably it represents a new species, or possibly it is identical with *Ph. oelandicum* ANG. (ANGELIN, 1854, p. 62, Pl. XXXIII, fig. 15), though the type specimen of this was found at a lower horizon (Chasmops Limestone).

Pharostoma foveolata TÖRNQUIST. Pl. IV, figs. 11—20.

1884. *Calymene foveolata,* TÖRNQUIST, p. 43, Pl. I, fig. 45.

Specific Characters. — Cephalon semielliptical in outline, surrounded by narrow border and with the genal angles produced into spines. Cranidium about four sevenths as long as wide at base; anterior margin strongly arched forwards. Glabella moderately convex, elevated above the cheeks, width across frontal lobe about five sevenths that at base, where it is somewhat wider than long, very broadly rounded in front. Frontal lobe occupying a little more than one third of the entire glabella, transversely sub-elliptical in outline; anterior pair of lateral glabellar lobes small, scarcely separated from frontal lobe, sub-triangular; 2d pair rather large, irregularly quadrilateral in outline; basal pair large, about three eighths the length and fully one third the width of glabella, rounded sub-triangular to irregularly quadrilateral in outline; central lobe of glabella nearly as wide at base as between inner extremities of 2d pair of lateral furrows, strongly and rather suddenly elevated above 2d and 3d pairs of lateral lobes. Anterior pair of lateral glabellar furrows short and very weak (in some specimens scarcely recognizable), extending less than half-way up the sides of glabella, nearly straight and directed slightly backwards; 2d pair strongly marked, originating in axial furrows nearly at the same places as anterior pair or just behind these, directed obliquely inwards and backwards, widening a little at their inner extremities, which are situated less than half the width of glabella apart; basal pair with narrow and very shallow outer portions curving inwards and slightly backwards, deepening and becoming broader and slightly bifurcate at their inner extremities, the stronger branch turning nearly straight backwards towards occipital furrow, the smaller branch turning forwards; the node upon the side of the glabella between the two branches is very inconspicuous.

Axial furrows converging anteriorly, slightly curved inwards at base and at 3d and 2d lateral glabellar furrows, so that their anterior ends in front of the latter are almost parallel or turned slightly outwards, deep and broad outside basal glabellar lobes, the depressed sub-semicordate area on the inner slope of the cheek lying nearly on the same level as the furrow, narrowing and growing much shallower outside 2d pair of lobes, then widening again and terminating in small rounded pits outside lateral extremities of frontal lobe. Preglabellar furrow narrow and shallow, but with two rounded impressions, one on each side in front of glabella, placed about half the width of frontal lobe apart; middle portion of furrow very slightly arched forwards; lateral portions curving strongly backwards from the impressions just mentioned to terminating pits of axial furrows. Occipital furrow rather strong, deepening laterally, arched backwards behind basal pair of glabellar lobes. Occipital ring rather strongly arched from side to side, flattened from back to front, rather broad (in longitudinal direction) behind central lobe of glabella, decreasing in width laterally. Preglabellar field long, from one third (in a small specimen) to more than half the length of glabella, bounded laterally by shallow furrows running obliquely forwards and outwards from terminating pits of axial furrows to anterior border, slightly flattened in the middle adjacent to preglabellar furrow, with a rounded elevated node on each side between the impression in the preglabellar furrow and the bounding furrows, sloping down anteriorly and laterally with convex surface. Anterior border strongly elevated with narrow rounded edge. Anterior border furrow scarcely impressed.

Cheeks moderately convex, rising up from all sides to eye lobes, which are situated nearly opposite the 2d pair of lateral glabellar lobes. Free cheeks about as wide at posterior margin as glabella at base. Palpebral lobes small, sub-semicircular in outline, very strongly turned upwards, gently arched from back to front, separated from inner portions of cheeks by palpebral furrows which are very shallow especially outside inner extremities of eye ridges, deepening somewhat behind and in front of these. Eye ridges very indistinctly marked, being very slightly raised and anteriorly almost confluent with the general surface of the cheek; in most specimens very shallow grooves, which define them posteriorly are, however, seen running from bases of palpebral lobes obliquely inwards and forwards to end in axial furrows just in front of 2d pair of lateral glabellar lobes; the inner extremities of the ridges can also generally be detected forming very inconspicuous buttresses in the axial furrows between the terminating pits and the inner extremities of the grooves just mentioned. Inside the palpebral lobes, behind the eye ridges there is a low oval node on each side, the longer axis of which is directed forwards and slightly inwards. Posterior border slightly raised, rather narrow at axial furrow, becoming flatter and broader laterally; inner portion directed nearly straight outwards, lateral portion rather strongly downwards and very slightly backwards. Posterior border furrow deep and strong, becoming obsolete a little within margin of fixed cheek. Postero-lateral portion of edge of fixed cheek slightly raised — representing innermost part of lateral border of cheek — confluent with posterior border and separated from inner part of cheek by shallow groove, which dies out before meeting facial suture. Anterior branches of facial sutures comparatively long, slightly diverging anteriorly; posterior branches long, running from palpebral lobes at first outwards for about one third their length, then obliquely outwards and backwards to posterior borders, here turning nearly straight backwards and ultimately somewhat inwards to cut posterior margin of cephalon at slightly acute angles. Lateral border of free cheek (only fragments of free cheeks known) rounded, narrow when seen in dorsal aspect, only very slightly raised above the border furrow but hanging down a good way below this, so that it appears rather wide when seen in lateral aspect; under side of border furnished with a row of rather coarse and rather closely placed spines. Lateral border furrow very shallow. Genal spine rounded, compressed from the side at least anteriorly, apparently rather long, exact length not known.

Thorax (only detached and fragmentary segments known) with strongly convex axis, narrower than side lobes. Axial rings without lateral nodes. Pleuræ nearly horizontal and straight for about two sevenths the way out, then curving abruptly downwards and very slightly backwards to lateral margins, increasing in width (in a longitudinal direction) from axial furrows to truncate extremities. Each pleura marked by deep but rather narrow furrow rounded at the bottom, originating in axial furrow near anterior edge of pleura, running at first slightly diagonally, becoming nearly median along the middle portion of the pleura, distally slightly arched forwards and dying out on the flattened distal portion of the pleura just inside extremity.

Pygidium sub-triangular in outline, about three fourths as long as wide. Anterior margin arched forwards in middle, recurved at sides. Posterior margin rather strongly bent upwards and angulated in centre. Axis narrow, width at anterior margin about two sevenths that of entire pygidium, rather strongly convex, decreasing somewhat in height and gently tapering posteriorly to rounded extremity, and terminating well within margin, annulated for three fourths its length with 11 to 13 axial rings decreasing in strength posteriorly, the last one very incompletely defined behind. Ring furrows nearly straight across the median portion of axis, or the 2 anterior ones very slightly arched forwards, the posterior ones slightly backwards, their lateral portions successively more and more strongly curved backwards. Axial furrows in testiferous specimens scarcely impressed anteriorly, in casts rather strongly marked, growing deeper posteriorly, and united behind extremity of axis by shallow groove. Side lobes sloping away from axis at first rather gently but near margin very abruptly to slightly incurved edge. Each side lobe bearing one half rib on anterior edge with slightly raised inner portion and flattened distal portion for rolling up, followed by 10 to 11 slightly raised regular ribs, decreasing successively in size and becoming more and more strongly turned backwards posteriorly, at least in casts without traces of interpleural furrows, but separated by strong pleural furrows, the anterior ones nearly reaching the margin, the posterior ones dying out at a somewhat greater distance from this, so that a narrow, unfurrowed border is formed, which increases slightly in width posteriorly. 11th pair of ribs very short, sub-parallel, very indistinctly defined within, when discernible at all, nearly confluent with narrow and short postaxial piece, on which faint traces of 2 following pairs of ribs can sometimes be detected. On the anterior portion of the pygidium the pleural furrows merge into the axial ring furrows and the ribs are in distinct connection with the rings, the axial furrows here being very shallow; posteriorly the connection grows more and more indistinct and on the posterior portion of the pygidium it is quite broken, the axial furrows here being relatively broad and deep and the pleural furrows originating in these well back of the lateral extremities of corresponding ring furrows.

Test ornamented with small, rounded tubercles of different sizes, which are placed close together on the glabella, more scattered on other parts. Edge of anterior border with a few larger, obtusely pointed tubercles, but apparently without spines. Edge of pygidium smooth.

Dimensions. — While all other hitherto described members of the genus *Pharostoma* are relatively small, this species is very large. In fact it seems to attain greater dimensions than any other known species of the family Calymenidæ. The length of the largest cranidium which has come under my observation is 40 mm and the approximate width at the posterior margin 70 mm. In the largest pygidium the distance between the anterior margin and the posterior end is over 30 mm and the greatest width over 40 mm.

Remarks. — This species was founded by TÖRNQUIST on a single relatively small, incomplete cranidium from Furudal (figured below, Pl. IV, fig. 16), which evidently belongs to a young individual. Several other larger cranidia, a considerable number of pygidia, fragments of free cheeks and fragments of thoracic segments evidently belonging to this species have since been collected at Kullsberg. Most of the specimens were found in the closest association in a single small specimen of rock. In one specimen a portion of the free cheek is preserved together with the cranidium. It is not attached in position but slightly displaced and the posterior part is broken off. A portion of the genal spine occurs among the fragments, however, which proves that the species really was spine-bearing.

The cranidia from Kullsberg agree very closely with the type specimen, except in their size and in their having a relatively much longer preglabellar field. This indicates that the preglabellar field is shorter in young than in adult individuals.

The species is also represented from Amtjärn by a hollow cast of a pygidium in the Museum of the Geological Survey.

Further there is a cranidium of this species in the State Museum of Natural History labelled Osmundsberg S. eastern hill Dalarne. This specimen is, however, probably not from Osmundsberg but from the locality which we generally call Sinksjön, a little hill near the lake with the same name, south-east of the larger hill of Osmundsberg. The two hills lie very near each other but are separated by a deep depression and whereas the rock which forms the Osmundsberg is Upper Leptæna Limestone, the hill at Sinksjön consists of Lower Leptæna Limestone and is thus of the same age as the limestone at the other localities where the species has been found. Moreover the piece of rock in which the specimen in question occurs has the same appearence as certain portions of the rock at Sinksjön but is unlike the typical limestone at Osmundsberg.

Affinities. — The shape and lobation of the glabella, the possession of genal spines, the spinosity of the lateral border of the cheek, and the absence of a distinct fulcral point on the thoracic pleuræ are all characters which prove that this species must be referred to *Pharostoma*. It differs, however, from all the other known species of the genus by its size, its long preglabellar field, and especially by the great number of axial rings and pleural ribs on the pygidium. The latter seems in fact to be composed of a considerably greater number of segments than that of any other known member of the family Calymenidæ.

Horizon and Localities. — Lower Leptæna Limestone; Kullsberg, Furudal, Amtjärn, Sinksjön(?).

Genus **Calymene** BRONGNIART.

Calymene cf. **senaria** var. **Stacyi,** SCHMIDT. Pl. IV, fig. 10.

1894. *Calymene senaria* CONR. var. *Stacyi,* SCHMIDT, p. 23, Pl. II, figs. 9—11.

Remarks. — A hollow cast of a portion of a pygidium from Lissberg in the Museum of the Geological Survey recalls the pygidium of *Cal. senaria* var. *Stacyi* SCHMIDT from the East Baltic Lyckholm formation and is possibly referable to the same form. Only the posterior portion of the axis, the postaxial piece and the posterior portion of the right side lobe are to be seen. The axis is moderately convex with a rounded extremity, extends nearly to the posterior margin and shows on the specimen 2 distinct transverse furrows, followed by 1 or 2 weaker ones, which are incomplete in the middle. The pleural ribs are narrow, separated by strong, wide pleural furrows, which increase in width towards the margin, the anterior ribs are marked by distinct though not deep interpleural furrows, the posterior one is unfurrowed, somewhat narrower than the preceding ones, relatively long, and directed nearly straight backwards.

Horizon and Locality. — Upper Leptæna Limestone; Lissberg.

Family **Proëtidæ** CORDA.

Genus **Proëtus** STEININGER.

Distinguishing Characters of the Species.

a. Distinguishing Characters of the Cephala.

1. Preglabellar field short, less than one fourth the length of glabella, or glabella reaching anterior border furrow 2.

Preglabellar field long, more than one third the length of glabella. Glabella moderately convex, rounded in front. Anterior branches of facial sutures distinctly diverging anteriorly. Occipital ring flattened from back to front, with median tubercle placed half-way between anterior and posterior margins, without distinct occipital lobes *Proëtus remotus* n. sp.

2. Glabella bluntly rounded in front, gently convex. Anterior branches of facial sutures slightly diverging anteriorly (or their course not distinctly observed). Occipital ring flattened, without or with very faint traces of occipital lobes 3.

Glabella narrowly rounded but not pointed in front, moderately convex or its middle portion gently convex, its marginal portions abruptly bent downwards. Free cheeks wide 4.

Glabella pointed in front, gently convex. Anterior branches of facial sutures slightly converging anteriorly. Occipital ring flattened with distinct occipital lobes *Proëtus pentagonoides* n. sp.

3. Glabella reaching anterior border furrow; its anterior margin evenly arched. Free cheeks very narrow. Eyes large. (All furrows on the cephalon weak or almost obsolete) *Proëtus parvigena* n. sp.

Glabella not reaching anterior border furrow; its anterior margin evenly arched; its sides nearly straight. Preglabellar field very short in middle, gradually increasing in size laterally. Free cheeks relatively wide. Eyes of moderate size *Proëtus convexus* n. sp.

Glabella not reaching anterior border furrow, slightly expanded at sides a little in front of base; its anterior margin most strongly curved at sides. Preglabellar field about one sixth the length of glabella, its middle portion nearly parallel-sided *Proëtus kullsbergensis* n. sp.

4. Surface of glabella evenly arched or slightly compressed from the sides. Anterior branches of facial sutures strongly diverging anteriorly. Occipital ring flattened from back to front, with median tubercle on posterior edge and nearly obsolete occipital lobes *Proëtus modestus* TÖRNQUIST.

Glabella rather gently convex in the middle, its marginal portions abruptly bent downwards. Anterior branches of facial sutures very slightly diverging anteriorly. Occipital ring raised, marked off by strong furrow; occipital lobes distinct *Proëtus Ainæ* n. sp.

b. Distinguishing Characters of the Pygidia.

1. Pleural and interpleural furrows of about equal strength *Proëtus?* sp. ind. c.

Pleural furrows considerably stronger than interpleural furrows 2.

2. Pygidium rounded behind. Axial rings less than 9 3.

Pygidium sub-triangular, obtusely pointed behind. Axial rings 10, the anterior one slightly rounded, following ones flattened from back to front *Proëtus* sp. ind. b.

3. Axial rings more than 4 4.

Axial rings 4, the anterior one slightly rounded, following ones flattened 6.

4. Axial rings 6 or 7, the anterior one slightly rounded, following ones flattened. Doublure wide or rather wide 5.

Axial rings 7 or 8, at least the 4 anterior ones distinctly rounded. Doublure narrow. Pygidium sub-semicircular to semielliptical *Proëtus Ainæ* n. sp.

5. Pygidium semielliptical. Axis strongly convex, sub-cylindrical. Doublure rather wide *Proëtus modestus* TÖRNQUIST.

Pygidium transversely sub-oval. Axis moderately convex, rapidly tapering posteriorly. Doublure very wide *Proëtus* sp. ind. a.

6. Pygidium sub-semicircular, about half as long as wide *Proëtus convexus* n. sp.

Pygidium sub-parabolic, somewhat more than half as long as wide *Proëtus kullsbergensis* n. sp.

Proëtus modestus TÖRNQUIST. Pl. V, figs. 15—16, 18.

1884. *Proëtus modestus,* TÖRNQUIST, p. 46, Pl. II, fig. 3.
1907 b. *Dicellocephalus? Leptænarum,* WIMAN, p. 5, Pl. II, figs. 1—3.

Specific Characters. — Entire body sub-oviform in outline, more than one and a half times as long as wide.

Cephalon semielliptical in outline, length along median line rather less than two thirds the width at posterior margin, moderately convex, surrounded by narrow flattened or slightly rounded border and with the genal angles produced into tapering, pointed spines reaching back to fifth or sixth thoracic segment. Glabella about three fourths the length of cephalon and one third its width, moderately convex, somewhat longer than wide at base, slightly narrowing anteriorly, narrowly rounded in front, not reaching anterior border furrow, defined by narrow and rather shallow axial and preglabellar furrows. Lateral glabellar furrows indistinguishable except in a few specimens where there are very faint traces of the 2 posterior pairs; the foremost of these starting at sides a little behind a line joining anterior extremities of eyes and extending inwards and very slightly backwards about half-way up on the glabella; basal pair represented by slightly impressed sub-triangular area on each side opposite posterior half of eye lobe with the longest side oblique to the median line of body, not reaching either axial or occipital furrows. On one specimen a small rounded auxiliary impression (Cf. BARRANDE, 1852, p. 111 and p. 432) is distinguishable on each side just inside the basal furrow. Occipital furrow narrow, generally not quite reaching axial furrows. Occipital ring of moderate width, slightly narrowing laterally, flattened from back to front and gently arched from side to side, its surface slightly depressed below glabella with small median tubercle on posterior edge and faint traces of occipital lobes. Preglabellar field short, its length along the median line not more, generally less, than one fifth that of glabella — comparatively longer in small than in larger specimens — descending rather steeply to weak anterior border furrow, the slope, however, generally becoming somewhat less steep anteriorly.

Cheeks wide, the distance from axial furrow to genal angle being about equal to basal width of glabella, rather strongly bent downwards to border, with convex surface, their anterior slope somewhat more abrupt than the lateral slope. Eyes sub-reniform, rather strongly convex in both directions, more than twice as long as high, situated at about two thirds their own length from posterior margin of cephalon and very close to the glabella, extending rather less than half the length of latter. Palpebral lobes very narrow, sub-crescentiform, gently upturned. Lower eyelids narrow, raised, slightly increasing in width anteriorly and posteriorly, marked off by fairly distinct furrows. Anterior branches of facial sutures distinctly diverging anteriorly, slightly outwards convex; posterior branches running straight backwards from eyes to posterior borders, then bending outwards to cut posterior margin of cephalon at very acute angles about half-way between axial furrows and genal angles. Lateral border almost horizontally extended; lateral border furrow rather weak, meeting deeper posterior border furrow at acute angle and then continuing backwards nearly to tip of genal spine. Posterior border flattened from back to front, directed slightly backwards and sloping downwards laterally, its outermost portion nearly vertically bent down. Anterior portion of spine distinctly differentiated in an inner vertical portion forming a direct continuation of the posterior border, and a horizontal outer portion forming the continuation of the lateral border.

Thorax composed of 10 segments. Axis strongly convex, tapering gradually to pygidium, in the middle of thorax about one third the width of latter; axial rings flattened from back to front, without or with very faint traces of lateral nodes. Axial furrows scarcely impressed. Pleuræ straight, horizontally extended to weak fulcrum, which is situated about half-way out; outer portions of pleuræ gently bent downwards and the anterior ones slightly, the posterior ones more strongly curved backwards to end in short backward directed falcate spines successively increasing in length posteriorly: pleural furrow strong, nearly median, dying out before reaching extremity of pleura.

Pygidium semielliptical in outline, about three fifths as long as wide. Axis strongly convex, its width at anterior margin about one third that of entire pygidium and extending about five sevenths the length of latter, gently tapering posteriorly to rounded extremity, which is continued backwards by narrow postaxial ridge; divided into 6 or 7 axial rings and a short terminal piece by weak furrows, which become very faint posteriorly; 1st axial ring slightly raised, following ones flattened from back to front. Axial furrows scarcely impressed. Side lobes with flat, horizontal inner anterior portions, lateral and posterior portions very slightly bent down; with 4 pairs of distinct, slightly raised regular ribs — in good specimens marked by weak interpleural furrows — behind anterior pair of half-ribs, defined by fairly strong though not deep pleural furrows, which increase in width laterally and become obsolete or very faint just inside margin, and with faint traces of 1 or 2 pairs of very narrow ribs between the 4 th and the postaxial ridge (or median unpaired rib); posterior edge of regular ribs higher than anterior one, except in the inner portions of the anterior 2 pairs. Doublure of pygidium rather wide.

Test ornamented with fine closely set striæ, which on the axial parts of the body are arched forwards, on the cheeks are more or less parallel to the posterior margin but bend forwards on the lateral border, on the thoracic pleuræ they are directed obliquely outwards and forwards and on the side lobes of the pygidium they are strongly undulating and their general direction is not concentric with the margin but somewhat more transverse.

Dimensions. — The largest entire individual of this species which has come under my notice, is TÖRNQUIST's type specimen, the approximate total length of which is 14 mm., length of cephalon along median line 5 mm., length of thorax approximately 6 mm. (the specimen is broken and the anterior portion is bent upwards and pushed backwards so that some of the thoracic segments are overlapped by the preceding ones), length of pygidium 3 mm., width of cephalon between genal angles approximately 9 mm., width of pygidium 5 mm. The approximate length of a large cranidium is 6,25 mm. and that of a large pygidium 4,25 mm. (articulating half-ring not included).

Remarks. — This species has been described and figured by TÖRNQUIST (Op. cit. p. 46, Pl. II, fig. 3) but the acquisition of more and partly better preserved material has enabled me to add some further details. A considerable number of more or less complete individuals as well as detached parts of the carapace have been collected at different localities in the Upper Leptæna Limestone in Dalarne.

The pygidia from the West Baltic Leptæna Limestone described and figured by WIMAN (Op. cit. p. 5, Pl. II, figs. 1—3) as *Dicellocephalus? Leptænarum* evidently belong to *Proëtus modestus* and agree very closely with those from Dalarne.

Affinities. — As already pointed out by TÖRNQUIST this species agrees rather closely with *Pr. decorus* BARR. (BARRANDE, 1852, p. 468, Pl. XVII, figs. 13—21). In the latter, however, the preglabellar field is comparatively longer than in our species and scarcely bent downwards, and the basal pair of lateral glabellar furrows are said to be very distinct; further, the cephalic border seems to be narrower and more strongly raised, the genal spines longer (at least in the adult), the eyes placed somewhat more backward, and the pygidial axis is composed of a greater number of rings than what is observed on any specimen of *Proëtus modestus.*

Horizon and Localities. — Upper Leptæna Limestone; Kallholn, Osmundsberg, Boda, Östbjörka, Lissberg, Unskarsheden. Westbaltic Leptæna Limestone; Öland (in boulders).

Proëtus remotus n. sp. Pl. V, fig. 7.

Specific Characters. — Glabella about five eighths the length of cranidium, somewhat longer than wide at base, tapering anteriorly, rounded in front, moderately convex, slightly compressed from the sides; lateral glabellar furrows indistinguishable. Axial and preglabellar furrows narrow, distinct. Occipital furrow narrow and rather shallow, slightly curved forwards in middle and at sides. Occipital ring of moderate width, narrowing laterally, flattened from back to front, strongly arched from side to side, with small indistinct median tubercle placed about half-way between anterior and posterior margins, but without occipital lobes. Preglabellar field long, its length along the median line more than one third that of glabella, with longitudinally slightly concave surface sloping gently to anterior border. Anterior border of moderate width, flattened with somewhat thickened edge, bent upwards; its anterior margin gently arched forwards. Anterior branches of facial sutures distinctly diverging anteriorly. The surface seems to have been striated but its ornamentation is not distinct on either of the specimens.

Remarks. — This new species is founded on two small cranidia (the largest measuring 4,5 mm. in length) from Kallholn in the Lund Museum. The type specimen is, with the exception of the palpebral lobes and the posterior portions of the fixed cheeks, rather well preserved. The other specimen is more fragmentary but clearly shows the characters of the glabella, preglabellar field and anterior border.

Affinities. — This species resembles *Pr. modestus* in several points, but the glabella tapers more strongly anteriorly and its anterior extremity is somewhat more bluntly rounded, the preglabellar field is relatively much longer and more gently inclined and the occipital tubercle is differently placed.

Horizon and Locality. — Upper Leptæna Limestone; Kallholn.

Proëtus convexus n. sp. Pl. V, figs. 8—13, 19—20, 23.

Specific Characters. — Entire body sub-oval to sub-oviform in outline, about twice as long as wide, strongly convex; thorax slightly longer than cephalon and about two and a half times as long as pygidium.

Cephalon semi-oval to sub-parabolic in outline, its length along the median line about three fourths the width between genal angles, strongly convex, surrounded by narrow, tumid border, marked off by strong furrow, and with the genal angles produced into rounded, tapering pointed spines reaching back to 4th or 5th thoracic segment.

Glabella with gently convex surface sloping down rather steeply from base to front end, about as long as wide at base, very slightly tapering anteriorly with nearly straight sides, bluntly and evenly rounded in front, bounded by distinct, narrow axial and preglabellar furrows. Lateral glabellar furrows scarcely impressed and generally indistinguishable, but in a few specimens with well preserved test standing out against the otherwise light surface as darker band or spots; anterior pair represented by small sub-triangular spots placed about half the width of glabella apart and a little in front of a line joining anterior extremities of eyes; 2d pair originating in axial furrows nearly opposite anterior extremities of eyes, extending inwards and backwards about one third across glabella, very narrow at sides, widening proximally; basal pairs starting at sides opposite middle of eyes, running inwards and then backwards towards occipital furrow, but not quite reaching this, extending about as far inwards as 2d pair, generally widest a little outside their middle, narrowing laterally and posteriorly; just inside the basal furrows a little in front of their middle is a pair of small elongated spots (auxiliary impressions), in some specimen confluent with the furrows, forming small inner anterior branches of these. Occipital furrow rather strong, curved forwards in the middle and at sides, reaching axial furrows. Occipital ring rather wide, narrowing laterally, strongly arched from side to side, flattened from back to front, with small median tubercle placed about half-way between anterior and posterior margins and with very faint traces of small inconspicuous occipital lobes. Preglabellar field varying in length but always very short, generally somewhat longer in the interior casts than on the surface of the test, in some specimens almost obsolete, so that the preglabellar and anterior border furrows become nearly confluent, when normally developed convex, nearly vertically bent down, and increasing in size laterally.

Cheeks rather narrow, the distance between axial furrow and genal angle about two thirds the width of glabella at base, nearly vertically bent down, their surface inside border strongly convex. Eyes sub-reniform, strongly convex in both directions, about twice as long as high, situated at about two thirds their own length from posterior margin of cephalon, close to the glabella and extending nearly half the length of latter. Palpebral lobes narrow sub-crescentiform, slightly upturned. Lower eyelids narrow (low) outside middle portions of eyes, widening considerably anteriorly and posteriorly, marked off by distinct furrows. Anterior branches of facial sutures very slightly diverging anteriorly to near anterior margin, where they bend strongly inwards; posterior branches running straight backwards from eyes to posterior borders, then obliquely outwards to cut posterior margin of cephalon at acute angles at about one third the distance from axial furrow to lateral margin. Lateral border slightly bent outwards anteriorly, nearly vertically inclined posteriorly, marked off by deep furrow, which meets the about equally strong posterior border furrow at slightly acute angle and is continued backwards on genal spine by shallow groove which soon becomes obsolete. Posterior border slightly raised, very narrow near axial furrow, where it is directed straight outwards, widening laterally and bending strongly downwards and slightly backwards.

Thorax composed of 10 segments. Axis convex, wider than side lobes, gradually tapering to pygidium; axial rings arched forwards in middle and at sides, slightly arched from back to front, without distinct lateral nodes. Pleuræ strongly bent downwards beyond fulcrum but very slightly curved backwards and sharply facetted; their inner portions straight, horizontally extended; fulcrum rather strong, situated about one third the way out; extremities slightly recurved, pointed; pleural furrow strong, scarcely oblique, dying out before reaching extremity of pleura.

Pygidium sub-semicircular in outline, about half as long as wide. Axis convex, occupying about one third the width of pygidium at anterior margin and extending rather less than three fourths its length, tapering posteriorly to bluntly rounded extremity, composed of 4 axial ring and a short terminal piece continued backwards by low indistinctly defined and not always recognizable postaxial ridge; 1st axial ring generally somewhat narrower (in a longitudinal direction) than 2d and distinctly elevated above this; following rings very weak, their surface being flattened from back to front and the furrows between them very slightly impressed. Axial furrows narrow and shallow. Side lobes flattened, horizontally extended in front adjacent to axial furrows, then gently bent downwards, with one pair of anterior half-ribs and 2 or 3 pairs of raised regular ribs defined by rather strong pleural furrows, which become weaker posteriorly, and longitudinally divided by faint interpleural furrows — sometimes only distinguishable on 1st pair — and generally with the posterior edge higher than the anterior one. In some specimens there are very faint traces of a 4th pair of ribs between the 3d pair and the postaxial ridge (or median unpaired rib). Doublure of pygidium rather wide.

Surface of cephalon and pygidium ornamented with fine striæ similar to those in *Pr. modestus* (Cf. above, p. 169) and in some specimens with a few scattered minute tubercles. Edge of cephalic border furnished with 2 or 3 coarse rugæ parallel to the margin. Ornamentation of thorax not observed.

Dimensions. — The dimensions of the largest of the entire individuals figured below (Pl. V, fig. 8) are: total length 13,75 mm., length of cephalon along median line 5 mm., width of cephalon between genal angles 6 mm., length of thorax 6,5 mm., length of pygidium 2,25 mm., width of pygidium 4,5 mm. The approximate length of some large cranidia is 7 mm.

Remarks. — This species seems to be the most common member of the genus *Proëtus* in the fauna of the Upper Leptæna Limestone in Dalarne and is represented by two nearly complete individuals from Kallholn in the Upsala Museum and by a great number of detached cranidia, free cheeks and pygidia from this and other localities in different collections.

There is an imperfect cephalon from Östbjörka in the State Museum of Natural History, which shows a peculiar anomaly in the free cheek (only the left free cheek is preserved in the specimen) inasmuch as the genal angle is not produced into a spine. The posterior border is broken off and on the surface of the lateral border the test is slightly fractured just in front of the genal angle, but it is preserved on the edge and around the angle and as far inwards as to the lateral border furrow just where this meets the posterior border furrow, the inner boundery of which is distinctly seen, which proves that the spine was not broken off after the death of the animal. Since the lateral and the posterior border furrows meet each other at or just in front of the posterior margin of the cheek the outermost portion of the posterior border must have been exceedingly narrow. This could evidently not have been the case originally, even if the specimen should have belonged to a spineless form. Consequently we must assume that it had a spine — or at least a normal genal angle — and that this was broken off while the animal was still alive and did not regenerate, but the test grew together.

Affinities. — This species resembles in its chief characters *Pr. complanatus* BARR. (BARRANDE, 1852, p. 463, Pl. XVII, figs. 34—41). The latter is, however, from a much higher stratigraphical horizon and, to judge from BARRANDE's description and figures, its cephalon is slightly pointed in front and the cheeks are not so strongly bent downwards as in *Pr. convexus,* the glabella increases decidedly in width posteriorly, all the furrows on the pygidial axis are strong and all the rings rounded, and there is a marginal border on the pygidium.

The differences between *Pr. convexus* and the new and probably closely allied form that will be described below as *Pr. kullsbergensis* n. sp. will be pointed out in connection with the description of this form.

Horizon and Localities. — Upper Leptæna Limestone; Kallholn, Boda, Unskarsheden, Lissberg, Östbjörka, Gryssen, Änderåsen.

Proëtus kullsbergensis n. sp. Pl. V, figs. 24—25.

Specific Characters. — Glabella somewhat longer than wide at base, slightly expanded at sides a little in front of base, gently tapering anteriorly, very bluntly rounded in front, gently convex; lateral glabellar furrows indistinguishable. Axial and preglabellar furrows of about equal strength, narrow but distinctly impressed; middle portion of preglabellar furrow very slightly arched forwards, side portions more strongly curved back, meeting axial furrows at obtuse angles. Occipital furrow deeply impressed, nearly straight in the middle, weakening and bending forwards near axial furrows. Occipital ring of moderate width, slightly narrowing laterally, flattened from back to front, gently arched from side to side, with faint traces of lateral nodes. (Its middle portion is not completely preserved in either of the specimens observed, so that is not possible to see whether it had a median tubercle). Preglabellar field rather short, about one sixth the length of glabella, nearly parallel-sided in the middle, slightly increasing in size towards the sides, with gently convex surface descending to anterior border furrow. Anterior border marked off by distinct furrow, relatively wide, flattened, gently upturned; its anterior margin gently arched forwards. Anterior branches of facial sutures slightly diverging anteriorly. Surface of cranidium traversed by fine forwards convex striæ; edge of border with 2 or 3 coarse rugæ parallel to the margin.

Dimensions. — Approximate length of largest cranidium observed 6 mm. Length from anterior margin to occipital furrow in type specimen 3,25 mm.

Remarks. — The material on which the above description is based consists of two fragmentary cranidia from Kullsberg in the Upsala Museum. The type specimen is best preserved, though it only shows parts of the fixed cheeks and nearly the whole of the occipital ring is broken off. In the other specimen the posterior middle portion of this is damaged, but the impression of it is partly quite distinct and its other portions well preserved, so that its general characters are seen. In the figure (Pl. V, fig. 24) the anterior portion of the occipital ring is restored so as to show the course of the occipital furrow distinctly.

There are two rather badly preserved pygidia in the Upsala Museum, from the same locality as these cranidia, which most probably are to be associated with them. They are sub-parabolic in outline, about four sevenths as long as wide. The axis is strongly convex, rather wide, its width at anterior margin being about three eighths that of the entire pygidium, tapering posteriorly and extending about two thirds the length of the pygidium; it is composed of 4 axial rings and a short terminal piece; the anterior ring is very narrow (longitudinally), considerably narrower than the two following ones, slightly raised and comparatively well defined; the following ones are flattened from back to front and very indistinctly defined, the 4th is scarcely recognizable in the type specimen, somewhat more distinct in the other specimen. The posterior portion of the pygidium is badly preserved in both specimens, but the axis seems to be truncated behind and continued backwards by a very short (the shortness may, however, be due to the state of preservation) postaxial appendage. The side lobes are flattened and horizontally extended in front adjacent to the axial furrows, which are very slightly impressed, and then gently bent downwards; there are 2 distinct ribs on each side behind the anterior half-rib and faint traces of a 3d (scarcely recognizable on the type specimen); the pleural furrows are strong and appear wider than they really are because the anterior portions of the ribs are so strongly depressed that their surface becomes nearly confluent with the furrows.

Affinities. — As already mentioned above (p. 173) this species seems to be closely related to *Pr. convexus* but the glabella is more bluntly rounded in front and distinctly expanded at sides, the preglabellar field is relatively longer and does not seem to be quite so strongly bent downwards, the anterior margin is more flattened and relatively broader; the pygidium is longer in relation to its width, parabolic rather than semicircular in outline, and its axis is relatively wider.

Horizon and Localitity. — Lower Leptæna Limestone; Kullsberg.

Proëtus parvigena n. sp. Pl. V, figs. 32—33.

Description. — Cephalon sub-parabolic in outline, its length along the median line about five sevenths the basal width, with the genal angles produced into rapidly tapering spines, which seem to have been quite short (their exact length not known) and pressed against sides of thorax. Border surrounding cephalon narrow, strongly bent downwards, posteriorly marked off by extremely weak furrow, anteriorly still more indistinctly defined, its surface here being essentially a continuation of the surface of the glabella and the inner portions of the cheeks, only marked off by a narrow band or line, which by its somewhat darker colour stands out indistinctly against the otherwise light surface.

Glabella about as long as wide at base, very slightly tapering anteriorly, bluntly rounded in front, depressed convex, almost confluent with anterior border and anterior portions of fixed cheeks; lateral glabellar furrows indistinguishable. Axial furrows narrow, distinctly marked from posterior margin of cephalon to nearly opposite anterior extremities of eyes, then growing extremely weak and dying out before reaching anterior border. Occipital furrow very weak, not reaching axial furrows, slightly curved forwards in middle and at sides. Occipital ring of moderate width, laterally confluent with glabella, very gently arched from side to side; the portion above the articulating half-ring of 1st thoracic axial ring marked off by faint furrow and slightly raised in the middle above the anterior portion, at sides depressed below this so that there are faint indications of occipital lobes; posterior margin arched backwards. Cheeks nearly vertically bent down with slightly convex surface, narrow, their width at level of occipital furrow less than half that of glabella at base; lateral margins of cheeks nearly straight from posterior portions of spines to opposite middle of eyes. Eyes large, prominent, sub-reniform, extending more than half the length of glabella and situated close to it and far back, their posterior extremities nearly reaching posterior border furrow. Palpebral lobes long and narrow, widest across middle, rapidly narrowing posteriorly, but only slightly decreasing in width anteriorly. Posterior branches of facial sutures bending outwards at posterior border furrows to cut posterior margin of cephalon at acute angles about half-way between axial furrows and lateral margins; the anterior branches have not been distinctly observed, but they seem to be directed nearly straight forwards. Posterior border of cheek flattened, directed obliquely outwards, downwards and backwards; its posterior margin and inner margin of spine forming an unusually even and slight curve. Posterior border furrow very faint just at axial furrow, then growing quite distinct though not deep, becoming fainter again laterally, meeting lateral border furrow at very acute angle.

Thorax (only partly known) with broad, moderately convex axis defined by distinct axial furrows. Axial rings with very faint traces of lateral nodes. Anterior pairs of pleurae (the posterior ones are not known) abruptly bent downwards and beyond fulcrum gently curved backwards and sharply facetted, with narrow, short pleural furrows and — at least the anterior pair — pointed extremities; fulcrum weak, situated very near axial furrow.

Ornamentation not known.

Remarks. — There is only one small specimen — consisting of a nearly complete cephalon with 3 fragmentary thoracic segments attached — of this species available and from it the above description is drawn up. The specimen does not seem to have been pressed or distorted, but the test is rather worn and it has evidently undergone some other alteration as well, which accounts for the indistinctness of the sutures and probably also for the faintness or obliteration of nearly all the furrows on the cephalon. Because of this the description given above cannot in all respects be considered as a definitive diagnosis of the species. But apart from such features, which may be due to the state of preservation, the species is well characterized by the shape of the cephalon, the large eyes, and especially by the shape and narrowness of the free cheeks and the narrowness of the inner portions of the thoracic side lobes.

Affinities. — This species resembles *Pr. convexus* to a certain extent in the shape of the cephalon, the strong inclination of the cheeks and the outer portions of the thoracic pleuræ, and the narrowness of the inner portions of the latter, and it seems probable that its affinities are with that species. The relationship does not, however, seem to be especially close.

Horizon and Locality. — Upper Leptæna Limestone; Kallholn.

Proëtus pentagonoides n. sp. Pl. V, fig. 22.

Specific characters. — Glabella irregularly sub-pentagonal in outline, gently convex, slightly compressed from the sides, extending about three fourths the length of cranidium, widest at base and between middle of eyes, where it is slightly expanded, the width at these places about equal to the length, narrowing anteriorly, pointed in front. Lateral glabellar furrows and auxiliary impressions inside basal pair of furrows represented, in type specimen, by slight elevations of the surface, very distinct by their colouring; anterior pair of furrows represented by small round spots situated about half the width of glabella apart and far forward, nearly opposite antero-lateral angles of glabella; 2d pair starting at sides a little in front of a line joining anterior extremities of palpebral lobes, extending obliquely inwards and backwards rather more than one third the way across glabella, widest proximally; basal pair reaching about equally far inwards as 2d pair, starting opposite middle of palpebral lobes and running obliquely inwards and backwards, widest a little in front of their middle. Axial furrows narrow, deeply impressed, gently arched outwards opposite middle of eyes, slightly converging anteriorly, meeting preglabellar furrow at obtuse angles. Preglabellar furrow about equalling axial furrows in strength, angulated in centre at about 110°, its side portions nearly straight. Occipital furrow narrow, rather strongly impressed in the middle, deepening laterally, reaching axial furrows, slightly arched forwards in middle and backwards at sides behind postero-lateral portions of glabella. Occipital ring rather wide, narrowing laterally, flattened from back to front, rather strongly arched from side to side, with small median tubercle placed half-way between anterior and posterior margins and rather small and inconspicuous but quite distinct occipital lobes. Preglabellar field very short in the middle, increasing in size laterally, sloping down to anterior border furrow. Anterior border narrow, marked off by distinct, though rather weak furrow; its anterior margin arched forwards, very slightly angulated in the middle. Palpebral lobes sub-triangular rather than crescentiform in outline, extending about one third the length of glabella and situated very close to it and about their own length from posterior margin of cephalon, strongly convex transversely, their inner portions sloping abruptly upwards from axial furrows, the lateral portions gently downwards to facial sutures. Anterior branches of facial sutures nearly straight, slightly converging anteriorly.

Surface of cranidium traversed by closely set, fine, arched striæ.

Remarks. — The material on which this new species is founded consists of three cranidia, all of about the same size, one from Unskarsheden in the State Museum of Natural History, another from Osmundsberg in the Museum of the Geological Survey and a third from Kallholn in the Upsala Museum. The type specimen is, with the exception of the posterior portions of the fixed cheeks, well preserved, though the striation of the surface is only traceable in a few places. The others are more imperfect, but in the specimen from Kallholn the ornamentation of the test is very distinct. In this the preglabellar field is slightly longer than in the other two, but in other characters it agrees with them and the length of the preglabellar field seems to vary somewhat in most species of this genus.

Affinities. — This species is well characterized by the shape of the glabella and the palpebral lobes and the combination of other characters, and does not seem to be especially closely related to any previously described species. The ornamentation of the test indicates that it belongs to the same large group of species as *Pr. modestus* and *Pr. convexus.* The lateral glabellar furrows also seem to have about the same characters as in these species, but this evidently does not prove any close relationship, since the development of these furrows appears to be nearly identical in several otherwise very different members of the genus.

Horizon and Localities. — Upper Leptæna Limestone; Unskarsheden, Kallholn, Osmundsberg.

Proëtus Ainæ n. sp. Pl. V, figs. 26—31.

Specific Characters. — Cephalon surrounded by narrow border marked off by wide, shallow furrow, and with the genal angles produced into tapering spines, which seem to have been rather short (their exact length not known). Glabella about five sevenths the length of cranidium, slightly longer than wide at base, tapering anteriorly and narrowly rounded in front, its middle portion rather gently convex, the marginal portions strongly curved downwards. Lateral glabellar furrows shallow, scarcely impressed on the surface of the test but distinct by their colouring, generally more distinctly impressed on the inner casts; anterior pair very far forward, directed obliquely inwards and backwards, with their inner extremities about half the width of glabella apart and well in front of a line joining inner extremities of palpebral lobes, widest proximally, narrowing distally and generally becoming obsolete before reaching axial furrows; 2d pair parallel to anterior pair, reaching somewhat farther inwards than these, narrowing laterally but distinct all the way out to axial furrows, which they meet nearly opposite anterior extremities of palpebral lobes; basal pair originating in axial furrows opposite middle of palpebral lobes, curving inwards and then backwards towards occipital furrow and nearly reaching this, dividing base of glabella into three nearly equal portions, widest in the middle, narrowing laterally and posteriorly and in some specimens almost confluent with the pair of small auxiliary impressions situated just inside their wide middle portions. Axial and preglabellar furrows narrow, distinctly impressed, forming a continuous curve. Occipital furrow deep and strong, narrowing laterally, bent forwards in middle, and at sides in front of occipital lobes, reaching axial furrows. Occipital ring strongly raised above occipital furrow and strongly arched from side to side, narrow, widening at sides, with pair of small, convex, sub-oviform occipital lobes bounded posteriorly by weak furrows. Preglabellar field very slightly convex, short, increasing in length laterally, descending to anterior border furrow. Anterior border flattened with rounded edge, gently upturned, its anterior margin rather gently arched forwards.

Fixed cheeks very narrow. Palpebral lobes crescentiform, rather prominent, gently upturned, placed far back and close to the glabella and extending rather less than half the length of latter. Anterior branches of facial sutures nearly straight, very slightly diverging anteriorly; posterior branches running nearly straight backwards from eyes to posterior border furrows, then obliquely outwards to cut posterior margin of cephalon at very acute angles. Free cheeks sub-triangular in outline, their surface inside borders gently convex. Eyes prominent, sub-reniform, elevated on distinct lower eyelids with wide, shallow furrows below. Lateral border thickened, its surface rounded but with a slight flattening close to border furrow. Lateral border furrow deepest anteriorly, becoming shallower posteriorly, meeting deep posterior border furrow at very acute angle, and continued backwards on genal spine by narrow, shallow groove. Posterior border narrow, raised.

Pygidium sub-semicircular to semielliptical in outline, about four sevenths as long as wide. Axis strongly convex, occupying nearly one third the width of pygidium at anterior margin and extending more than four fifths its length, gently tapering posteriorly, rounded behind, and continued backwards by low, indistinct postaxial ridge; divided into 7 or 8 rounded axial rings, which become faint posteriorly, and a short terminal piece; anterior axial ring slightly narrower (longitudinally) than following ones. Axial furrows scarcely impressed. Side lobes with a slight flattening in front adjacent to axial furrows, then sloping rather strongly downwards with convex surface to near margin, where the slope generally becomes more gentle; with 6 pairs of regular ribs behind anterior pair of half-ribs, followed by narrow postaxial region, which bears the postaxial ridge (or median unpaired rib); anterior pairs of regular ribs defined by deep pleural furrows and longitudinally divided by distinct interpleural furrows, which are narrow and shallow proximally, decreasing in strength distally; both kinds of furrows reaching margin; posteriorly the ribs become much fainter, the last 1 or 2 pairs being scarcely recognizable. Doublure of pygidium narrow.

Surface of free cheeks inside borders ornamented with small rounded closely set pits. On the other parts the test is not well enough preserved to show the ornamentation clearly, but it seems as if the preglabellar field was pitted and the glabella ornamented with an irregular network of low, narrow ridges.

Dimensions. — The largest cranidia of this species that have been observed, have a length of 7 or 7,5 mm., and the largest pygidia a length of about 5,5 mm. (articulating half-ring not included) and a width of about 9,5 mm.

Remarks. — The species has only so far been found at Lissberg, from which locality it is represented by a considerable number of detached cranidia, free cheeks and pygidia in the Museum of the University of Stockholm and in the Museum of the Geological Survey.

In one specimen, in the former collection, a few thoracic pleuræ — the axial part of the segments is broken off — are attached to the pygidium. The pleuræ are marked by strong, nearly median furrows; their inner portions are straight and extended horizontally to the fulcrum, which is situated less than half-way out; the outer portions are very strongly bent downwards and very slightly curved backwards and distinctly faceted, the extremities are not very well preserved, but seem to have been pointed and slightly recurved.

Among the fragments (in the same collection) there is a hollow cast of the middle body and posterior border of a hypostoma, which probably belonged to this species. The middle body was convex, long and narrow, at least twice as long as wide (the anterior extremity is not represented in the cast), rounded behind, narrowing near front end, and towards the posterior extremity its sides were marked by a pair of short, oblique middle furrows. The posterior border was narrow and raised and separated from the body by a distinct furrow.

The species is named after Miss AINA LAURELL, who has made most of the drawings for this work.

Affinities. — The ornamentation of the cheeks (and the preglabellar field), and the relatively great number and general characters of the axial rings and of the ribs and furrows on the side lobes of the pygidium, indicate that the affinities of this species are with certain members of the genus described from the Silurian of Gothland and the East Baltic Area (Cf. LINDSTRÖM, 1885 and SCHMIDT 1894). From all these it differs, however, in several other characters and does not seem to be especially closely related to any of them.

Horizon and Locality. — Upper Leptæna Limestone; Lissberg.

Proëtus sp. ind. a. Pl. V, figs. 14, 17.

Specific Characters. — Pygidium transversely sub-oval in outline, about three fifths as long as wide. Axis moderately convex, its width at front end rather more than one third that of entire pygidium, rapidly tapering posteriorly to narrow rounded extremity and continued backwards by narrow postaxial ridge; divided by faint furrows into 7 axial rings and a short terminal piece; 1st axial ring narrower (longitudinally) than following ones and generally slightly rounded; following rings flattened from back to front. Axial furrows scarcely impressed. Side lobes flattened and horizontally extended in front adjacent to axial furrows, then gently bent downwards, with one pair of anterior half-ribs and 5 pairs of well-marked regular ribs separated by strong pleural furrows generally not quite reaching margin, and in some specimens with faint traces of a 6th pair between the 5th and the postaxial ridge (or median unpaired rib). 1st pair of regular ribs generally divided by faint interpleural furrows into depressed anterior and raised posterior bands; on the following ribs the interpleural furrows have become obsolete, but the posterior portion is higher than the anterior one, the slope towards the preceding pleural furrow being gentle, the slope towards the succeeding one, abrupt. Doublure very wide, slightly decreasing in width posteriorly, with rather closely set continuous striæ (or fine terraced lines) sub-parallel to margin. Dorsal surface of pygidium ornamented with fine striæ, which are arched forwards on the axis; on the lateral lobes their general direction is transverse but they are strongly undulating and bend slightly forwards on the lateral edges.

Dimensions. — In the largest specimen observed, which is somewhat incomplete, the approximate length (the articulating half-ring not included) is 5,5 mm. and the width 9 mm.

Remarks. — There are a few pygidia from Kallholn in the Upsala Museum and one from Unskarsheden in the State Museum of Natural History which possess the above characters. It seems possible that they belong to the same species as the cranidia described above as *Pr. pentagonoides*, since they have been found at the same localities as two of these and appear to be of the proper relative size, and since the ornamentation of the test is similar, but as they have not been found in direct association with these cranidia it is preferable to describe them separately.

Horizon and Localities. — Upper Leptæna Limestone; Kallholn, Unskarsheden.

Proëtus sp. ind. b. Pl. V, fig. 63.

Specific Characters. — Pygidium sub-triangular in outline, with gently rounded lateral angles, obtusely pointed behind, about five eighths as long as wide. Axis strongly convex, sub-cylindrical, its width at anterior margin about one third that of entire pygidium, extending about four fifths the length of latter, very gently tapering posteriorly to bluntly rounded extremity and continued backwards to margin by low, indistinctly defined postaxial ridge; divided by faint furrows — the posterior ones scarcely recognizable — into 10 axial rings and a short terminal piece; 1st axial ring slightly rounded, following ones flattened from back to front. Axial furrows scarcely impressed. Side lobes flattened and horizontally extended in front adjacent to axial furrows, then gently curved downwards, with 6 pairs of slightly raised regular ribs behind anterior pair of half-ribs growing weaker towards the extremities and separated by distinct, though rather narrow pleural furrows, the last pair very weak and indistinctly marked off from the relatively wide unfurrowed posterior portion, the surface of which is raised in the middle, forming the postaxial ridge. Interpleural furrows very weak, growing fainter posteriorly, on the posterior pairs of ribs almost obsolete. Anterior band of ribs about as high as posterior band adjacent to axial furrows, depressed below this laterally. Surface of pygidium ornamented with fine, sinuous striæ, which are arched forwards over the axis, on the side lobes directed obliquely outwards and forwards, but becoming nearly transverse behind axis.

Remarks. — One isolated pygidium from Kullsberg in the Lund Museum possesses the above characters and appears to represent a new species of *Proëtus*. The cranidia from the same locality described above as *Pr. kullsbergensis* are, as is already mentioned, presumably to be associated with some pygidia of another type, and no other *Proëtus* cranidia from the Lower Leptæna Limestone have come under my notice. It shows several characters typical of a large group of Proëtids — to which group among others *Pr. modestus, Pr. convexus* and *Pr. kullsbergensis* may be referred — but it does not seem to bear any specially close resemblance to any previously described member of the genus.

Horizon and Locality. — Lower Leptæna Limestone; Kullsberg.

Proëtus? sp. ind. c. Pl. V, fig. 64.

Specific Characters. — Pygidium sub-semicircular in outline, about two thirds as long as wide. Axis strongly convex, its width at anterior margin rather more than one third that of entire pygidium, extending about two thirds the length of latter, gently tapering posteriorly to bluntly rounded extremity and continued backwards by low postaxial ridge; marked anteriorly by 3 axial rings defined by weak but distinct axial ring furrows curving backwards laterally, and behind these with very faint traces of 2 or 3 following furrows; 1st axial ring slightly raised and somewhat narrower (longitudinally) than the following ones, which are flattened from back to front. Axial furrows of moderate strength. Side lobes slightly flattened in front adjacent to axial furrows, then strongly curved downwards, with 4 pairs of curved, slightly raised pleuræ, which become weaker towards the extremities, and with faint traces of a 5th pair lying close to the postaxial ridge and nearly parallel to this. Interpleural and pleural furrows of about equal strength growing weaker laterally, the former reaching the margin, the latter dying out just inside this. The surface of the pygidium is not very well preserved but it seems to have been striated.

Remarks. — The above description is based on one single and not very well preserved pygidium from Östbjörka in the Upsala Museum. Its general characters indicate that it belongs to a species of *Proëtus,* but it does not, as far as I am able to judge, particularly resemble any previously described member of the genus.

Horizon and Locality. — Upper Leptæna Limestone; Östbjörka.

Proëtus sp. ind. d. Pl. V, fig. 21.

Remarks. — There are three small hypostomata, two from Kallholn, the third from Klittberg, in the Lund Museum, which probably belong to one of the foregoing species and which possess the following characters: — General shape elongate, about one and a half times as long as wide, anterior end very bluntly rounded, posterior end pointed, middle portion nearly parallel-sided. Middle body elongated sub-oval in outline, defined by distinct furrows except inside anterior wings, very strongly elevated, most so a little in front of middle; its anterior portion compressed from the sides, the posterior portion more evenly arched; sides of body marked at about two thirds the distance from anterior end by pair of short, shallow oblique furrows. Anterior border very narrow, strongly raised. Anterior pair of wings triangular, short, only extending about one third the length of body, strongly inclined. Lateral borders narrow, gently raised, becoming flatter posteriorly and confluent with posterior border. Posterior border narrow, flattened, its edge furnished with short, triangular median spine and pair of lateral spines.

Horizon and Localities. — Upper Leptæna Limestone; Kallholn, Klittberg.

Proëtus? sp. ind. e. Pl. V, fig. 37.

Specific Characters. — Pygidium sub-triangular in outline, with gently rounded lateral angles, about two thirds as long as wide. Axis rather strongly convex, its width at anterior margin rather more than one third that of entire pygidium, extending somewhat less than two thirds the length of latter, very slightly tapering posteriorly to rounded extremity and continued backwards to posterior margin by narrow postaxial ridge; divided by faint furrows — the hindmost one incomplete in the middle — into 4 axial rings and a relatively long terminal piece. 1st axial ring slightly raised and rounded and somewhat narrower (longitudinally) than following ones, which are flattened from back to front. Axial furrows of moderate strength. Side lobes slightly flattened in front adjacent to axial furrows, then rather strongly curved downwards, with 4 pairs of gently curved, distinctly defined pleuræ growing weaker and straighter posteriorly, and with faint traces of a 5th pair lying close to and nearly parallel to postaxial ridge. Pleural furrows somewhat stronger than interpleural ones. Neither kind of furrows quite reach the margin. Pleural bands with gently rounded surfaces; anterior ones broader and more strongly raised than posterior ones. Ornamentation not observed.

Remarks and Affinities. — A small pygidium, measuring 1 $^{1}/_{3}$ mm. in length, from Klittberg in ISBERG's collection in Lund possesses the above characters. It seems to agree rather closely in its general characters with the pygidium which SCHMIDT (1894, p. 59, Pl. IV, fig. 43) hesitatingly referred to *Cyphaspis planifrons* EICHW., but it differs in its more triangular outline. The characters of the pleuræ seem to indicate, however, that its affinities are with the Proëtidæ rather than with *Cyphaspis*.

Horizon and Locality. — Upper Leptæna Limestone; Klittberg.

Genus »**Phaëtonides**» ANGELIN.

»**Phaëtonides**» sp. ind. Pl. V, fig. 36.

Description. — Glabella gently convex, about two thirds the length of cranidium, somewhat wider than long, slightly expanded posteriorly at sides, broadest a little in front of base, slightly narrowing anteriorly, very bluntly rounded in front, not reaching anterior border furrow; with pair of gently convex, narrow, elongated sub-ovate basal lobes, pointed in front, nearly half the length of glabella and about one fourth its basal width, projecting somewhat laterally, marked off by strong, slightly curved, oblique furrows inclined about 65° to occipital furrow, most strongly impressed in the middle, weakest near axial furrows. No other lateral glabellar furrows are distinctly recognizable, but there are faint traces of 3 anterior pairs, of which the two foremost especially are very obscure (possibly they are not real furrows but only scratches on the surface of the glabella, which is very badly preserved on the specimen); 1st pair short, placed far forward, nearly at the antero-lateral angles of glabella, directed obliquely inwards and backwards; 2d pair likewise short, nearly transverse, placed somewhat nearer to 3d than to 1st pair; 3d pair parallel to 2d pair, rather long, extending more than one third the way across glabella, and situated just in front of its middle. Axial furrows narrow, their anterior portions, in front of basal glabellar lobes, distinctly impressed, outside anterior portions of latter they are very weak, but seem to increase in strength again posteriorly. Preglabellar furrow equal to anterior portions of axial furrows in strength and forming a continuous curve with these. Occipital furrow of moderate strength. Occipital ring broad (longitudinally), flattened from back to front, strongly arched from side to side, with pair of well defined, convex, oval occipital lobes projecting a little outside base of glabella. Preglabellar field very short, descending to anterior border furrow. Anterior border (only partly preserved) seems to have been of moderate width, narrowing laterally, slightly rounded. Fixed cheeks very fragmentarily preserved, but it seems as if the palpebral lobes had been situated close to the glabella and very far backward and the posterior branches of the facial sutures had cut the posterior margin of the cephalon rather far out.

Remarks and Affinities. — The above description is based on a single, imperfect cranidium from Lissberg in the Museum of the University of Stockholm. It seems to represent a new species belonging to the family Proëtidæ, and its general characters, as far as they are known, indicate that its affinities are with »*Phaëtonides*» *Stokesi* MURCH. (MURCHISON, 1839, Pl. XIV, fig. 6; LOVÉN, 1845, p. 50, Pl. I, fig. 3) and »*Phaëtonides*» *rugulosus* LINDSTR. (LINDSTRÖM, 1885, p. 75, Pl. XVI, fig. 13). These species evidently represent a separate genus of the family Proëtidæ, the genotype of which should be »*Phaëtonides*» *Stokesi*, and as it seems as if the name *Phaëtonides* must be given up,[1] they ought to receive a new generic name. Since, however, the specimen from Lissberg is so poor that it is impossible to be quite sure whether it really belongs to this genus, I do not think it appropriate to introduce a new generic term here nor to designate the species by a specific name, but have for the present called it »*Phaëtonides*» sp. ind.

This new genus represented by the species »*Ph.*» *Stokesi* and »*Ph.*» *rugulosus* resemble the genera *Tropidocoryphe* NOVÁK (1890, p. 10) and *Astycoryphe* R. & E. RICHTER (1919 b, p. 2) in having a narrow, raised rim, the »tropidia», on the preglabellar field and cheeks running parallel to the outer margin of the cephalon and corresponding to the inner margin of the doublure.

It further resembles some species of *Tropidocoryphe* to a certain extent in the lobation of the glabella and the shape of the latter too recalls some species both of this genus and of *Astycoryphe*. It seems probable that its affinities are with these genera, although it differs from them in the characters of the pygidium, in the possession of occipital lobes, and in some other features. It is not possible to see whether the species from Lissberg possesses a tropidia, but it hardly seems so. Its preglabellar field is shorter than those of »*Ph.*» *Stokesi* and »*Ph.*» *rugulosus*. Further the third pair of lateral glabellar furrows seems to be more strongly marked anteriorly, the basal glabellar lobes are narrower and the occipital lobes smaller and of somewhat different shape than in these. In other respects it seems to agree fairly well with the two species just mentioned.

The form which seems to bear the closest resemblance is POMPECKI's *Cyphaspis parvula* (POMPECKI, 1890, p. 57, Pl. IV, figs. 28—28 a), but this appears to have a more strongly convex glabella, a somewhat longer pre-

[1] The generic name *Phaëtonides* was used by ANGELIN in 1854 (p. 21) as a substitute for the preoccupied term *Phaëton* BARR. (BARRANDE, 1846 a, p. 61), but he altered the definition of the genus, giving it a wider scope and referred to it some species, viz. *Proëtus decorus* BARR. (BARRANDE, 1852, p, 468, Pl. XVII, figs. 13—21), *Astycoryphe (Prionopeltis) Astyanax* CORD. [CORDA, 1847, p. 125; by R. and E. RICHTER (1919 b, p. 11) referred to the genus *Astycoryphe* and to the species *Ast. gracilis* BARR.] and *Proëtus (Phaëtonides) Stokesi* MURCH., which, as pointed out by NOVÁK (1890, 11), belong to other groups and which evidently represent three different genera. The name *Phaëton* was, however, already earlier exchanged by CORDA (1847, p. 121) for *Prianopeltis* and this latter name must evidently be kept for those species which BARRANDE originally referred to *Phaëton* and which CORDA placed in his group A of *Prianopeltis* (Cf. R. and E. RICHTER, 1919 b, p. 2, foot-note). Novák's suggestion that the name *Phaëtonides* should be kept for this group and CORDA's name rejected, does not seem to be well grounded. In 1885 LINDSTRÖM refers to *Phaëtonides*, in addition to »*Ph.*» *Stokesi*, two other Gothlandic species (only known by the cranidia) viz. *Ph. rugulosus* LINDSTR. and *Ph. longifrons* LINDSTR. It does not seem, however, as if the latter species belonged to the same genus as the two others. Nor do the species referred to *Phaëtonides* by HALL (1888, pp. 134—139) belong here.

glabellar field, and a narrower (longitudinally) occipital ring. Otherwise the characters of these parts seem to be almost identical. It is true that POMPECKI does not mention the presence of occipital lobes, nor are they seen on the figure of the cranidium, but it does not seem as if the whole of the occipital ring was represented, but as if there had been occipital lobes, broken off on the specimen along the furrows, which defined them from the main portion of the occipital ring. The fixed cheeks are not preserved on the cranidium figured, but to judge from the accompanying figure of a detached free cheek, the facial suture has the course typical for the Proëtidæ, which proves that the species at any rate cannot belong to *Cyphaspis* or to any other genus referable to the family Cyphaspidæ. POMPECKI does not mention the occurrence of a tropidia, but to judge from the figure of the cranidium it seems almost as if it might be present, although it is not marked on the figure of the free cheek.

REED has suggested that POMPECKI's species might be allied to the Girvan trilobite described by him (1914, p. 27, Pl. IV, fig. 8) as *Cyphaspis Jamesoni*. The narrowness of the fixed cheeks and the course of the posterior branches of the facial sutures indicate that the latter too must be separated from *Cyphaspis* and referred to the family Proëtidæ. Several of its characters suggest that it ought to be placed with »*Phaëtonides*» *Stokesi* and »*Ph.*» *rugulosus*. It differs from these, however, in having much weaker occipital lobes, and the pygidium — which is only imperfectly known — seems to be comparatively smaller and composed of fewer segments, and it is not possible to find out from the description and figure available whether it possesses a tropidia. From the form from Lissberg it differs in the shape of the glabella, the weaker basal glabellar furrows, longer preglabellar field, narrower (longitudinally) occipital ring, and less distinct occipital lobes.

Horizon and Locality. — Upper Leptæna Limestone; Lissberg.

Genus **Isbergia** n. gen.

Cephalon *Proëtus*-like, but with the posterior branches of the facial sutures turned sharply outwards to cut the posterior margin close to the genal angles. (Preglabellar field long, nearly vertically bent down. Genal angles not produced into spines.) Thorax and pygidium unknown.

Genotype: *Isbergia planifrons* n. sp.

Remarks: — The two apparently very closely allied species which will be described below show in the cephalon a combination of characters which makes it necessary to refer them to a separate genus, which may aptly be called *Isbergia* after Amanuensis O. ISBERG, who has collected most of the material on which the two species are founded.

The affinities of the genus seem to be with the Proëtidæ and the Cyphaspidæ, and I have been rather in doubt as to which of these two families it ought to be referred to. In the course of the posterior branches of the facial sutures it resembles the Cyphaspidæ and differs from the typical members of the Proëtidæ. In the situation of the eyes close to the glabella and in several other features, on the other hand, it agrees so closely with the latter that it appears as if it must be placed, at least for the present, with these. In both the species which I have referred to *Isbergia* the preglabellar field is long and nearly vertically bent down, the cheeks are likewise very steeply inclined, and the genal angles not produced into spines. This combination of characters is not in accord either with the Proëtidæ or the Cyphaspidæ, but it seems doubtful whether it can be considered a difference of even generic importance. It is to be hoped that in the future the other, hitherto unknown — or not recognized — parts of the carapace will be found, and that this will help to decide the affinities of the genus *Isbergia*.

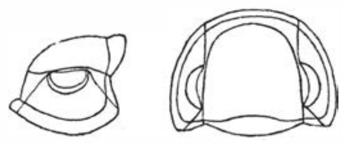


Fig. 17. *Isbergia planifrons* n. sp. a lateral, b dorsal view of cephalon × 6. Kallholn. Upsala Museum.

Distinguishing Characters of the Species.

Glabella gently and uniformly convex, very slightly tapering anteriorly. Eyes about half the length of glabella, situated at about half their own length from posterior margin of cephalon. *Isbergia planifrons* n. sp.

Glabella rather strongly convex, compressed from the sides, distinctly tapering anteriorly. Eyes about one third the length of glabella, situated at about their own length from posterior margin of cephalon. *Isbergia parvula* n. sp.

Isbergia planifrons n. sp. Pl. V, figs. 54—57, text-fig. 17.

Specific Characters. — Cephalon semioval in outline, its length along median line about three fourths the greatest width, which is a little in front of genal angles, strongly convex, surrounded by narrow border marked off by narrow, distinct furrow; border flattened and slightly bent downwards in front of glabella, gradually growing more and more steeply inclined and slightly convex posteriorly. Genal angles not produced into spines.

Glabella gently and uniformly convex (transversely), sloping downwards anteriorly, generally somewhat shorter than wide at base, tapering slightly anteriorly, very bluntly rounded in front, bounded by distinct narrow axial and preglabellar furrows. Lateral glabellar furrows very faint, only discernible in some specimens, nearly parallel to each other, directed obliquely inwards and backwards; anterior pair short, situated just behind antero-lateral angles of glabella; 2d pair originating in axial furrows nearly opposite anterior extremities of palpebral lobes, reaching about half-way up on glabella; basal pair beginning in axial furrows somewhat nearer to lateral extremities of 2d pair than to occipital furrow, extending about as far inwards as 2d pair. Occipital furrow rather strongly impressed, arched forwards in the middle. Occipital ring rather wide in the middle, rapidly narrowing laterally, strongly arched transversally, slightly rounded longitudinally, its posterior margin gently arched backwards. Preglabellar furrow slightly arched downwards. Preglabellar field long (high), about one third the length of glabella, nearly vertically bent down with slightly convex surface. Cheeks rather wide (high), their greatest width across middle of eyes about three fourths that of glabella, nearly vertically bent down, their surface inside border gently convex. Eyes sub-reniform, strongly convex in both directions, about twice as long as high, situated at about half their own length from posterior margin of cephalon close to the glabella and extending nearly half the length of latter. Palpebral lobes very narrow, sub-crescentiform, directed nearly straight outwards, slightly convex longitudinally. Lower eyelids narrow, of uniform width, marked off by faint furrows. Anterior branches of facial sutures directed nearly straight forwards and downwards; posterior branches nearly straight, strongly turned outwards, cutting posterior margin of cephalon just within genal angles. Posterior border of cheek narrow, slightly raised and rounded, directed slightly backwards, marked off by narrow furrow.

Surface of test smooth.

Dimensions. — The cranidia observed vary from 2 mm. to 3 mm. in length.

Remarks. — This new species is represented by one well-preserved entire cephalon and one cranidium from Kallholn in the Upsala Museum, several cranidia from the same locality in ISBERG's collection in Lund, by one cranidium from Osmundsberg in the Museum of the Geological Survey and by one from unknown locality — to judge from the appearance of the rock it seems probable that it is from Boda — in the Lund Museum. One cranidium of this species, now in the Upsala Museum, was also found by the present writer, in the limestone of the Chair of Kildare in Ireland.

Horizon and Localities. — Upper Leptæna Limestone; Kallholn, Osmundsberg, Boda?

Kildare Limestone; Chair of Kildare.

Isbergia parvula n. sp. Pl. V, figs. 49—53.

Specific Characters. — Cephalon semielliptical in outline, length along median line about two thirds the greatest width, which is at the genal angles, strongly convex, surrounded by narrow border marked off by narrow furrow; border flattened and nearly horizontally extended in front of glabella, becoming more und more steeply turned downwards and slightly convex posteriorly. Genal angles not produced into spines.

Glabella rather strongly convex, slightly compressed from the sides and with the anterior portion rather strongly bent down, about as long as wide at base, tapering anteriorly to rounded front end, bounded by narrow, distinct axial and preglabellar furrows. Lateral glabellar furrows very faint, only discernible in some of the specimens; anterior pair originating in axial furrows a little in front of anterior extremities of eyes, curving inwards and slightly backwards, reaching rather more than halfway up on glabella; 2d pair directed slightly more backwards than anterior pair, extending about as far inwards as these, their inner ends opposite middle of eyes; basal pair not quite distinctly recognized but seems to be represented in one specimen by faint lines beginning in axial furrows a little in front of posterior extremities of eyes and running nearly parallel to 2d pair of furrows and extending about as far inwards as these. Occipital furrow of moderate strength, arched forwards in the middle. Occipital ring rather narrow, tapering laterally, strongly arched transversally, slightly rounded longitudinally. Preglabellar furrow strongly arched downwards. Preglabellar field rather long (high), from one fourth to one third the length of glabella, nearly vertically bent down with gently convex surface. Cheeks wide (high), their greatest width across posterior ends of eyes about four fifths that of glabella at base, very steeply bent down, somewhat more steeply in front than posteriorly, their surface inside border gently convex. The eyes seem to have been sub-reniform and moderately convex (the eye lobes are very badly preserved in the only entire cephalon found); they are rather short, about one third the length of glabella, placed close to the latter and comparatively far forward, about their own length from posterior margin of cephalon. Palpebral lobes very narrow, sub-crescentiform, directed nearly straight out with slightly convex surface. Lower eyelids narrow. Anterior branches of facial sutures directed nearly straight forwards and outwards; posterior branches strongly turned outwards, cutting posterior margin of cephalon a little within genal angles. Posterior borders of cheeks slightly raised and rounded, directed nearly straight outwards and downwards, marked off by narrow furrows.

Dimensions. — The cranidia observed have a length of 1,5 to 2 mm.

Remarks. — The material on which this new species is founded consists of one entire, but not very well preserved cephalon and several cranidia in ISBERG's collection in Lund, one cranidium in the Upsala Museum, and one in the Lund Museum, all from Kallholn.

Affinities. — This species seems to be very closely allied to the foregoing. It differs from this chiefly in the shape and convexity of the glabella and in the eyes, which are relatively much shorter and placed farther forward.

Horizon and Locality. — Upper Leptæna Limestone; Kallholn.

Family **Cyphaspidæ** Salter.

Genus **Cyphaspis** Burmeister.

Distinguishing Characters of the Species.

Basal pair of lateral glabellar lobes completely circumscribed by furrows. Anterior branches of facial sutures slightly converging anteriorly. *Cyphaspis trigoda* n. sp.

Basal pair of lateral glabellar lobes incompletely marked off from depressed 2d pair. Anterior branches of facial sutures strongly diverging anteriorly. *Cyphaspis Holmi* n. sp.

Cyphaspis trigoda n. sp. Pl. V, figs. 38—39.

Specific Characters. — Glabella sub-triangular in outline, rounded in front, somewhat more than half the length of cranidium, about as long as wide at base, moderately convex; 1st and 2d pairs of lateral glabellar furrows very short and faint, being scarcely more than slight indentations upon the sides of the glabella; 1st pair (not recognizable in all specimens) situated nearly opposite anterior extremities of palpebral lobes, 2d pair just in front of mid-length of glabella; basal pair strong, originating in axial furrows about three fifths the distance from anterior extremity of glabella to occipital furrow and running in slight inwards convex curves obliquely backwards, meeting occipital furrow about half-way between its middle point and axial furrows, thus completely cutting off a pair of small, sub-semicircular, somewhat depressed basal lobes. Axial furrows narrow, rather shallow outside anterior portions of basal glabellar lobes, increasing in depth posteriorly and anteriorly. Preglabellar furrow deep and wide, widening in the middle so as to make a slight indentation on the surface of the preglabellar field; it generally reaches a little farther out than the lateral extremities of the axial furrows — owing to its greater width — and in some specimens faint, narrow grooves are seen running from its lateral extremities obliquely outwards and forwards to anterior border furrow. Occipital furrow narrow, rather deeply impressed, nearly transverse behind central lobe of glabella, gently bent back and slightly arched behind basal pair of lateral glabellar lobes. Occipital ring of moderate width, narrowing laterally, very gently convex longitudinally and strongly arched from side to side. Preglabellar field one fourth to one third the length of glabella, with gently convex surface sloping down to anterior border furrow. Anterior border of moderate width, gently rounded, marked off by distinct narrow furrow; its anterior margin very gently arched forwards.

Fixed cheeks of moderate width, widening posteriorly and narrowing anteriorly (in front of palpebral lobes), rising steeply with gently convex surface from axial furrows to palpebral lobes and (at least in some specimens) separated from these by very faint grooves, thus forming slight lateral rolls outside glabella. Behind the palpebral lobe the fixed cheek slopes away rather abruptly to posterior margin. Anterior portion of fixed cheek gently convex longitudinally and gently sloping to anterior border furrow, its surface either forming a direct continuation of the surface of the lateral roll or, in some specimens, slightly depressed below this and separated from it by faint groove running from lateral extremity of preglabellar furrow obliquely backwards und outwards to anterior extremity of palpebral lobe, so that when viewing the cranidium in frontal aspect one gets the impression that there is a slight ridge just behind this groove. This »ridge», which probably represents the anterior edge of the eye ridge, is, however, not marked off posteriorly but confluent with the general surface of the fixed cheek. Palpebral lobes crescentiform in outline, generally not very strongly turned upwards (a little different in different specimens), rather large and prominent, extending more than half the length of glabella, situated rather close to the latter and far back, their highest points at a slightly lower level than top of glabella. Posterior border of cheek very narrow, rounded, marked off by distinct furrow. Anterior branches of facial sutures nearly straight, slightly converging anteriorly; posterior branches directed obliquely outwards and backwards.

Test of cranidium very finely granulated.

Dimensions. — The cranidia observed vary from 1,5 mm. to 3 mm. in length.

Remarks. — This new species is represented by several cranidia from Boda and Klittberg in ISBERG's collection in Lund and by one cranidium from the former locality in the State Museum of Natural History.

In the same small specimen of rock as contained one of the cranidia from Klittberg, there is a pygidium probably attributable to this species, possibly belonging to the same individual as the cranidium. Although otherwise rather well preserved the pygidium seems to have been pressed (probably before it was fossilized) so that its posterior portion has become abnormally bent down and the surface of the postaxial ridge confluent with the surface of the axis. As a figure of this specimen might be misleading as to the true characters of the pygidium, it seems better, until a better one is found, only to give a description of the pygidium. Excluding the apparently abnormal features the description would be as follows. Entire pygidium semicircular in outline, with rounded lateral angles, about twice as wide as long, gently convex. Axis rather gently convex, its width at anterior margin rather less than one third that of entire pygidium, extending about two thirds the length of latter, rapidly tapering posteriorly to bluntly pointed extremity and continued backwards by distinct, narrow postaxial ridge, which nearly reaches the margin;

divided into 6 longitudinally gently rounded axial rings growing weaker posteriorly and a short terminal piece. Axial furrows rather narrow and shallow. Side lobes slightly flattened in front adjacent to axial furrows and then curving gently downwards to margin; with 5 pairs of gently curved, very slightly raised pleuræ, growing straighter and directed more backwards posteriorly, defined by narrow, distinct interpleural furrows nearly reaching the margin and divided by likewise distinct but somewhat shorter pleural furrows. Posterior pleural bands (except in the anterior pair of pleuræ) somewhat more strongly raised than anterior ones.

Affinities. — This species differs from most other species referred to the genus *Cyphaspis* in having relatively long palpebral lobes and a comparatively slightly convex and anteriorly very strongly tapering glabella, but in its other characters it agrees rather closely with more typical members of the genus.

It affinities seem to be with *C. megalops* M'Coy-Salter (M'Coy, 1846, p. 54, Pl. IV, fig. 5; Salter, 1853, Pl. V) and *C. elegantula* Ang. (Lovén, 1845, p. 51, Pl. I, figs. 4 a—c). In these as in our species the fixed cheeks are relatively narrow and only moderately convex, and their surfaces are almost confluent with those of the palpebral lobes — the palpebral furrows, when distinguishable, being very faint — whereas in most of the Bohemian species of *Cyphaspis* the palpebral lobes are very distinctly marked off from the more strongly convex and generally wider fixed cheeks. Further, both the species just mentioned have comparatively elongated eyes and palpebral lobes. In *C. elegantula*[1] the latter are not very much shorter than in our species and placed nearly as far back. In Salter's type form of *C. megalops* they are shorter — extending hardly one third the length of the glabella — and placed farther forwards, but in one specimen (Op. cit. fig. 7) — which is said to represent a variety of the species, and which I have had the opportunity to examine in the Sedgwick Museum in Cambridge — they are about half the length of the glabella and placed rather far backwards. Other points of resemblance are that, at least in some specimens of the three species here under consideration, a faint 2d pair of lateral glabellar furrows is present and furrows running from the lateral extremities of the preglabellar furrow to the anterior extremities of the palpebral lobes are indicated.[2] Both *C. megalops* and *C. elegantula* differ, however, very distinctly from our species in the shape of the glabella, which is strongly convex and nearly parallel-sided or only slightly tapering anteriorly, though it might be pointed out

[1] In Lovén's figure the eyes and palpebral lobes are much too short. In this respect the figure given by Angelin (1854, Pl. XVII, fig. 7) is better. I have not seen either of the specimens from which these figures are drawn, but I have seen others indubitably belonging to this species, which are in the Upsala Museum.

[2] These features are pointed out by M'Coy (Op. cit.) with regard to *C. megalops* and I have seen them both on his type specimen in the Dublin Museum and on several specimens from Dudley in the Museum at Cambridge.

that in one specimen of the former (SALTER, op. cit., fig. 3) — considered by SALTER as a variety of the species — the glabella tapers distinctly anteriorly and is said to be much less inflated than usual. *C. elegantula* also differs in having the anterior margin of the cephalon very strongly arched forwards and somewhat pointed in the middle.

A species which seems to be very closely related to *C. megalops* and *C. elegantula* and the cranidium of which shows some points of resemblance with that of our species, is *C. planifrons* EICHW. (SCHMIDT, 1894, p. 58, Pl. IV, figs. 40—43), but since I have not seen the original specimens and the description and figures are rather incomplete it is not possible to make any detailed comparison.

The pygidium described above, which seems to belong to *C. trigoda,* recalls that of CORDA's *Proëtus micropygus* (BARRANDE, 1852, p. 445, Pl. XV, figs. 37—40; as to the generic position of this species cf. below p. 207) but it differs in its more transverse shape, more gently convex side lobes, distinct postaxial ridge, and in the absence of a flattened marginal border.

Horizon and Locality. — Upper Leptæna Limestone; Klittberg, Boda.

Cyphaspis Holmi n. sp. Pl. V, figs. 34—35.

Specific Characters. — Glabella sub-triangular in outline, moderately convex, wider (at base) than long, rapidly tapering anteriorly, with nearly straight sides, very bluntly rounded in front, extending about half the length of cranidium. 2 posterior pairs of lateral glabellar furrows present (in all observed specimens) and in one specimen very faint traces of short, oblique anterior pair situated far forward, about half-way between antero-lateral angles of glabella and 2d pair; 2d pair short, rather weak, originating in axial furrows at about one third the distance from anterior extremity of glabella to occipital furrow, directed obliquely backwards and inwards and connected with basal pair by faint grooves. Basal pair strong, not confluent with axial furrows — or the lateral portions very faint — but beginning a little up on the sides of glabella just behind its mid-length and slightly farther outwards than posterior extremities of 2d pair, running in slight inwards convex curves obliquely back to occipital furrow. 2d and basal pairs of lateral glabellar lobes depressed below central lobe; 2d pair sub triangular to sub-pyriform in outline, with very slightly convex surface; basal pair irregularly quadrilateral in outline, somewhat more strongly convex than 2d pair; central lobe of glabella sub-pyriform in outline, rather strongly elevated, slightly compressed from the sides posteriorly. Axial furrows relatively wide and deep and slightly arched outwards outside posterior two thirds or three fourths of basal glabellar lobes, narrowing and decreasing in depth anteriorly and at the same time growing straighter and converging more strongly. Preglabellar furrow very gently arched forwards, wide and deep, its lateral extremities reaching farther out than the anterior extremities of axial furrows. Occipital furrow strong, nearly transverse behind central lobe of glabella, arched backwards and deepening behind basal glabellar lobes. Occipital ring narrow, widest behind central lobe of glabella, narrowing laterally, gently raised and rounded longitudinally, rather strongly arched transversally and compressed from the sides, with faint traces of small median tubercle near posterior edge. Preglabellar field long, about half the length of glabella, sloping down to anterior border furrow, strongly convex for about two thirds its length, its anterior third gently concave, its surface confluent with anterior parts of fixed cheeks, its posterior convex portion forming, together with corresponding portions of these, an anterior roll. Anterior border narrow, raised and rounded, gently arched forwards, marked off by narrow scarcely impressed furrow.

Fixed cheeks of moderate width inside palpebral lobes, widening anteriorly and posteriorly, rising very steeply with flattened or very slightly convex surfaces from axial furrows to palpebral lobes; behind the palpebral lobes the fixed cheeks slope abruptly to posterior borders; anterior portions slightly depressed below the portions of fixed cheeks behind them along a line running from lateral extremities of preglabellar furrow to anterior extremities of palpebral lobes, thus indicating the anterior boundaries of the eye ridges, their surfaces sloping rather gently to anterior border, at first gently convex longitudinally but becoming slightly concave close to border. Palpebral lobes (imperfectly known) strongly upturned, though not quite as steeply as the portions of the fixed cheeks inside them, not separated from these by any furrow, their highest portions on a higher level than top of glabella; they seem to have been rather long, moderately prominent, and crescentiform in outline. Posterior borders of fixed cheeks very narrow, gently rounded, directed slightly backwards and downwards. Anterior branches of facial sutures strongly diverging anteriorly; course of posterior branches not distinctly observed, but they seem to have been strongly bent outwards.

Ornamentation of test unknown.

Remarks. — The material on which this new species is founded consists of two imperfect cranidia and a fragment of a third in the State Museum of Natural History.

The specimens were collected by Professor G. HOLM, after whom I have named the species.

Two of the specimens are labelled with the locality-name Östbjörka, the third with the locality-name Gryssen, which is the name of the lake north of which the village of Östbjörka is situated. Leptæna Limestone has been exposed at several places along the valley which extends northwards from this lake through the village. Since it seems as if most collectors had labelled the fossils from all these exposures with the locality-name Östbjörka, and as if the exposures near the lake belong to the same mass of rock as others in the village, I have not made use of the name Gryssen as denoting a separate locality.

As is proved by other fossils labelled by HOLM with the locality-name Gryssen, the Leptæna Limestone near the lake is the Upper Leptæna Limestone, as in most other exposures in the village (Cf. above, p. 131), and it seems safe to assume that all the specimens under consideration are of this age.

Affinities. — The general character of the cranidium indicates that this species belongs to the genus *Cyphaspis* and in several features it agrees rather closely with the foregoing, but in others it differs so distinctly that the two species cannot be considered as very closely related to each other.

It differs from other Cyphaspidæ in having the basal lateral glabellar lobes incompletely defined in front. On the whole it recalls in the lobation and shape of the glabella some species of the genus *Tropidocoryphe* (NOVÁK, 1890, Pl. IV, figs. 2, 3) and in a measure »*Phaëtonides*» *Stokesi* MURCH. (LOVÉN, 1845, p. 50, Pl. I, fig. 3) and »*Phaëtonides*» *rugulosus* LINDSTR. (LINDSTRÖM, 1885, p. 75, Pl. XVI, fig. 13) but the preglabellar field shows no traces of a tropidia (Cf. above p. 185) and the width of the fixed cheeks shows that it cannot be placed with these or with any other members of the family Proëtidæ (sens. str.).

Horizon and Locality. — Upper Leptæna Limestone; Östbjörka.

Genus **Törnquistia** REED.

Cephalon semicircular, surrounded by narrow border, which is produced posteriorly into genal spines; glabella gently to strongly convex, rounded in front, without deep lateral furrows, defined by distinct furrows and outside these surrounded laterally and anteriorly by a rounded ridge, the anterior portion of which is often marked by a single preglabellar median groove or notch and separated from the lateral portions by a pair of lateral preglabellar grooves; eye lobes long, reaching far forward, separated by the ridge from the glabella; anterior branches of facial sutures cutting anterior margin separately; posterior branches turned strongly outwards, cutting posterior margin of cephalon just inside bases of genal spines. Thorax with well defined convex axis and furrowed pleuræ. Pygidium of moderate size (composed of few segments, and with a depressed border); axis well defined, convex, not reaching posterior margin, distinctly segmented; side lobes with strong furrows.

Remarks. — The term *Törnquistia* was proposed by REED in 1896 (p. 435) and used by him in a sub-generic sense. The sub-genus was originally placed under *Cyphaspis* and erected to contain two apparently very closely allied species, viz. the Keisley species described by REED (1896, p. 433, Pl. XXI, figs. 3—3 a) under the name of *Cyphaspis (Törn-*

quistia) Nicholsoni and TÖRNQUIST's *Trilobites triradiatus* (TÖRNQUIST, 1884, p. 92, Pl. III, fig. 18), differing from a typical *Cyphaspis* in »(1) the absence of the basal lobes to the glabella; (2) the presence of three radiating notches or grooves at the front end of the glabella».

Of neither of these forms are the thorax and pygidium known. In a later paper (1904) REED has described and figured specimens from the Girvan district in Scotland, which, though probably not attributable to *Törnquistia Nicholsoni*, are apparently very closely allied to this species (Cf. below, p. 202; REED op. cit. p. 86 describes the Girvan form as *Menocephalus? (Törnquistia)* cf. *Nicholsoni*). In one of these the thorax and pygidium are preserved together with the cranidium. The thorax is, however, forced by crushing partly underneath the cranidium, so that the number of segments is not quite determinable. REED states that there are 6 or 7 present; the axis is strongly convex and each pleura is divided by a sub-median furrow into an elevated anterior band and a narrower and lower posterior band. The axis of the pygidium is also strongly elevated, reaching to the posterior border and furnished with 3 axial rings separated by deep furrows; the pygidial side lobes are, according to REED, flattened and crossed by 3 rounded sub-parallel ridges corresponding to the axial rings, and the border of the pygidium »is sharply marked off, wide, smooth, depressed and excavated». To judge from the figures of the pygidium and from the characters of the thoracic pleuræ it seems as if the ridges on the pygidial side lobes were formed by the anterior pleural bands, the posterior ones being depressed and forming part of the separating furrows.

In the same paper REED again discusses the generic position of *Törnq. Nicholsoni* and comes to the conclusion that »on the whole the head-shield with its short swollen glabella, and the thorax, so far as they are known, seem to link this form more with species of *Menocephalus* (e. g. *M. minutus* NIESZK.) than with any representatives of *Cyphaspis* or any other genus, and therefore the sub-genus *Törnquistia* may preferably be placed under the genus *Menocephalus*».

The genus *Menocephalus* is, however, as SCHMIDT (1894, pp. 60—61) has already pointed out, very badly characterized and at any rate it does not seem as if either the forms referred to *Törnquistia* by REED or NIESZKOWSKI's species are congeneric with the other geologically much older species referred to it. The genus was founded by DALE OWEN (1852, p. 577) on a small specimen from the Upper Cambrian of Minnesota contisting only of a very globose glabella and a small portion of the fixed cheek, which he described under the name of *Men. minnesotensis*. Later on BILLINGS described his species *Men. globosus* (BILLINGS, 1860, p. 317, figs. 17—19; 1865, p. 408, figs. 388 a—c), which he considered congeneric with OWEN's species and further referred to the same genus his two species *Men. Sedgwicki* (Op. cit. 1860, p. 316, fig. 16; 1865, p. 407, fig. 387) and *Men. Salteri* (BILLINGS, 1863, p. 210, fig.; 1865, p. 203, fig. 187). As SCHMIDT (1894, p. 60) has remarked, »*Men.*» *Salteri*, which is the only one of the three species of which the thorax and pygidium are known, seems to differ rather much from the type represented by »*Men.*» *globosus.* As far as can be judged from the figures and descriptions available, this is also the case with »*Men.*» *Sedgwicki* and it seems very doubtful to me whether either this or »*Men.*» *Salteri* is congeneric with »*Men.*« *globosus.* Whether any of BILLINGS' species belongs to the same genus as *Men. minnesotensis* is of course, with our present meagre knowledge of the latter, quite impossible to decide. They seem to come from a somewhat higher stratigraphical horizon than this.[1]

MILLER (1877, p. 556) has given a diagnosis of the genus *Menocephalus,* but although he considered OWEN's species as the type and referred BILLINGS' species to this genus only with a mark of interrogation, the diagnosis is based on the latter and in it the characteristics of »*Men.*» *globosus* and »*Men.*» *Salteri* are mixed together.

In 1894 (p. 60) SCHMIDT redescribed NIESZKOWSKI's »*Sphoerexochus*» *minutus* from the East Baltic Kucker Formation and referred the species to the genus *Menocephalus* chiefly on account of its likeness to BILLINGS' *Men. globosus.* He also mentioned that it differs from this in some characters, pointed out its resemblance to *Cyphaspis,* and placed the genus *Menocephalus* in the family Proëtidæ (sens. lat.).

The East Baltic species is known only by the cephalon, and as far as can be judged from this, SCHMIDT is evidently right that it is closely allied to *Cyphaspis,* though not referable to this genus. Its likeness to »*Men.*» *globosus,* on the other hand, may only be superficial. The latter differs from the Cyphaspidæ, not only, as SCHMIDT has pointed out, in having a very short preglabellar field, but also in the very narrow fixed cheeks, which do not form swollen ridges, and in the general shape of the cephalon, the anterior margin of which is very strongly arched upwards.

The species referred to *Törnquistia* really seem to be very closely allied to NIESZKOWSKI's species[2] and referable to the same genus as this. The reason why REED refers the former to a separate sub-genus is that they are characterized by the presence of the 3 radiating grooves in front of the glabella. This character, however, seems to be rather variable

[1] BILLINGS' specimens were found in a conglomerate and BASSLER (1915, p. 797) gives their age as probably Ozarkian, they would thus come from a formation, which — or at least a part of which — is referred by some American geologists to the Upper Cambrian, by others to the lower Ordovician, and by still others is considered to represent a distinct geological system (on the top of the Cambrian), comparable to the Cambrian or Ordovician or any other well-founded system.

[2] When comparing *Törnquistia* to the species referred to *Menocephalus,* REED seems with regard to the cephalon chiefly to have taken into account the characters of the East Baltic species and not so much those of the American forms. With regard to the thorax of *Törnquistia* it appears as if it might have consisted of the same number of segments as that of »*Men.*» *Salteri*, but in other respects the resemblance does not seem to be great.

and hardly to be of sub-generic value. Im *Törnq. triradiatus,* as far as it is known, and in the specimens of *Törnq. Nicholsoni* known from Keisley, Kildare and Sweden the three radiating preglabellar grooves are always distinctly marked, though in the latter the median one is rather variable in length. In the Girvan form described by REED as being comparable to *Törnq. Nicholsoni* the lateral grooves are present and distinctly marked, but, according to REED, the median one is obsolete or only represented by a faint notch. Further, in a new species from the Leptæna Limestone, which is apparently closely allied to *Törnq. Nicholsoni* and which will be described below as *Törnq. depressa,* a short but well-marked median preglabellar groove or notch is present, but there are only exceedingly slight traces of a pair of lateral preglabellar grooves. In another new species from the same formation, which will be described below under the name of *Törnq. altifrons,* neither of the grooves is traceable, but in other respects it shows a great resemblance to *Törnq. Nicholsoni* and seems to link this to NIESZKOWSKI's species. Moreover, similar more or less strongly marked preglabellar grooves are found in several other species belonging to widely different genera or even families. That this is the case in *Agraulus? globosus* WALCOTT (1884, p. 61, Pl. IX, fig. 23) has already been pointed out by REED (Op. cit. 1904, 87). In the cranidia described above (p. 190) as *Cyphaspis trigoda* n. sp. the surface of the preglabellar field is slightly notched posteriorly in the median line and in some specimens faint lateral preglabellar grooves are present, and in *Pharostoma foveolata* TÖRNQ. there is a pair of distinctly marked lateral preglabellar grooves (Cf. above, p. 162, and below, Pl. IV, figs. 13, 16).

It thus seems as if the name *Menocephalus* must be dropped, at least for the present. Even if it could be used again, if new and better material of D. OWEN's species should be found, so that the genus could be properly defined, there appears hardly to be any reason to believe that the European species here in question could be referred to this genus. Anyhow they cannot in the meantime be without a generic name, and since there does not seem to be any reason to refer them to separate sub-genera the name of the genus must evidently by *Törnquistia* REED. When REED proposed the name he did not mention which of the two species, *Törnq. triradiatus* TÖRNQ. or *Törnq. Nicholsoni* REED, originally referred to *Törnquistia,* he considered the type, but it seems preferable to chose the latter, since only the cranidium of TÖRNQUIST's species is known. In addition to these two the following forms are referable to *Törnquistia:* the Girvan form, mentioned above, which REED has described as comparable to *Törnq. Nicholsoni, Törnq. minuta* NIESZK., and the two new species which will be described below as *Törnq. depressa* and *Törnq. altifrons.*

Only in the case of the Girvan form are the thorax and pygidium known and the above diagnosis of the genus is, with regard to these portions, founded on this form, as described and figured by REED. It is of course difficult to decide which of their characters can be considered to be of generic importance. Some, which in this respect seem rather doubtful, I have therefore put in parenthesis.

A genus which seems to be very closely allied (possibly synonymous) to *Törnquistia,* is *Haploconus* RAYMOND. The genus was founded by RAYMOND (1913 d, p. 61) »to include trilobites closely related to *Cyphaspis,* but differing in not having isolated basal lobes on the glabella, and in having a less prominent axial lobe on the pygidium». In addition to the genotype *Haploconus (Bathyurus) Smithi* BILL. (BILLINGS, 1863, p. 153, fig. 115; RAYMOND, 1913 d, p. 62, Pl. VII, figs. 13—14) he refers to this genus CLARKE's (1897, p. 759) *Cyphaspis? galenensis* and he thinks it probable that WALCOTT's (1884, p. 93, Pl. XII, fig. 10) *Cyphaspis? brevimarginata* belongs here too. The two latter are only known from imperfectly preserved cranidia, but of the genotype RAYMOND has described and figured a small entire individual, only measuring 3 mm. in length, which, as it has only 7 thoracic segments, he does not believe to be an adult. If only the characters of the cephalon are taken into consideration there seems to be little reason not to consider this species as congeneric with those referred above to *Törnquistia* (it seems to agree rather closely with *Törnq. minuta*), but the thorax and pygidium appear to differ rather much from those of the Girvan form described above. The pygidium agrees with that of the latter in having 3 axial rings and 3 pairs of ridges on the side lobes, but the axis is, according to RAYMOND, »not prominent, as in *Proëtus* and *Cyphaspis,* but low, triangular». RAYMOND's description is rather brief and his figures very indistinct, but it seems as if the thoracic axis too was low, and no furrows are to be seen on the thoracic pleuræ (this, of course, may be due to the indistinctness of the figures); the pygidium seems to be rather strongly convex and apparently it has no flattened or excavated border. It is not possible to estimate how great these differences really are from the description and figures available, but it seems better to keep the genera apart than to assume a possibly non-existent generic identity. Anyhow the name *Törnquistia* was proposed earlier than *Haploconus.*

Distinguishing Characters of the Species.

Glabella strongly convex, not overhanging in front; preglabellar field and fixed cheeks forming regularly swollen anterior and lateral rolls; a short distinctly marked preglabellar groove or notch and a pair of distinct lateral preglabellar grooves present. *Törnquistia Nicholsoni* REED.

Glabella very strongly convex, overhanging in front, preglabellar field and fixed cheeks forming regularly swollen anterior and lateral rolls; no median or lateral preglabellar grooves or notches present.
Törnquistia altifrons n. sp.

Glabella gently convex; preglabellar field and fixed cheeks not swollen, their surfaces only slightly convex; a short distinctly marked median preglabellar groove or notch present; lateral preglabellar grooves faintly indicated. *Törnquistia depressa* n. sp.

Törnquistia Nicholsoni Reed. Pl. V, figs. 40—44.

1896. *Cyphaspis (Törnquistia) Nicholsoni,* Reed, p. 433, Pl. XXI, figs. 3—3 a.

Specific Characters. — Cephalon semicircular in outline, its length along median line slightly more than half the width between genal angles, strongly convex, surrounded by narrow, tumid border marked off by strong furrow, and with the genal angles produced into spines.

Glabella strongly convex, highest just behind its middle, slightly bent down but not overhanging in front, somewhat longer than wide at base, slightly and gradually tapering anteriorly, rounded in front, bounded by broad and rather deep axial and preglabellar furrows; 2 pairs of weak lateral glabellar furrows discernible in a few well-preserved specimens; the first of these — probably corresponding to the so-called 2d pair in other trilobites — scarcely impressed, originating in axial furrows at a distance from occipital furrow about equal to two thirds the length of glabella, directed slightly backwards and extending about half-way up on side of glabella; basal pair shallow, but distinctly impressed, beginning in axial furrows at about two fifths the distance from lateral extremities of preceding pair to occipital furrow, running obliquely inwards and backwards towards occipital furrow but dying out before reaching this, thus incompletely marking off a pair of small sub-triangular basal lobes on the glabella, each only about one fourth its basal width. Occipital furrow of moderate strength, nearly transverse or slightly arched forwards in the middle. Occipital ring rather broad, measuring from back to front across its middle about one third the length of glabella, narrowing laterally, strongly arched transversally, gently rounded longitudinally, slightly protruding outside base of glabella, furnished with small median tubercle; its posterior margin arched backwards. Preglabellar furrow gently arched downwards. Preglabellar field measuring from back to front along the median line about one third the length of glabella, forming a swollen anterior roll, sloping down to anterior border, notched posteriorly by a short median preglabellar groove, somewhat varying in length in the different specimens. A pair of longer, rather wide grooves running from the points of union of the preglabellar and axial furrows obliquely outwards and forwards to anterior extremities of palpebral lobes, separate the anterior roll from the lateral rolls formed by the fixed cheeks, and continue forwards, where they become narrower, to anterior border furrow, marking off a narrow thread-like band on each side, inside the facial suture.

Cheeks rather wide, the distance between axial furrow and genal angle slightly longer than width of glabella at base. Fixed cheeks forming regularly swollen lateral rolls at the sides of glabella, about half as high as latter, with steep inner and gentler outer slope; their width inside palpebral lobes about half that of glabella. Palpebral lobes long, about two thirds the length of glabella, very narrow, reaching far forward, placed about three fourths their own length from posterior margin of cephalon, strongly convex in both directions. Palpebral furrows strong, but growing very narrow and shallow just in front before meeting the grooves mentioned above, which bound the anterior roll laterally; they are continued backwards by very weak grooves running parallel to the posterior branches of the facial sutures, marking off narrow thread-like bands corresponding to those inside the anterior branches. Eyes (imperfectly known) strongly convex in both directions. Lower eyelid narrow, of uniform width, marked off by weak furrow. Anterior branches of facial sutures directed nearly straight forwards and downwards; posterior branches curving strongly outwards from eyes to posterior border of cephalon, then turning backwards to cut the margin just inside bases of genal spines. Posterior border of cheek very narrow at axial furrow, widening laterally, gently rounded. Posterior border furrow rather strong, directed nearly straight outwards and downwards. Genal spine not completly known but seems to have been rather short und pressed to the side of the thorax.

Surface of cephalon covered, except in the furrows, by irregularly distributed tubercles of different sizes, which are more crowded on the glabella and the inner parts of the cheeks than on the marginal portions.

Dimensions. — The cranidia from the Leptæna Limestone vary from 2,5 mm. to 4,75 mm. in length.

Remarks. — This species is represented in the Upsala Museum by two cranidia from Boda and by one from Kallholn, of which latter both the natural cast and the hollow inner surface are preserved, and a little removed from the latter there is the intaglio of a detached free cheek apparently belonging to the same individual, further by two cranidia from Kallholn in ISBERG's collection in Lund, one with one of the free cheeks attached, and by one cranidium from Gulleråsen in the Museum of the Geological Survey. This material has enabled me to give the above description, which is somewhat fuller than REED's (1896, p. 433) original diagnosis of the species founded on some cranidia and a very badly preserved free cheek from the Keisley Limestone in England.

In the cranidia from Keisley no lateral glabellar furrows have been observed and, at least in REED's type specimen (Op. cit. Pl. XXI, fig. 3), the median groove on the preglabellar field is somewhat longer than in most of the specimens from the Leptæna Limestone, but, as mentioned above, the lateral glabellar furrows are only discernible in a few of the latter, which are better preserved than the others, and the length of the median groove is rather variable. Otherwise the cranidia from the Leptæna Limestone agree very closely with those from Keisley which I have had the opportunity to examine, and with others belonging to the same species from the Chair of Kildare in Ireland.[1]

[1] The species is represented from the Chair of Kildare both in the Sedgwick Museum in Cambridge and in the Collection of the Irish Geological Survey in Dublin, in the latter by a cranidium labelled *Cyphaspis megalops*.

That it occurs at this locality has already been stated by REED (1897, p. 85).

Affinities. — The Girvan form described by REED (1904, p. 86, Pl. XII, figs. 3—7) as comparable to *Törnq. Nicholsoni* seems indeed to be very closely allied to this species, but hardly attributable to it. According to REED »the only point of difference in the head-shield» of the Girvan form »is that the median preglabellar furrow is obsolete or only represented by a faint notch» and he also states that in one specimen there are slight traces of basal lateral glabellar furrows. These furrows seem to have the same position as in the specimens from the Leptæna Limestone in which they have been observed, but they are slightly longer, reaching the occipital furrow, but this difference may of course be due to different states of preservation of the specimens. In all the figures of the cranidium of the Girvan form the median preglabellar notch is present, and at least in some of them it is as long as in several of the Swedish specimens, in which, as already mentioned, the length of this notch or groove is rather variable. Although these features do not seem to indicate any specific difference in the Girvan form, it differs, to judge from the figures, in another character of much greater importance, viz. that the palpebral lobes are relatively much shorter, less than half the length of the glabella, and placed about one and a half times their own length from the posterior margin of the cephalon. Their shape too seem to be different. (It appears as if the characters of the palpebral lobes of *Törnq. Nicholsoni* were unknown to REED.)

The close resemblance which *Törnq. Nicholsoni* bears to *Törnq. triradiatus* TÖRNQ. (TÖRNQUIST, 1884, p. 92, Pl. III, fig. 18) and the points in which it differs from this species have already been pointed out by REED (1896, p. 434) and need not be repeated here.

Horizon and Localities. — The species has been found in the Upper Leptæna Limestone at Kallholn, Boda and Gulleråsen.

Outside Sweden it occurs in the Keisley Limestone at Keisley in England and in the Kildare Limestone at the Chair of Kildare in Ireland.

Törnquistia altifrons n. sp. Pl. V, figs. 47—48.

Specific Characters. — Glabella sub-oval in outline, its greatest width a little in front of the middle about equal to four fifths the length, gently tapering towards the ends, rounded in front, truncated behind, very strongly convex, slightly bent down in front and overhanging the preglabellar field, bounded by strong axial and preglabellar furrows; lateral glabellar furrows obsolete. Occipital furrow well marked, though shallower than axial furrows, nearly transverse along its middle part, curving forwards at the extremities. Occipital ring depressed below base of glabella, of moderate width, growing narrower laterally and slightly protruding outside base of glabella, strongly arched transversally, gently rounded longitudinally; its posterior margin nearly transverse in the middle, curving strongly forwards at sides. Preglabellar furrow gently arched downwards. Preglabellar field measuring from back to front along the median line about one fourth the length of glabella, forming a rather strongly convex anterior roll, steeply sloping to anterior border; its surface is confluent with the surfaces of the lateral rolls formed by the fixed cheeks, and there is no median groove or notch present. Anterior border narrow, gently rounded, marked off by distinct narrow and rather shallow furrow; its anterior margin very slightly arched forwards. Fixed cheeks very strongly convex both transversally and longitudinally, forming swollen lateral rolls with steep inner and somewhat gentler outer slopes, about half as high as glabella and at about the middle of their length about two thirds as wide as this, increasing in width posteriorly. The palpebral lobes are not preserved in the only specimen known, but on one side a furrow, which appears to be the palpebral furrow, is traceable, and to judge from this the lobes seem to have been about half as long as the glabella and situated at about their own length from the posterior margin of the cephalon. Posterior borders of fixed cheeks narrow near axial furrows, increasing in width laterally, gently rounded, marked off by shallow furrow directed slightly backwards. Anterior branches of facial sutures slightly converging anterioriy; posterior branches strongly turned outwards; the sutures seem to be accompanied on their insides by narrow thread-like ridges marked off by weak grooves.

Surface of cranidium except in the furrows covered with irregularly distributed tubercles of different sizes.

Remarks. — There is a single, small cranidium — measuring about 3 mm. in length — from Kallholn in the Upsala Museum, which possesses the above characters. With the exception of the palpebral lobes and the postero-lateral portions of the fixed cheeks, it is rather well preserved and appears to represent a new species of the genus *Törnquistia.*

Affinities. — The affinities of this species seem to be with *Törnquistia minuta* NIESZK. (NIESZKOWSKI, 1857, p. 601, Pl. I, figs. 7—8; SCHMIDT, 1894, p. 60, Pl. IV, figs. 46—49), but to judge from the descriptions and figures available, the preglabellar field in the latter is less steeply bent down, the glabella is not overhanging in front and is marked by 3 pairs of weak lateral furrows, and the inner slope of the lateral rolls is considerably gentler. The laterally protruding extremities of the occipital ring in our species may perhaps correspond to the small knobs (»Knötchen») at the sides of the occipital ring, which according to SCHMIDT are a peculiar characteristic of *Törnq. minuta.* SCHMIDT has, however, compared the latter with the occipital lobes found in several of the Proëtidæ, and he has explicitly stated that they do not belong to the occipital ring but are separated from this by the axial furrows and situated on the inner ends of the posterior borders of the cheeks. In our species they are not marked off from the main part of the occipital ring, and although the portions of the axial furrows lying outside them are very narrow and shallow, they are distinctly separated from the posterior borders of the cheeks.

Haploconus Smithi BILL. (BILLINGS, 1863, p. 153, fig. 115; RAYMOND, 1913 d, p. 62, Pl. VII, figs. 13—14) may also be compared, but the shape and convexity of its glabella appear to be rather different, the eye lobes comparatively smaller, and the fixed cheeks not so strongly convex.

Horizon and Locality. — Upper Leptæna Limestone; Kallholn.

Törnquistia depressa n. sp. Pl. V, fig. 45.

Specific Characters. — Glabella about as long as wide at base, gradually tapering anteriorly, rounded in front, gently convex, bounded by strong axial and preglabellar furrows of moderate depth; 2 pairs of short and weak lateral glabellar furrows discernible; the first of these beginning in axial furrows at a distance from occipital furrow about equal to three fifths the length of glabella, slightly curved, directed obliquely inwards and backwards; basal pair more strongly curved backwards and somewhat more strongly impressed than preceding pair, incompletely marking off a pair of triangular basal glabellar lobes about one third the length of glabella. Occipital furrow strong, arched forwards in the middle. Occipital ring of moderate width, narrowing towards the sides, more strongly arched transversally than base of glabella, gently rounded longitudinally; its posterior margin arched backwards. Preglabellar field about one third the length of glabella, with gently convex surface rather steeply sloping to anterior border, notched posteriorly by short, median preglabellar groove. Behind it laterally there are very faint traces of a pair of lateral preglabellar grooves running from the points of union of the preglabellar and axial furrows outwards and slightly forwards towards the facial sutures. Anterior border narrow, with slightly rounded surface, marked off by distinct, though rather shallow, narrow furrow; its anterior margin nearly transverse along its middle, slightly curved backwards at sides. Fixed cheeks inside palpebral lobes rather narrow, their width being scarcely more than one fourth that of glabella, gently convex longitudinally, forming low lateral rolls outside glabella with a short, rather steep inner slope and a longer, gentle outer slope; behind palpebral lobes their surfaces slope rather steeply to posterior borders and more gently towards the sides. The palpebral lobes are not preserved, but they seem to have been very long, about two thirds the length of glabella, and placed considerably less than their own length from posterior margin of cephalon. Posterior borders of fixed cheeks (badly preserved) seem to have been narrow, gently rounded and marked off by distinct furrows directed nearly straight outwards and downwards. Anterior branches of facial sutures straight, very slightly converging anteriorly; posterior branches turned very strongly outwards.

Surface of cranidium except in the furrows finely granulated.

Remarks. — The above description and this new species is based on one single small cranidium, measuring 2 mm. in length, which with the exception of the palpebral lobes and the hindmost portions of the fixed cheeks is rather well preserved.

It belongs to the old collection in the Upsala Museum and is only labelled Dalarne, but in the same small specimen of rock, which consists of light Leptæna Limestone, there are fragments of *Bronteus laticauda* and *Illænus oviformis*. This proves that the rock is Upper Leptæna Limestone, and to judge from its general appearance and for other reasons — most of the fossils from the Upper Leptæna Limestone in the old collections are from Osmundsberg — it seems most probable that it is from Osmundsberg.

Affinities. — This species seems to be rather closely allied to *Törnq. Nicholsoni*. It differs in the weakness of the lateral preglabellar grooves, the much less convex glabella, preglabellar field and fixed cheeks, in the narrowness of the latter, and in the slighter deflection of their postero-lateral portions, which indicates that the entire cephalon was rather gently convex.

Horizon and Locality; Upper Leptæna Limestone; Osmundsberg?

Törnquistia cf. **depressa** n. sp. Pl. V, fig. 46.

Remarks. — There is an incomplete cranidium from Kullsberg in the Lund Museum, which in its general characters much resembles the foregoing. Its glabella is, however, considerably shorter and broader and much more broadly rounded in front, and has the lateral glabellar furrows placed farther forward. This difference may perhaps not be of very great specific importance, but since in addition to this it is from a considerably older stratigraphical horizon it does not seem very probable that it is attributable to the same species.

Horizon and Locality. — Lower Leptæna Limestone; Kullsberg.

Cyphaspidæ *incertæ sedis*.

»**Cyphaspis**» sp. ind. a. Pl. V, figs. 59—60.

Description. — Glabella gently convex, somewhat longer than wide at base, rapidly tapering anteriorly to the pointed front end, bounded by deeply impressed axial and preglabellar furrows forming one continuous curve. The surface of the glabella is very badly preserved in all the specimens known, but it seems as if 3 pairs of lateral glabellar furrows situated at about the same distance apart, were present; the anterior two pairs very short, being little more than slight indications upon the lateral surfaces of glabella, and placed very far forward; basal pair beginning in axial furrows a little behind mid-length of glabella, curving obliquely inwards and backwards towards occipital furrow but dying out before reaching this. Occipital furrow distinctly marked, though not as deep as axial furrows, nearly transverse. Occipital ring of moderate nearly uniform breadth, gently rounded longitudinally, rather strongly arched transversally and about as high as glabella, slightly protruding laterally outside base of latter; its posterior margin gently arched backwards. Preglabellar field measuring from back to front along the median line about one third the length of glabella; its surface gently rounded, sloping gently to anterior border and confluent with the surfaces of the fixed cheeks. Anterior border rounded, rather wide, narrowing laterally, marked off by distinct furrow; its anterior margin gently arched forwards. Fixed cheeks gently convex, their marginal portions are very badly preserved, but the width inside the palpebral lobes seems to have been about half the middle width of glabella. The palpebral lobes (which are not preserved) appear to have reached rather far forwards. Posterior borders of fixed cheeks very narrow near axial furrows, increasing in width laterally, marked off by distinct furrows directed slightly backwards. The anterior branches of the facial sutures seem to have been straight and nearly parallel or slightly diverging anteriorly and the posterior branches to have curved from the eyes outwards and slightly backwards at first, and then to have bent more strongly backwards to cut the posterior margin of the cephalon at a distance from the axial furrows somewhat greater than the basal width of glabella.

Remarks and Affinities. — There are 3 small imperfectly preserved cranidia — measuring from 1,5 mm. to 2 mm. in length — from Kallholn in the Upsala Museum, which possess the above characters. They seem to represent a new species referable to the family Cyphaspidæ, but the generic position is uncertain and the material hardly sufficient to attach to it a new specific name.

The affinities of this species seem to be with »*Proëtus*» *micropygus* CORD. (CORDA, 1847, p. 78; BARRANDE, 1852, p. 445, Pl. XV, figs. 37—40; 1872, p. 15, Pl. XIV, figs. 20—21), but it differs in the somewhat shorter preglabellar field and the wider anterior border, and the eye lobes seem to have been placed farther forward.

CORDA founded his species on the pygidium alone, of which he gave a brief description but no figure. The cephalon was first described and figured by BARRANDE in 1852, who also gave a new description and figures of the pygidium and later on (1872) the same author figured an entire, though probably immature individual, and described the thorax. In the cephalon first described and figured by BARRANDE the eyes are broken off and only known from the traces of their bases, but, according to the author just mentioned, they are a little removed from the axial furrows. To judge from the figure of the entire individual afterwards given by him, their distance from the glabella is considerable, being at their posterior extremities nearly one third the basal width of the glabella. The facial sutures are not drawn in the figures nor mentioned in the text, but whether this is because they are not developed in the species, or only indistinct in the small specimens known, it is of course impossible to say, though the latter alternative seems to be most probable. As pointed out above, the sutures are not distinctly observed in the form from the Leptæna Limestone either, but they appear to be developed and to have the course suggested.

From BARRANDE's description of the pygidium of »*Proëtus*» *micropygus* (which in this respect is somewhat vague) it seems as if the relief of the two pleural bands was rather different and, to judge from his figure of the detached pygidium (in the figure of the entire pygidium this character is less distinct), it is the posterior one which is most strongly raised. I have observed a similar difference between the pygidial pleural bands in several specimens of *Cyphaspis elegantula* ANG., whereas among the Proëtidæ the bands have either about the same height or, when there is a difference in the relief, the anterior band is more strongly raised and the posterior one depressed. In the relative strength of the interpleural and pleural furrows the pygidium of this species seems also to resemble species of *Cyphaspis* more than the typical Proëtidæ.

There are two forms of pygidia from the Leptæna Limestone (they will be described below as »*Cyphaspis*» sp. ind. b and c), which in their chief characters agree very closely with this pygidium, and it seems probable that one of them belongs to the same species as the cranidia from the same formation described above.

On account of the position of the eyes and the characters of the pygidium and since in its other characters it does not show any more points of resemblance with the Proëtidæ than with the Cyphaspidæ, it seems preferable to place CORDA's species and the probably congeneric forms from the Leptæna Limestone in the latter family.

These species are evidently not referable to *Cyphaspis* (sens. str.) since, among other differences, they lack the isolated basal glabellar lobes which characterize this genus. From the species referred to *Törnquistia* they differ in the shape of the glabella and occipital ring, the posterior branches of the facial sutures (if present) seem to have a different course, and the thorax and pygidium, as far as they are known, show great differences. It seems probable that they represent a separate genus, but until their characters and position are a little clearer it appears best not to introduce a new generic name. I have therefore for the present only designated the species from the Leptæna Limestone as »*Cyphaspis*».

Horizon and Locality. — Upper Leptæna Limestone; Kallholn.

»Cyphaspis» sp. ind. b. Pl. V, fig. 61.

Specific Characters. — Pygidium semielliptical to sub-parabolic in outline, about two thirds as long as wide, rather strongly convex. Axis moderately convex, occupying about one third the width of pygidium at anterior margin and extending rather more than three fourths its length, rapidly tapering posteriorly to bluntly pointed extremity and continued backwards by short, indistinctly defined postaxial ridge; divided into 6 to 8 axial rings and a very short triangular terminal piece by distinct though weak furrows which grow fainter posteriorly. 1st axial ring gently rounded and slightly narrower (longitudinally) than following ones; following ones almost without independent convexity. Axial furrows deeply impressed, growing shallower posteriorly. Side lobes sloping rather steeply downwards with convex surface; in some species (casts) the marginal portion forms a narrow, thickened border, very slightly differentiated from the general surface, growing a little wider and more distinct posteriorly; in testiferous specimens the border does not seem to be indicated at all. Each side lobe with 6 pleuræ defined by narrow and shallow interpleural furrows, which become fainter posteriorly — the last two pairs of pleuræ being recognizable only in some specimens — and divided by somewhat broader pleural furrows, which terminate a little inside margin. Interpleural furrows generally somewhat longer than pleural ones, but with the exception of the 1st pair not quite reaching the margin. Posterior pleural bands generally slightly bent upwards so that their posterior edges are slightly raised above the surface of the more depressed anterior bands of nearest following pair of pleuræ. This feature is, however, not distinctly pronounced in all of the specimens, in some the relief of the bands seems to be about the same or the difference is very slight. Doublure narrow, widening a little posteriorly.

The surface of the pygidium seems to be very finely granulated.

Dimensions. — The pygidia observed vary from 1,75 mm. to 3 mm. in length.

Remarks. — The material on which the above description is based consists of several pygidia from Kallholn and one from Boda in the Upsala Museum and 3 pygidia from the latter locality and one from Östbjörka (Gryssen) in the State Museum of Natural History. As already mentioned (p. 207), it seems possible that these pygidia belong to the same species as the cranidia described above as »*Cyphaspis*» sp. ind. a. The glabella of the latter corresponds in its shape to the axis of the pygidia. One pygidium is also really found in rather close association with one of these cranidia, but it is too large to have belonged to the same individual; it measures 3 mm. in length, the cranidium only 2 mm. The smaller of the pygidia seem, however, to correspond in size to two of the cranidia (which are 2 mm. long, the third being only 1,5 mm.) and it appears possible that the cranidia, of which such a small number is known, represent young individuals.

Affinities. — This pygidium agrees in its chief characters, as already mentioned above (p. 207), with the pygidium described by CORDA and BARRANDE as *Proëtus micropygus,* but the latter differs in its distinctly marked, flattened marginal border, and it is more broadly rounded.

The pygidium associated above (p. 191) with the cranidia described as *Cyphaspis trigoda* also shows several points of resemblance, but it is much wider in relation to its length, the side lobes are not so strongly bent down, the pleural furrows, at least posteriorly, more distinct and the postaxial ridge is higher.

Horizon and Localities. — Upper Leptæna Limestone; Kallholn, Boda, Östbjörka.

»Cyphaspis» sp. ind. c. Pl. V, fig. 58.

Specific Characters. — Pygidium semielliptical to slightly parabolic in outline, about two thirds as long as wide. Axis rather strongly convex, occupying rather less than one third the width of pygidium at anterior margin, and extending nearly three fourths its length, gently tapering posteriorly to rounded extremity; divided by very faint furrows into 7 or 8 axial rings and a short terminal piece, and continued backwards by short, low, indistinctly defined postaxial piece not reaching posterior margin. Axial rings without independent convexity. Axial furrows rather shallow, not united behind axis. Side lobes gently to moderately convex, the degree of convexity being rather different in different specimens, sloping more steeply downwards posteriorly than laterally, the slope becoming more abrupt near the margin; with 7 pairs of pleuræ separated by narrow interpleural furrows, which become fainter posteriorly — the posterior ones being scarcely recognizable — and with the exception of the anterior pair dying out a little inside margin. Anterior 3 or 4 pairs of pleuræ divided by pleural furrows, which are somewhat shorter than the interpleural ones; the first pair strongly marked; following ones gradually growing weaker posteriorly; on the posterior pairs of pleuræ no pleural furrows are discernible. Posterior bands of pleuræ generally bent slightly upwards, so that their posterior edges are slightly raised above the surface of the more flattened anterior bands of nearest following pair of pleuræ. Doublure of pygidium narrow, increasing in width posteriorly. (Ornamentation not observed.)

Remarks and Affinities. — The material on which the above description is based consists of 4 very small pygidia, measuring from 1 mm. to 1,5 mm. in length, from Östbjörka in ISBERG's collection in Lund.

In several of their chief characters, especially in the characters of the pleuræ, they agree very closely with the pygidium described above as »*Cyphaspis*» sp. ind. b and with that of »*Proëtus*» *micropygus* CORD. (cf. above pp. 207, 208) and it seems probable that they represent a new species referable to the same genus as these. The former differs in the general outline of the pygidium, which is not so bluntly rounded behind, and in the more strongly inclined side lobes, the latter in the presence of a distinctly marked, flattened marginal border, and both in having a more strongly tapering and more distinctly annulated axis.

As mentioned above (p. 207) it seems possible that these pygidia belong to the same species as the cranidia described as »*Cyphaspis*» sp. ind. a. They correspond better in size than the foregoing, but not so well with regard to the shape of their axis.

Horizon and Locality. — Upper Leptæna Limestone?[1] Östbjörka.

»Cyphaspis»? sp. ind. d. Pl. V, fig. 62.

Specific Characters. — Pygidium sub-triangular in outline, bluntly pointed behind, about two thirds as long as wide, strongly convex, surrounded by indistinctly defined, narrow, tumid border. Axis rather gently convex, narrow, its width at anterior margin slightly more than one fourth that of entire pygidium, extending nearly seven eighths the length of latter, gradually tapering posteriorly to obtusely pointed extremity and continued backwards by narrow postaxial ridge not quite reaching margin; divided into 9 longitudinally gently rounded axial rings and a short terminal piece by distinct furrows, which become weaker posteriorly — the anterior ones being relatively broad and deep. Axial furrows of moderate strength. Side lobes with a slight flattening in front adjacent to axial furrows, then curving abruptly downwards to border; composed of 7 pairs of pleuræ and a narrow postaxial piece bearing the postaxial ridge, separated by distinct, narrow interpleural furrows reaching the margin. Anterior pair of pleuræ curving slightly backwards laterally; following ones progressively more and more backward in direction. Pleuræ marked by strong, rather broad pleural furrows, growing weaker posteriorly, reaching to marginal border. Posterior bands of pleuræ, except in the two anterior pairs, somewhat more strongly raised than anterior bands, this feature growing more pronounced laterally and posteriorly.

Test of pygidium very finely granulated.

Remarks and Affinities. — There is one small pygidium, measuring 2 mm. in length, from Boda in ISBERG's collection in Lund, which possesses the above characters. Its true generic position is uncertain. In

[1] As mentioned several times above (cf. p. 131 and p. 195), most of the exposures of Leptæna Limestone in the village of Östbjörka are in the Upper Leptæna Limestone, although it appears as if the Lower Leptæna Limestone too had been exposed within this village, and it appears, also to judge from the general appearance of the rock in which these pygidia occur, most probable that they are of Upper Leptæna Limestone age.

some characters it recalls species of *Pterygometopus* [e. g. *Pteryg. annulatus* RAYM. (RAYMOND, 1905 a, p. 376, Pl. XIV, figs. 24, 25)], but on the whole it seems to be more closely related to the Cyphaspidæ. In the characters of the pleuræ and in some other features it resembles rather closely the pygidia described above as »*Cyphaspis*» sp. ind. b and c and that of »*Proëtus*» *micropygus* CORD. (cf. above p. 207), although the pleural furrows are considerably stronger than in any of those. It differs from them in its more triangular shape, in its relatively longer and narrower axis and more steeply inclined side lobes; further the marginal border is less distinct, narrower and more tumid than in the latter.

Horizon and Locality. — Upper Leptæna Limestone; Boda.

Family **Harpedidæ** CORDA.

The Harpedidæ have generally been considered to be closely related to the Trinucleidæ on account of the similarity in several respects in the organization of the cephalon in the two groups. In the characters of the thorax and the pygidium they show, however, great differences, and the fact that in both groups the eyes are reduced, the free and fixed cheeks fused, and the cephalon enlarged by the development of a wide bilaminar marginal portion[1], may perhaps only be a case of parallel, independent evolution in the adaptation for a similar mode of life.

As a rule, among the trilobites, the reduction of the eyes seems to be accompanied by the reduction of the free cheeks and the increase of the fixed ones and a corresponding shifting of the facial sutures closer to the margins; more seldom the fixed and the free cheeks have become fused. This latter change appears to have taken place in the Harpedidæ and the Trinucleidæ, but that the two groups have followed this more unusual line of development need not prove a close relationship; in *Ampyx*, a genus which apparently is very nearly allied to the Trinucleidæ, the other line has been followed. That closely related species have, in this respect, followed different lines is also exemplified among the Proëtidæ. In most of the blind forms belonging to this family a shifting of the sutures has taken place, but in a few species the free and fixed cheeks appear to have fused instead (cf. RICHTER, 1913, p. 356). The Harpedidæ are, as is well known, as a rule not blind, though the eyes are much reduced, but since these apparently have kept their original place, the facial sutures could not shift towards the margins, but when they became unnecessary (for the ecdysis?) they grew together.

[1] I base this on the assumption that this really has taken place, and that the forms in question have originated from ancestors with normal compound eyes and real, dorsal facial sutures.

[As is well known a similar coalescence of the fixed and free cheeks seems to have taken place in e. g. *Acidaspis (Ceratocephala) Verneuili* BARR. (BARRANDE, 1852, p. 710, Pl. XXXVIII, figs. 1—9) and in *Acid. (Ceratocephala) vesiculosa* BEYR. (BARRANDE, 1852, p. 715, Pl. XXXVIII, figs. 13—21), which species possess normal compound eyes]. In at least some of the Trinucleidæ the conditions seem to have been similar.

A wide, bilaminar marginal portion on the cephalon is found in several otherwise very different forms (e. g. among the Asaphidæ, the Dikelocephalidæ, in the genera *Tropidocoryphe* and *Astycoryphe* among the Proëtidæ). In the Harpedidæ and the Trinucleidæ this portion is, however, very similarly constructed and unlike that of other trilobites, and this, together with some other similarities, seems really to indicate that they are rather closely related. It is well known that in both groups the upper and lower lamellæ are pitted, and, at least in some cases (in *Harpes* probably always) they have partly coalasced —the hour-glass shaped hollow pillars representing the opposite and communicating pits on the two lamellæ being continuous— and a marginal suture or line of weakness is present. It might be pointed out, however, that in *Harpes* the latter appears to have the same course as in the Trinucleidæ, running rather close to the upper edge of the marginal rim and when the rims of the horns are prolonged into spines —as seems to be very seldom the case— cutting these off from the upper lamella.

In *Harpes* the bilaminar portion of the cephalon is divided into an outer more or less horizontally extended portion (brim) and an inner raised portion (cheek-roll) separated on the ventral surface of the lower lamella by a sharply edged ridge, and on the upper lamella generally by a narrow smooth band. Something corresponding is found in most Trinucleids, in which the lower lamella is more or less distinctly angulated at some distance inwards from the margin, and thus divided into an outer and an inner band. When the angulation is strongly developed, the former is more or less horizontal and the latter inclined and most often inwards concave, and as a rule the bands are separated not only by the angular junction, but also by the marked enlargement and thickening of the concentric ridge (the »girder») along this line (cf. REED, 1912 b, p. 350—351; RICHTER, 1921, p. 190). This division into an outer and an inner band is generally not at all or very faintly marked on the upper lamella, which usually is either uniformly flat, or gently concave, or weakly convex; but in some species (e. g. *Trinucleus (Tretaspis) seticornis* HIS. and *Trin. (Tretaspis) Bucklandi* BARR.) the division is indicated on this too, its marginal portion being horizontal and its inner portion steeply inclined and more or less convex, and in *Trin. (Cryptolithus) Lloydi* MURCH. (cf. SALTER, 1853, Pl. VII, fig. 3 and text p. 2) the 2d and 3d rows of pits, counting from the outer margin, are (except posteriorly, where the pitting is more irregular) rather remote from each other, and the narrow smooth band lying between them is apparently situated just above the girder.

REED (1912 a, p. 202) has already pointed out that the circumferential region of the cheeks inside the marginal row of pits in *Dionide atra* SALT. recalls the cheek-roll of *Harpes*.

The smooth, more or less semicircular areas (alæ) which occur typically in *Harpes* close to the base of the glabella and are cut off from the rest of the cheeks, seem to be represented in larval stages at least in some of the Trinucleidæ (cf. BEECHER, 1895 c, Pl. III, figs. 1—2; BARRANDE, 1852, p. 624, Pl. XXX, figs. 41—43) and are indicated in some of the adults, where the corresponding portions are smooth or ornamented differently from the rest of the cheeks (cf. REED, 1916, pp. 119, 120).

Genus **Harpes** GOLDFUSS.

On the strength of the hypostomal characters NOVÁK (1884, pp. 215—217) put the two and only known Bohemian Ordovician species of *Harpes* —viz. *H. benignensis* BARR. and *H. primus* BARR.— into a separate genus or sub-genus, which he named *Harpina*. He pointed out that they differed from the Silurian and Devonian species also in another character of minor importance, viz. in having fewer thoracic segments, not over 14, the latter, as far as is known, never having less than 20. RAYMOND (1905 b, p. 377) has shown that the name *Harpina* was preoccupied and has exchanged it for *Eoharpes*. He (cf. RAYMOND, 1913 a, p. 711) seems to be of the opinion that not only the two Bohemian species mentioned above, but also all other Ordovician species of *Harpes* s. lat. are referable to *Eoharpes*[1] and this opinion appears be shared by several other American writers. This seems doubtful, however, but as long as we are unacquainted with the hypostomata of these species this point cannot be decided. In *H. Hornei* REED (REED, 1914, p. 10, Pl. II, figs. 1—2) the thorax consists, according to REED, of 23—25 segments (most of the other species here under consideration are only known by their cephala or, at least, the number of their thoracic segments is not known) and in the characters of the cephalon too this species seems to resemble some of the Silurian and Devonian species more than it does the two Bohemian Ordovician species originally referred to *Harpina (Eoharpes)*. This latter fact appears also to hold true of most of the other species here in question, decidedly of the Leptæna Limestone species, which moreover seem to be rather closely allied to *H. Hornei* (cf. below, p. 223).

The peculiar construction of the cephalon of *Harpes* has made it neces-

[1] RAYMOND (Op. cit., p. 711, fig. 1360) gives a figure of *Harpes ungula* STERNB. under the name of *Eoharpes ungula* and states it to be of Ordovician age, but probably this is just a slip. As is well known, this species belongs to the Silurian (Etage E 2) fauna of Bohemia and its hypostoma (cf. BARRANDE, 1852, Pl. IX, figs. 5—6) shows the characters typical for *Harpes* s. str.

sary to introduce some special terms to designate certain parts. In the following descriptions most of those suggested by BATHER (1910) and REED (1914) have been adopted, the smooth semi-circular areas outside the posterior portion of the glabella being called the »alæ», the furrows bounding them the »alar furrows», the term »cheek-roll» being used for the raised inner part of the duplicated portion of the cephalon, and the impressed concentric line marking off the cheek-roll from the cheeks proper (the »cheek lobes») being designated the »lateral line». For the sharply edged ridge which on the lower lamella separates the cheek-roll from the brim, I have adopted the term »girder», introduced by REED (1912 b, p. 351) to designate the corresponding structure found in several Trinucleids (cf. above, p. 212). Brim, as suggested by BATHER, is a better name for the external horse-shoe shaped portion of the cephalon than limb, border, fringe or any other word which has been used; especially since it apparently only corresponds to the outer part of the fringe in the Trinucleidæ, and since if —as seems most likely to be the case— the whole of the bilaminar portion of the cephalon is due to the broadening out of the ordinary cephalic border (= limb in some authors) it can only be regarded as representing a part of the border. For the same reason the raised margins of the bilaminar portion are better termed »marginal rims» than borders, and it is preferable to use the name the »horns» of the brim for the prolongations of the brim back of the genal angles —as REED and some other authors do— than to call these genal spines.

Distinguishing Characters of the Species.

Brim flattened, horizontal or sloping gently and evenly towards the sides *Harpes costatus* ANGELIN.

Inner portion of brim flattened or gently convex, nearly horizontally extended, outer portion steeply arched down *Harpes Wegelini* ANGELIN.

Harpes costatus ANGELIN. Pl. V, figs. 1—6; text-fig. 18.

1854. *Harpes costatus,* ANGELIN, p. 85, Pl. XLI, figs. 4—4 a.
1894. *Harpes Wegelini,* SCHMIDT, p. 69, Pl. V, figs. 10—18.
?1896. *Harpes Wegelini,* REED, p. 436.
?1907 a. *Harpes Wegelini,* WIMAN, p. 139, Pl. VIII, fig. 24.

Specific Characters. — Cephalon horse-shoe shaped, with broad flattened brim prolonged posteriorly into long tapering horns, which curve inwards at the extremities, its length along the median line about two thirds the greatest width.

Median portion of cephalon, inside brim, strongly convex, rising very steeply from brim at sides, somewhat more gently in front, nearly two thirds as long as wide at base, slightly tapering anteriorly with very slightly outwards convex sides, bluntly rounded in front but more strongly arched and slightly protruding in the middle in front of glabella. Glabella sub-conical, strongly elevated above the general surface, somewhat compressed from the sides, so as to became slightly keeled in the middle, measuring about three fifths the length of cephalon (minus brim) and at the base generally about one third its width —in large specimens somewhat more— tapering anteriorly, bluntly rounded in front. 1st and 2d pairs of lateral glabellar furrows only represented by slight indentations on the sides of the glabella; 1st pair placed about two thirds the length of glabella from base; 2d pair somewhat in front of mid-length of glabella; basal pair distinctly impressed, arising in axial furrows at about one third the length of glabella from base, running obliquely inwards and backwards for about three fourths the length to occipital furrow, and generally connected with latter by shallow grooves, then curving upwards and continued by very narrow and shallow grooves, which grow weaker anteriorly and run in upwards convex curves forwards and then downwards to 2d pair of lateral glabellar furrows —the anterior portions of these grooves only discernible in a few specimens and always very faint.— Basal glabellar lobes subtriangular, slightly projecting at sides —more distinctly in the large than in the smaller specimens— extending about half-way up on the sides of glabella, their surfaces comparatively gently inclined and with slight independent convexity, the central lobe of the glabella rising steeply between them. Axial and preglabellar furrows not deeply impressed, in some specimens the latter almost obsolete. Occipital furrow broad, shallow and nearly transverse behind central lobe of glabella; its lateral portions narrower, deeper and directed slightly forwards. Occipital ring of moderate width, very strongly arched transversally and somewhat compresed from the sides, rounded longitudinally, with indistinctly defined median tubercle.

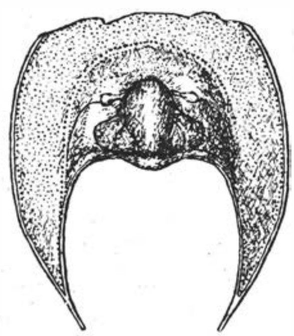


Fig. 18. *Harpes costatus* ANGELIN. Cephalon × 1. Kallholn. Upsala Museum.

Upper parts of cheeks (cheek lobes) and preglabellar area separated from lower bilaminar and perforated parts (cheek-rolls) by narrow continuous groove (lateral line), which generally is very distinctly impressed in front of glabella, growing weaker laterally and posteriorly. Preglabellar field proper (above the groove) very short, sloping gently downwards, with both transversally and longitudinally gently rounded surface. Surface of cheek lobes rising from all sides to the eye lobes, which are situated a little behind front end of glabella —nearly opposite anterior lateral glabellar furrows— and distant from it about one third its width. Eye lobes relatively large and prominent, bearing on their outer surface two separate, rounded, gently convex lenses, and connected with sides of glabella by narrow, low, nearly transverse eye ridges increasing in width inwards. From the outside of the eye lobe a narrow, slightly raised ridge runs in a slightly forwards convex curve backwards and outwards down the steep slope of the cheek lobe and cheek-roll, growing weaker and more backward in direction posteriorly, and dying out near the inner margin of the brim nearly opposite the occipital furrow. On the ventral surface of the inner lamella of the cheek-roll there is also a ridge corresponding to the one on the outer lamella. Behind the eye lobes on the sides of the glabella are smooth depressed areas (alæ) each marked off from the rest of the cheek by a strong, curved furrow arising in the axial furrow at about the same place as the 2d lateral glabellar furrow and running at first backwards and slightly outwards but soon bending more strongly outwards and then sweeping round in a sharp curve to unite with the occipital furrow at the base of the glabella. Each ala is longitudinally divided by a weak, gently curved groove into two sub-crescentic portions, an inner narrower, somewhat swollen one, and an outer broader one, the surface of which is flattened or only very gently convex and distinctly depressed beneath the surface of the outer adjoining portion of the cheek. At its greatest extent the width of each ala is about half that of the glabella.

Cheek-rolls proper (not including the portion of the roll in front of glabella) without independent convexity, steeply bent down, highest in front where they adjoin the preglabellar area, very gradually decreasing in height laterally and posteriorly to about opposite base of glabella, then increasing in height again to posterior borders of cheeks and elongated backwards into broad-based, rapidly tapering, steeply inclined prolongations reaching nearly half the length of the horns of the brim. Preglabellar portion of roll with slight independent convexity both longitudinally and transversally. Posterior border of cheek narrow raised, slightly thickened, directed nearly straight outwards for a short distance from axial furrow but soon bending backwards in a wide curve to pass into the inner marginal rim of the free protruding arm.

On the dorsal surface the cheek-roll is separated from the brim by a narrow smooth band which is less steeply inclined than the cheek-roll. Corresponding to this on the ventral side is a sharply edged ridge or crista (the girder) formed by the lower (inner) lamella. They follow the angulation all round the cephalon and have been observed to the base of the spines formed by the prolongations of the marginal rims, but they diminish in width towards the extremities of the horns and the girder grows lower and less sharply edged. The inner side of the girder is slightly inwards convex and its general direction is nearly straight downwards except posteriorly, where it might bend a little inwards; the outside is flattened and directed obliquely inwards. The inclination of the band on the upper surface and the direction of the outside of the girder vary a little in different specimens, but as a general rule the former seems to become more steeply inclined and the latter to be directed more strongly inwards posteriorly.

Brim broadest in front, measuring from back to front along the median line from four sevenths to two thirds the length of cephalon inside brim, gradually tapering —in some specimens very slowly, in others somewhat more quickly— posteriorly to about half or two thirds the length of the horns; then the decrease in width becomes more rapid; its surface flattened, generally sloping gently downwards laterally so that the anterior margin becomes gently arched upwards; extremities of horns gently bent upwards. The outer margin of the brim forms part of an elongated oval with a narrower posterior and a broader anterior end and generally with rather strongly but in some specimens only slightly convex sides. Generally the greatest width is across the middle of the glabella but in some specimens the sides are nearly parallel from that level to about the level of the occipital furrow. Inner margins of horns nearly parallel to near extremities, where they curve gently inwards. Outer marginal rim thickened, smooth, narrow, higher than broad, raised above the surface of the upper lamella and extending below the surface of the lower lamella, becoming confluent with the inner rims at the extremities of the perforated flattened parts of the horns, and prolonged backwards into relatively long (for the genus) incurving spines; its inside evenly rounded; its outside angulated and furnished with three parallel, sharply edged ridges, one near the upper and one near the lower edge of the rim, the third about mid-way between the two others (these ridges are formed by the thickening of the test, and are consequently hardly traceable on the casts); just above the uppermost ridge is a faint narrow groove, which rounds the extremities of the horns at the base of the spines and continues on the inner rims, gradually shifting farther away from the upper edge. To judge from specimens in which only the upper lamella of the brim and cheek-roll is preserved and which evidently represent exuviæ, the test, at the ecdysis, apparently split up along this groove, which thus seems to represent the so-called marginal suture. It does not seem as if this was a real open suture[1] but only a line of weakness, but the test is too badly preserved on the specimens available to decide this point. In the exuviæ observed the posterior portions of the horns are not preserved, but to judge from the course of the grooves, the spines belong to the lower lamella. Inner marginal rim similar to outer, but not extending below lower lamella of horn, but posteriorly following upper

[1] As is well known, the presence of a real marginal suture in the genus *Harpes* has generally been assumed. That it is present in some species of the genus, at least in *H. macrocephalus* GOLDF. seems now definitely to be proved by RICHTER (1915). It is not inconceivable, however, that the species are in a different position in this respect. If the presence of a marginal suture is a special adaptation, which seems most likely to be the case, it seems quite conceivable that in the geologically older species of the genus it was represented by a line of weakness and in the younger ones developed as a real open suture.

edge of girder and then upper edge of prolongation of cheek-roll, to pass finally into posterior border of cheek.

Outer and anterior slopes of cheek lobes covered with small, closely set, comparatively shallow pits, the walls of which form a network of irregular pentagons or quadrangles. In front and outside the eye lobes the pits show a tendency to be arranged in rows, generally running at nearly right angles to the lateral line. Inner slopes of cheek lobes with shallower, more sparsely distributed pits. Bilaminar portion of cephalon with small, closely set perforations, formed by the opposite and communicating funnel-shaped pits of the upper and lower lamellæ (cf. RICHTER, 1915, p. 147; 1921, p. 185). On the brim, the posterior portions of the cheek-rolls, and the portion of the roll just in front of the glabella the perforations are irregularly distributed, their walls forming on the surface a network of irregular pentagons. On the anterior portions of the cheek-rolls proper they are sometimes arranged in rather irregular sub-parallel rows, in which case the network of the walls may consist either of irregular quadrangles or of pentagons; the rows generally form direct continuations of the rows of pits on the cheek lobes. This feature is, however, never very pronounced; sometimes a few rows are seen here and there —most often in front of the eye lobes— separated by portions where the perforations are more irregularly distributed and sometimes the perforations are arrranged in rows on the upper but not on the lower parts of the cheek-rolls. Inside the outer and inner marginal rims is a single row of larger perforations. The narrow smooth band on the dorsal surface and the girder on the ventral surface, which separate the cheek-roll from the brim, are also bordered on both sides by a single row of relatively large perforations, those in the inner (upper) row generally being somewhat smaller than those in the outer (lower) one, which are of about the some size as the perforations in the intermarginal row.

Dimensions. — The specimens (cephala) from the Leptæna Limestone which have come under my notice are of very different sizes. In most of them the length along the median line is between 10 and 15 mm., and the greatest width between 15 and 22 mm. In the largest one the width is 37 mm., and the length seems to have been about 26 mm. In a very small specimen the length is not quite 4 mm.

Remarks. — The material on which the above description is based consists of a little over a dozen more or less complete cephala from Kallholn in the Upsala Museum and one cephalon from Lissberg in the Museum of the Geological Survey.

In 1854 ANGELIN figured under the name of *Harpes costatus* (Pl. XLI, figs. 4—4 a) a cephalon from the Leptæna Limestone of Osmundsberg, and under the name of *Harpes Wegelini* (Pl. XLI, figs. 3—3 a) another cephalon from the same formation. Both the specimens were incomplete —as is seen from the figures, the specimens are not now to be found— but the figures give a fairly good idea of the characters of the two forms, which differ in the characters of the brim. In the cephalon figured as *H. costatus* the brim is flattened, in the other convex. The accompanying diagnosis (Op. cit. p. 85), however, says the reverse, viz. that *H. costatus* has a convex, *H. Wegelini* a flattened brim, but this is evidently owing to a miswriting or a misprint. It is quite clear which of the forms is meant to be called *H. costatus* and which *H. Wegelini* both from the references to the figures and from the rest of the brief diagnosis.[1]

SCHMIDT (1894) was of the opinion that the two forms were not separable and referred them both to the same species, for which he used the name of *H. Wegelini* —this being the form first mentioned by ANGELIN— and under this name he described and figured (Op. cit., Pl. V, figs. 10–18) several specimens from the East Baltic Lyckholm Formation and one from the Leptæna Limestone of Dalarne (Unskarsheden). It seems, however, as if SCHMIDT was mistaken. In the material now available from the Leptæna Limestone there are over a dozen cephala which agree well with ANGELIN's figure of *H. costatus* and several others which are referable to *H. Wegelini*. It is true that the two forms agree in most of their characters and that ANGELIN's statement that *H. Wegelini* differs from *H. costatus* in the absence of eye ridges, is incorrect, but the difference in the characters of the brim seems to justify us in keeping the two forms apart. In *H. costatus* the brim is, as mentioned above, flattened or it may be slightly concave or even slightly convex, but in the latter case the surface is evenly rounded, whereas in *H. Wegelini* (cf. below, p. 224) the outer portion of the brim is always strongly bent down. There is also a slight difference in some others characters, as will be pointed out below.

SCHMIDT (Op. cit. pp. 69, 70), judging from the East Baltic material, has alleged as one of the reasons for uniting the two forms, that it is impossible to make any sharp distinction between flattened, somewhat concave, and convex brims. In all the figures given by him the brim seems distinctly flattened, however, and in the diagnosis of the species he has stated it to be flattened or slightly concave. It appears probable that in the former statement he only referred to very slightly convex brims, and that he thought that in ANGELIN's figure of *H. Wegelini* the convexity of the brim was exaggerated (ANGELIN's figures are not always reliable). Otherwise, to judge from the usual correctness of his statements, even if he had referred the forms to the same species he would presumably have given a more exact diagnosis of this, and most probably have figured a specimen with convex brim. It seems thus as if the true *H. Wegelini* had not been found in the East Baltic Area, since, if the two

[1] In the diagnosis it is stated that eye ridges are present in *H. costatus* but not in *H. Wegelini*, and in the figure of the former they are drawn but not in that of the latter. As a matter of fact they are, as proved by the material now available, present in both forms, although they may be more or less distinct in different specimens.

forms are to be kept apart, the specimens figured and described by SCHMIDT are evidently not referable to this species but to *H. costatus.* They seem to agree well with those from the Leptæna Limestone.

The cephalon from the North Baltic Östersjö Limestone which WIMAN (1907 a, p. 139, Pl. VIII, fig. 24), pointing out its agreement with SCHMIDT's figures and description, attributed to *H. Wegelini,* ought also evidently rather to be assigned to *H. costatus.* It differs, however, from the form from Dalarne and the East Baltic Area in the brim, which is widest at the sides at about the level of the occipital ring and grows narrower anteriorly, measuring from back to front along the median line scarcely more than one third the length of the cephalon inside the brim. In the specimen of *H. costatus* from the Leptæna Limestone the width of the brim varies a little, but in all which have come under my notice, it measures along the median line more than half (from four sevenths to two thirds) the length of the cephalon inside the brim. This seems also as a rule to be the case in the East Baltic specimens; only in one of SCHMIDT's figures (Op. cit. Pl. V, fig. 12) does it measure somewhat less. Further, the brim is always widest in front both in the specimens from the Leptæna Limestone and, to judge from SCHMIDT's figures and table of measurements, in those from the Lyckholm Formation. This makes it seem somewhat doubtful whether the cephalon from the Östersjö Limestone really is referable to *H. costatus* either, although, as far as can be seen on the rather badly preserved specimen, it shows otherwise the characters typical for this species.

REED (1896, p. 436) has referred, with a note of interrogation, a portion of a cephalon from the Keisley Limestone in England to *H. costatus,* and further reported that fragments of *H. Wegelini* are not very uncommon in this formation. It is evident, however, from what he says of the former, that he has mistaken the two species for one another, apparently on account of ANGELIN's erroneous diagnosis (cf. above, p. 219). I have, moreover, had the opportunity to examine, in the Sedgwick Museum in Cambridge, one of the specimens assigned by REED to *H. Wegelini*, and this, which consists of a portion of a rather large flattened brim, evidently does not belong to this species, but seems referable to *H. costatus.* Thus it seems probable that the species of *Harpes* »not very uncommon» in the Keisley Limestone is identical with *H. costatus,* but until more complete specimens are available this point cannot be decided.

REYNOLDS and GARDINER (1896, p. 593) and REED (1897, p. 85) have reported *H. Wegelini* also from the Kildare Limestone of the Chair of Kildare in Ireland and it seems probable that in this case too it is *H. costatus* which is meant.[1]

[1] The determination of very many of REYNOLDS' and GARDINER's specimens from the Kildare Limestone has apparently been made by REED (cf. REYNOLDS and GARDINER, op. cit, p. 593, foot-note).

H. costatus (as well as *H. Wegelini*) has further been reported by KIÆR (1897, p. 74) from Etage 5 in Norway.

The narrow, raised ridges, mentioned above, which run from the eye lobes obliquely outwards and backwards are discernible in all well preserved specimens. They are also found in *H. Wegelini* and in several other species of *Harpes*, e. g. *H. crassifrons* BARR. (BARRANDE, 1852, Pl. VIII, figs. 24, 25), *H. vittatus* BARR. (Op. cit. Pl. IX, figs. 7, 8), *H. (Eoharpes) ottawensis* BILL. (BILLINGS, 1865, p. 182, fig. 165) and *H. (Eoharpes) antiquatus* BILL. (RAYMOND, 1910 b, Pl. XXXII, fig. 1). It has been suggested that these ridges may mark the position of the posterior branches of the facial sutures, but this seems very improbable. They have also (cf. RAYMOND, 1920, pp. 82, 83) been considered to be of the same nature as the markings or, to use RAYMOND's (Op. cit.) term, genal cæca, found on the cheeks and preglabellar field (generally only on the under surface of the test) in *Conocoryphe, Elyx, Ptychoparia, Parabolina Olenus* etc., and which have been supposed to be traces of structures of some functional importance (digestive glands, branches of the circulatory system, nerves), and this appears more likely. They do not start from the posterior extremities of the eye lobes, but from their outside, in the Leptæna Limestone species nearly at or just behind the middle. Further if the lateral portions of the ventral lamella of the brim and cheek roll are formed by the doublures of the free cheeks, as seems most probable —judging from the conditions in other forms with a wide, bilaminar marginal expansion to the cephalon— the posterior branch of the facial suture would probably have run inside the cheek-roll or, in any case, could not have cut the ventral lamella, and, as already mentioned, there is a ridge on this too, corresponding to the one on the dorsal lamella. As is well known, the »genal cæca» on the free cheek of such forms as *Parabolina, Ptychoparia, Olenus*, etc. radiate from the outside of the eye lobe; in *Ogygopsis Klotzi* ROM. (RAYMOND, 1913 a, p. 718, fig. 1382) —where similar markings occur on the free cheek— one or two seem to be more strongly developed than the rest, and in *Tropidocoryphe Barroisi* MILL. (R. and E. RICHTER, 1919 b, p. 31, fig. 2) there are only two (or three) on each free cheek. It seems thus as if in *Harpes* the posterior branches of the facial sutures must have run inside the ridges in question, and as if the latter consequently were situated on the free cheeks, and it appears probable that we may correctly compare them with the markings or »genal cæca» found on the free cheeks of other forms.

A comparison with forms generally considered to be related to *Harpes* seems also to support the belief that these ridges are »genal cæca» rather than the assumption that they are suture lines. In several of the Trinucleidæ in which the eye ridge and the »eye tubercle» are developed (viz. most of the members of M'COY's species *Tretaspis*) a similar ridge has been observed (cf. REED, 1916, p. 121; RAYMOND, 1920, p. 83) running from the latter to the postero-lateral angle of the cheek lobe. This seems to be the »facial suture» described by M'COY (1846, p. 56; 1851, p. 146) or rather the posterior portion of the »suture». REED (1916, p. 174) too has suggested that it may »mark the original course of the posterior branch of the facial suture». He seems, however, more inclined to believe that it is a structure similar to the group of radiating markings (nervures) found in some other Trinucleidæ (e. g. *Trin. Murchisoni* SALT.) and which originate from the same place in the axial furrow as the eye ridge in those first mentioned. This latter seems very probable, at any rate the ridge in question does not appear to be a suture line. In well preserved interior casts of *Trin. (Tretaspis) seticornis* HIS. from the Black Trinucleus Shales of Dalarne this ridge running obliquely outwards and backwards from the »eye-tubercle» is well developed, and in one of the specimens which I have examined it is distinctly seen that it branches off at some distance from the postero-lateral angle of the cheek lobe, and there are traces of one branch which runs out from the main trunk farther inwards. There is further a second more faintly developed ridge (in another specimen there seem to be 3) starting from the outside of the »tubercle» a little in front of the other, at first slightly diverging from this, then approaching it again, and finally, as it appears, merging into one of its branches. RAYMOND (1920, p. 84) has described some similar markings (genal cæca) observed on interior casts of *Trin. (Cryptolithus) tesselatus* GREEN. In this species there is, according to this author, a short main trunk,[1] which »gives rise to two principal branches, the first of which in its turn sends off lines from the anterior side». This is also distinctly seen on the figure given by RAYMOND, and to judge from this there seems to be a third very short branch, which lies between the two principal ones.[2]

[1] This main trunk seems to occupy the same place as the eye ridge in the larva, but, as RAYMOND (Op. cit. pp. 83, 84) has already pointed out, the primary trunk of the genal cæca and the eye ridge are apparently coincident in other species too, and it appears as if this was merely a coincidence and as if they were different structures.

[2] RUEDEMANN (1916 c, p. 145) has described these markings as suture lines, but he seems only to have observed the two principal branches, not the minor ones. He seems to be of the opinion that the two ridges found on the cheek lobe of *Trin. (Cryptolithus) Bureaui* OEHL. (cf. OEHLERT, 1895, p. 303, Pl. I, fig. 7) *Trin. (Cryptolithus) ornatus* STERNB. (cf. BARRANDE, 1852, p. 625, Pl. XXX, fig. 54), and *Dionide formosa* BARR. (cf. BARRANDE, 1852, p. 641, Pl. XLII, fig. 24) and the single ridge on the cheek lobe of *Dionide atra* SALT. (REED, 1912 a, p. 200, Pl. XI) are also suture lines. They seem, however, to judge from the descriptions and figures available, to start from the axial furrow —at the same place as the radiating markings in *Trin. Murchisoni* and the primary trunk of the markings in *Trin. (Cryptolithus) tesselatus*— and (in the forms where there are two ridges) to unite in front of the postero-lateral angle of the cheek lobe. If the two ridges were the representatives of the anterior and posterior branch of the facial suture, the eye would have been situated in, or just at, the axial furrow, and this as well as the circumstance that the two branches of the suture would unite seems more than doubtful. Nor does it seem probable that one of them —or rather the outer part of one of them and the outer part of the single ridge in *Dionide atra*— represents a branch of the suture and the other is a structure of a quite different nature, or that

Affinities. — As REED (1914, p. 11) has pointed out, the affinities of this species[1] seem to be with the Girvan species *H. Hornei* REED (Op. cit. p. 10, Pl. II, figs. 1—2), which occurs in a formation nearly homotaxial to the Upper Leptæna Limestone. This author has already remarked that the Girvan species differs in the division of the alæ, but he evidently believed —judging from the descriptions and figures available to him— that the alæ were not divided in *H. costatus*. This is, however, the case, at least in the Swedish specimens, but in the Girvan species the division seems to be more distinct and the two portions of the alæ more equal in shape. Besides this and the other characters pointed out by REED, *H. Hornei* seems to differ in having the eye bosses more distinctly set off from the posterior portions of the cheek lobes, in the more semicircular alæ, the coarser perforations on the cheek-roll and brim and the smaller and more sparsely distributed pits on the cheek lobes.

H. ottawensis BILL. (BILLINGS, 1865, p. 182, text-fig. 165), as described and figured by BILLINGS has a relatively much wider cephalon, a much narrower brim and a more pointed glabella. The cephalon referred to BILLINGS' species by RAYMOND (1905 a, p. 331, Pl. X, fig. 2) seems, to judge trom the descripton and figure, to bear a closer resemblance to our species, but the cephalon inside the brim is relatively narrower, the glabella more truncated in front, the basal lateral glabellar lobes have a different form and no eye ridges seem to be present.

In *H. Flanagani* PORTL. (REED, 1914, p. 9, Pl. I, figs. 7 - 9) the brim seems to be narrower in the middle in front and wider at the sides and its perforations appear to be coarser than in our species, the horns of the brim seem to be relatively longer, the eyes to be situated farther back, and the eye ridges to be oblique.

The characters in which *H. Spasski* EICHW. (SCHMIDT, 1894, p. 66, Pl. V, figs. 3—9) differs have already been pointed out by SCHMIDT (Op. cit.) and other species described do not seem to be closely related.

Horizons and Localities. — This species has been found in the upper Leptæna Limestone at Kallholn, Osmundsberg and (according to SCHMIDT) Unskarsheden.

Outside Sweden it occurs in the East Baltic Lyckholm Formation and probably in the Keisley Limestone at Keisley in England and in the Kildare Limestone at the Chair of Kildare in Ireland. It is further re-

they are different structures from the radiating markings on the cheek lobe of other Trinucleidæ. Finally as regards *Ampyx Hornei* REED (REED 1903, p. 19, Pl. III, figs. 8-10), in which species too, according to RUEDEMANN, »suture lines» occur, the lines —they are, according to REED, 9-10 on each side, not only 2, though 2 or 3 are said usually to be larger and more distinct than the rest— radiate from the axial furrow and are situated on the fixed cheek, and inside the suture.

[1] REED calls the species *H. Wegelini*, but it is evident that *H. costatus* is meant; he refers to SCHMIDT's description and figures (cf. above, pp. 219-220).

ported from Etage 5 in Norway and possibly the cephalon from the North Baltic Östersjö Limestone mentioned above (p. 220) belongs to this species.

Harpes Wegelini ANGELIN. Pl. IV, figs. 21—26.

1854. *Harpes Wegelini,* ANGELIN, p. 85, Pl. XLI, figs. 3—3 a.
?1896. *Harpes costatus* ANG.?, REED p. 436.

Remarks. — This species is represented by several cephala from Kallholn and one from Arvet in the Upsala Museum and by one cephalon from the former locality in the Museum of the Geological Survey. It is not stated at which locality ANGELIN's type specimen was found.

It differs from the foregoing chiefly in the characters of the brim. The inner portion of this is flattened and nearly horizontally extended, or gently convex, the outer portion is very strongly, generally nearly vertically, arched down. Posteriorly the inner horizontal portion decreases rapidly in width, the outer portion grows less steeply inclined, and the surface of the posterior portions of the horns — in one specimen the surface of nearly the whole of the horns— is flattened and rather steeply inclined towards the sides. In small specimens the outer inclined portion of the brim seems to be narrower than in the larger ones. Owing to its convexity the brim appears narrower than in *H. costatus;* measured along the surface it is in most specimens relatively wider than in that species, but decreases more rapidly in width behind the genal angles, and on the whole the outline is very similar in the two species.

In the characters of the portion of the cephalon inside the brim this species agrees almost completely with *H. costatus.* The only differences which I have found are that in the former the portion of the roll in front of the glabella is somewhat more convex in both direction and less steeply inclined, and the alæ are more semicircular in outline.

One of the specimens (Pl. IV, fig. 22) shows a peculiar anomaly. One of the horns of the brim — the other is not preserved on the specimen— is very short and abruptly truncated. The steep prolongation of the check-roll extends somewhat farther back than the horn itself, but not with its entire width (height), the lower margin back of the horn being directed rather strongly upwards. The inner posterior portion of the horn —inside the marginal rim— is bent down, but not so much as the outer portion. Consequently the rim along the posterior margin does not lie in the same general plane as the outer rim, but slopes gently upwards from the postero-lateral angle to the prolongation of the cheek-roll; it continues obliquely upwards and backwards along the lower edge of the latter to meet the inner (upper) rim at an acute angle, and seems to be prolonged into a point or spine, of which, however, only the base is preserved on the specimen. This posterior portion of the rim seems to be somewhat thicker than the outer rim of the brim, and there is no row of large perforations along its inside. It appears as if the horn and the prolongation of the cheek-roll had been partly destroyed while the animal was still alive, and as if along the edge of the damaged portion a rim —forming a direct continuation of the outer rim of the brim— had been developed.

As pointed out above (pp. 219—220) the East Baltic form described by SCHMIDT as *H. Wegelini* is referable to *H. costatus*, and probably the specimens from the Keisley and Kildare Limestones and possibly the cephalon from the North Baltic Östersjö Limestone assigned to the same species, are also attributable to *H. costatus* or at any rate not to *H. Wegelini*. It seems, however, as if *H. Wegelini* too was represented in the Keisley Limestone. As already mentioned, REED has evidently mistaken the two species for one another, and it appears as if the specimen —a portion of a cephalon— which he (1896, p. 436) has described as *H. costatus* ANG.? is attributable to *H. Wegelini*. Besides, I have seen a fragment of a small *Harpes* cephalon from the Keisley Limestone in the Carlisle Museum (possibly the specimen described by REED), which, as far as it is preserved, shows the characters typical for this species.

H. Wegelini (as well as *H. costatus*) has further been reported by KJÆR (1897, p. 74) from Etage 5 in Norway.

Dimensions. — This species seems to reach somewhat greater dimensions than the foregoing. In the largest cephalon from the Leptæna Limestone which has come under my notice the length along the median line is 30 mm. and the greatest width 43 mm.; the length of the cephalon inside the brim is 20 mm. and its width at the level of the occipital furrow 27 mm. In the smallest cephalon the total length along the median line is 18 mm. and the greatest width approximately 27 mm.; the length of the cephalon inside the brim is 11,5 mm. and its width at the level of the occipital furrow 16 mm. In the other specimens the length of the cephalon inside the brim is from 14 to 15,5 mm. and the width at the level of the occipital furrow from 18,5 to 21 mm.

Horizons and Localities. — This species has been found in the Upper Leptæna Limestone at Kallholn and Arvet.

It seems further to be represented in the Keisley Limestone at Keisley in England and is reported from Etage 5 in Norway.

Family **Raphiophoridæ** ANGELIN.

Genus **Ampyx** DALMAN.

Ampyx foveolatus ANGELIN. Pl. VI, fig. 10.

1854. *Ampyx foveolatus,* ANGELIN, p. 80, Pl. XL, figs. 2—2 a.
?1890. *Ampyx foveolatus*, POMPECKI, p. 16, Pl. IV, figs. 17—17 a.

Specific Characters. — Cranidium transverse, sub-triangular; margin of anterior border rather strongly arched forwards (the entire outer margin of the cephalon evidently forming a semicircle); foremost portion of glabella projecting freely beyond the remainder of the cephalon.

Glabella sub-oval, rather pointed anteriorly; contracted at base and very slightly contracted in front of lateral lobes, its basal width about half the middle width; its anterior portion strongly convex and strongly raised above the fixed cheeks, rounded but with the anterior (lower) surface, which slopes steeply upwards, somewhat flattened, with stout, rounded, slightly upturned frontal spine (only the base is known); its posterior portion moderately convex in the middle, highest a little in front of occipital furrow, depressed at sides outside the lateral impressions. 2 pairs of distinct lateral impressions or furrows present. Basal pair beginning in the pits in the axial furrows — a little in front of base of glabella — curving obliquely inwards and forwards, at first shallow and rather narrow, growing deeper and wider within and continued obliquely forwards and outwards as very shallow, slightly outwards convex grooves, which reach the lateral extremities of anterior pair; incompletely separating off a pair of longitudinal, depressed lateral lobes. The anterior pair short, rounded with the longer axes directed obliquely outwards and forwards, reaching slightly farther inwards than basal pair, the inner ends placed about one third the width of glabella apart and just behind its mid-length. In front of the latter and in a line with their longer axes there are on each side of the glabella 2 very faintly marked, unsculptured, scarcely impressed, rounded spots placed rather close together, the foremost one situated just above the axial furrow a little behind the antero-lateral angle of the glabella. Preglabellar furrow coinciding in the middle with anterior border furrow, narrow and shallow, ending at sides a little in front of antero-lateral angles of glabella in small, very slightly impressed pits. Axial furrows not impressed in front but beginning below the anterior pair of lateral glabellar spots (Cf. above), narrow and shallow, running in slightly outwards convex curves backwards and then somewhat inwards, becoming almost obsolete outside posterior portions of lateral glabellar lobes and ending in rather deep pits behind extremities of latter. Behind the pit on each side is a very low sub-triangular elevation posteriorly confluent with the inner portion of the posterior border of the cheek. Occipital furrow scarcely impressed. Occipital ring of moderate, nearly uniform width, arched gently backwards and distinctly projecting on posterior margin of cephalon, laterally continuous with posterior borders of cheeks; its surface flattened with rounded posterior edge, sloping gently upwards from base of glabella and more steeply from the sides, rather gently arched (transversally) in the middle.

Fixed cheeks broad posteriorly, the basal width of each somewhat greater than middle width of glabella, their inner posterior portions gently convex; the antero-lateral portions curving steeply downwards to anterior border furrow. Posterior borders of cheeks slightly bent upwards —more strongly distally than proximally— with gently rounded surface, of moderate, nearly uniform width and directed nearly straight outwards for about three fourths their length, their outermost fourths gently bent downwards and rapidly narrowing to mere points. Posterior border furrows shallow and rather narrow within, growing wider and deeper laterally, but decreasing in width again and bending slightly backwards near the extremities, to die out nearly at the postero-lateral angles of the cranidium. Anterior border of cranidium narrow, of nearly uniform width, flattened, bent gently downwards, marked off by narrow, shallow furrow. Facial sutures weakly sigmoidal, their general course at about 55° to posterior margin of cephalon.

Surface of test of glabella, except in the lateral impressions and spots, ornamented with an irregular net-work of very fine, undulating and anastomosing ridges. On the other portions of the cranidium the ornamentation is less distinct, but they seem to be covered by rather sparsely distributed minute pits and on each fixed cheek is a group of very fine radiating lines, which seem to arise from the side of the glabella at about its middle (their inner portions are very obscurely marked on the specimen) and run obliquely backwards or outwards.

Dimension. — In the type specimen (cranidium) the distance along the median line between the anterior and posterior margins is 16 mm., and the basal width 30 mm.; the length of the glabella to the base of the spine (behind latter) is 13 mm. [to the anterior (under) side of the base of the spine the length is 14 mm.], and its width at about the middle is 11,5 mm.; the distance from the anterior border to the under-side of the base of the spine is 2,5 mm.

Remarks. — The foregoing description is based on an examination of ANGELIN's type specimen, which is the only one known from the Leptæna Limestone. With the exception of the frontal spine, which is broken off some distance from the base, it is well preserved.

ANGELIN's (1854, Pl. XL, figs. 2—2 a) figures are on the whole fairly good, but unsatisfactory in some respects. On the specimen the glabella projects only slightly in front of the fixed cheeks and is much lower than in his fig. 2 a, the distance from the anterior border to the under-side of the base of the spine being less than one fifth the length of the glabella, and the elevations at the sides of the base of the glabella are very obscure, sub-triangular in outline and posteriorly confluent with the posterior borders of the cheeks. Further the postero-lateral portions of the fixed cheeks are not drawn on ANGELIN's figures, although preserved on the specimen. In the figure given below (Pl. VI, fig. 10) the specimen is viewed somewhat obliquely to show the anterior portions of the facial sutures and the anterior border.

ANGELIN (Op. cit. p. 80) has stated that the specimen is from Osmundsberg. Other fossils contained in the same piece of rock, as well as the appearance of the latter, indicate, however, that the rock is Lower Leptæna Limestone. As already mentioned above (pp. 131, 164), it appears as if the whole mass of rock which forms the Osmundsberg hill consists of Upper Leptæna Limestone, whereas the small hill situated just south east of the former near Lake Sinksjön consists of Lower Leptæna Limestone. It appears probable that ANGELIN did not make any distinction between the two localities and that the specimen of rock in question is from the latter.

The fragmentarily preserved cranidium which POMPECKI (1890, p. 16, Pl. IV, figs. 17—17 a) has referred to this species seems to agree fairly well with the type specimen, except that, to judge from the figures, the glabella appears to be more highly raised above the fixed cheeks, especially anteriorly, and to project somewhat farther in front of the latter. POMPECKI seems to be of the opinion that the specimen, which is found in a boulder, comes from the Swedish Chasmops Limestone, the upper part of which is homotaxial to the Lower Leptæna Limestone.

Affinities. — The affinities of this species seem to be with *A. costatus* BOECK. (ANGELIN, 1854, p. 80, Pl. XL, figs. 1—1 e). The latter differs, to judge from ANGELIN's description and figures, in the characters of the lateral glabellar impressions, of which all 4 pairs are distinctly marked and the basal pair very short and not confluent with the preceding pair; in the shape of the glabella, which is less contracted at base, less pointed in front and has straighter sides; in the differently ornamented and nearly straight forward directed frontal spine; in having the posterior margin of the occipital ring only very slightly arched; further the glabella seems to be separated from the anterior border by a very short preglabellar field.

The fragmentary cranidia from the East Baltic Echinosphærites Limestone which SCHMIDT (1894, p. 84, Pl. VI, figs. 24—25) with a mark of interrogation referred to *A. costatus,* seem to resemble our species more than does the specimen figured by ANGELIN, in the characters of the lateral glabellar impressions and in the direction of the frontal spine, but they seem to differ in the shape of the glabella and they come from a lower stratigraphical horizon.

The cranidium from Girvan described and figured by REED (1903, p. 23, Pl. III, fig. 15) as *Ampyx* cf. *foveolatus* is not referable to our species, and does not seem to be closely related. It differs not only, as REED has pointed out, in having only one pair of lateral glabellar impressions, but also in the much stronger anterior projection of the glabella, in the shortness of the fixed cheeks, in the straight posterior margin and in the ornamentation of the surface. Further the glabella appears to be relatively wider and more rounded in outline, the posterior portions of the basal pair of glabellar impressions seem to be deeper and the lateral glabellar lobes to be less depressed.

Horizons and Localities. — The only specimen of this species known from Dalarne occurs in a piece of Lower Leptæna Limestone, which probably has been collected at Sinksjön (Cf. above).

Probably a cranidium found in East Prussia in a boulder, possibly of Chasmops Limestone, is referable to this species.

Family **Ityophoridæ** n. fam.

Cephalon with a broad, bilaminar marginal expansion. Glabella long and prominent. Facial sutures extending forwards from posterior margin of cephalon within genal angles, and cutting anterior margin separately. Thorax of few segments with furrowed pleuræ. Pygidium of moderate size with entire margin.

Genus **Ityophorus** n. gen.

Entire body sub-ovate in outline. Cephalon horse-shoe shaped, strongly convex, with a broad bilaminar marginal expansion, which is produced posteriorly into flat, tapering, pointed horns. Glabella convex, long, broadest in front, with 3 pairs of lateral glabellar furrows. Eyes small, situated close to the glabella and well forward. Thorax of few segments with convex axis and furrowed pleuræ. Pygidium of moderate size, axial and pleural portions with strong furrows.

Ityophorus undulatus n. sp. Pl. XI, figs. 40—43.

Specific Characters. — Entire body sub-ovate in outline.

Cephalon horse-shoe shaped, strongly convex, large, more than half the length of the entire animal, its length along the median line about five sevenths the greatest width, which is at about the level of the eyes; with a broad, bilaminar marginal expansion divided into an inner, nearly vertically raised roll (cheek-roll) and an outer wide, obliquely inclined brim, which is produced posteriorly into rapidly tapering, pointed horns reaching back to pygidium.

Inner portion of cephalon separated from outer bilaminar portion by distinct furrow (lateral line) which coincides anteriorly with the preglabellar furrow, strongly convex, its length rather more than half that of entire cephalon along median line, somewhat longer than wide at base, gently tapering anteriorly to broadly rounded front end. Glabella convex, strongly raised above the cheeks, broadest across the frontal lobe where the width is about three fourths the length, narrowing posteriorly to about five sevenths its frontal width, broadly rounded and gently bent down in front, defined by distinctly impressed axial and preglabellar furrows; with 3 pairs of very short lateral glabellar furrows, which are very narrow adjacent to axial furrows, growing wider within, their outer extremities placed at about equal distances apart; 1st pair situated opposite posterior extremities of eyes, directed nearly straight inwards, generally somewhat shallower and often shorter than following pairs; 2d pair parallel to 1st pair; basal pair beginning in axial furrows mid-way between 2d pair und occipital furrow, directed slightly backwards. Occipital furrow narrow and shallow in the middle, growing wider and deeper behind basal glabellar lobes, gently arched forwards. Occipital ring of moderate width, narrowing laterally, rather strongly arched transversally and slightly compressed from the sides, very gently rounded longitudinally, with indistinctly defined, low median tubercle (only discernible in some specimens); its posterior margin gently arched backwards.

Cheek lobes narrow, the basal width of each being scarcely more than half that of glabella at base, narrowing anteriorly, their surfaces strongly convex with a short, rather gentle inner and a longer, very steep outer slope. Eye lobes small and prominent, strongly convex both longitudinally and transversally, placed a little in front of mid-length of glabella and close to this. No defined palpebral lobes present, the inner portions of the lobes being formed by a pair of short, nearly transverse eye ridges, which are of uniform width from the glabella to the eyes and truncated at their distal extremities; they are marked off both in front and behind by distinct furrows. Eyes very small, very strongly convex in both directions, situated on the lower slopes of the lobes and comparatively far down on the cheeks; in some specimens they seem to reach to the lateral line, in others narrow strips are left between their lower margins and this. Posterior borders of cheeks of moderate width, strongly raised, increasing in width and height laterally, directed outwards and slightly backwards from axial furrows, curving strongly backwards at sides to pass into the inner marginal rims of the free protruding arms of the bilaminar portion of the cephalon. Posterior border furrows strongly impressed, growing narrower and shallower laterally. Anterior branches of facial sutures running from the eyes in wide curves obliquely outwards and forwards, bending inwards near anterior margin of cephalon; posterior branches curving at first obliquely downwards, outwards and backwards, but soon bending nearly straight backwards and running just above lateral line, then curving slightly upwards and inwards near posterior borders of cheeks, and then nearly straight across these to cut posterior margin of cephalon at slightly acute angles.

Bilaminar portion of cephalon angulated at some distance from its inner margin and thus divided into two regions: an outer obliquely inclined, wide brim and an inner rather narrow convex band or roll (cheek-roll) of uniform width, which rises nearly vertically from the brim and encircles the inner portion of the cephalon immediately below the lateral line. Brim horse-shoe shaped, rather gently bent down in front, more steeply at sides, of nearly uniform width in front, very gradually tapering posteriorly to opposite occipital ring and prolonged backwards into more rapidly tapering, horns, which end in short pointed spines formed by the prolongations of the marginal rims; length of horn rather more than one third that of cephalon along median line. Inner margins of horns nearly straight, directed slightly outwards; outer margins strongly arched, the entire outer margin of brim forming part of an ovate figure. Outer edge of brim gently upturned, forming a narrow (thin) marginal rim, thickening a little posteriorly, marked off by shallow furrow. Inner rim of horn considerably wider than outer rim, thickened and strongly raised, gradually increasing in height anteriorly, continued along posterior end of cheek-roll to pass into posterior border of cheek lobe, marked off by distinct furrow. Surface of brim inside rims marked by 3 or 4 sub-concentric rather broad ridges (or narrow rolls), separated by distinct, narrow furrows. The 1st ridge (numbering the ridges from the cheek-roll and outwards) situated immediately below the cheek-roll (which latter might be counted as the inmost ridge) and separated from this by distinct furrow, widest posteriorly, gradually decreasing in width anteriorly to grow very narrow in front of glabella; in some specimens it becomes obsolete in the middle; 2d ridge generally somewhat broader and more strongly raised than 1st ridge, posteriorly occupying the entire width of the horns inside the rim furrows, widest at sides, narrowing a little after crossing anterior branches of facial sutures, its anterior portion in front of glabella of nearly uniform width; 3d ridge widest in the middle at front, where it is generally wider than any of the ridges behind it, narrowing laterally to die out at sides (in outer rim furrow) generally rather soon after crossing anterior branches of facial sutures, its length, however, varying a little in different specimens; in a few specimens a 4th ridge is discernible in front of the 3d, it is very narrow, widest in the middle and narrowing laterally, dying out in the rim furrow at the antero-lateral corners of the cephalon. Doublure (or ventral lamella) of brim and cheek-roll separated from dorsal lamella by very narrow intervening space and showing the same configuration as this, the ridges on the dorsal surface of the latter thus being represented by furrows on the ventral surface of the doublure and the furrows by ridges.

Thorax of 6 segments, about five sevenths as long as wide, gradually decreasing in width posteriorly. Axis strongly convex, in front wider than side lobes, rapidly narrowing posteriorly; axial rings gently rounded longitudinally, arched slightly forwards at sides. Axial furrows scarcely impressed. Pleuræ straight and nearly horizontally extended as far out as fulcrum; their outer portions rather strongly curved downwards and strongly faceted, extremities pointed; pleural furrows strong, dying out before reaching extremities of pleuræ; fulcrum rather weak, on the middle-most pleuræ situated about half-way out, anteriorly more, posteriorly less than half-way out.

Pygidium semielliptical in outline, nearly two thirds as long as wide, surrounded by very narrow, flattened border. Axis strongly convex, narrow, its width at anterior margin being only about one fourths that of entire pygidium, gradually tapering posteriorly to rounded extremity, not quite reaching the border; divided into 5 or 6 longitudinally gently rounded axial rings and a short terminal piece by rather strong furrows, which grow weaker posteriorly. Axial furrows weak. Side lobes with a slight flattening in front adjacent to axial furrows, then curving rather gently downwards to border; with 5 pairs of raised and rounded regular ribs behind anterior pair of half ribs, and a short, rather narrow, somewhat swollen postaxial piece; the ribs growing successively weaker and decreasing in size and becoming more and more strongly turned backwards posteriorly, the 5th pair —only discernible on a few of the specimens observed— directed nearly straight backwards. Pleural furrows rather strong, reaching to marginal border. Interpleural furrows very weak adjacent to axial furrows, somewhat increasing in strength laterally, reaching to border. Posterior bands of regular ribs narrower and lower than anterior ones, slightly decreasing in width laterally. Doublure of pygidium narrow.

The surface of the test of all parts of the carapace appears to be smooth.

Dimensions. — In the larger cephala the length along the median line is from 3,5 to 4 mm. In one individual, which, with the exception of the outer portion of the brim, is entirely preserved, the length seems to have been just over 6 mm., the length of the cephalon being approximately 3,5 mm., the length of the thorax about 1 $^2/_3$ mm. and the length of the pygidium about 1 mm.

Remarks. — This new species is represented by 3 nearly entire individuals, a good number of cephala, and a few pygidia and portions of the thorax (the latter attached to the cephala or to the pygidia) from Kallholn in the Upsala Museum.

In the above description some of the terms suggested by BATHER (1910) and REED (1914) for certain parts of the cephalon of *Harpes* (Cf. above p. 214) have been adopted.

The bilaminar structure of the brim and cheek-roll has been proved by the examination of thin slides. It is easily recognizable otherwise too. As is the case in *Harpes,* at least in the Leptæna Limestone specimens, the bilaminar portion of the cephalon is generally distinguished from the inner portion by its different colour, and the thin plate formed by the two lamellæ of the test and the infilling matrix (or, when the test is not preserved, by the latter alone) comes off very easily.

The small number of thoracic segments and the small size of the specimens, might lead one to believe that none of the specimens were adults. Otherwise they do not, however, show characters of immaturity and in all the examples in which the thorax is preserved it consists of the same number of segments, although the examples are of rather different sizes. Moreover, there is no larger trilobite known which could be the adult of this species.

Affinities. — This peculiar little species is so distinct from all others hitherto described, that it evidently must be referred not only to a separate genus but even to a separate family.

In the presence of the broad bilaminar marginal expansion divided into a wide horse-shoe shaped brim and a vertically raised cheek-roll it resembles *Harpes* and to a certain degree the Trinucleidæ. This portion is, however, not perforated as in those forms, and since the species differs so decidedly from them in most of its other characters this likeness must be considered to be a case of independent parallel evolution. *Ityophorus* appears to be a rather specialized form, probably adapted for the same mode of life as the Harpedidæ and the Trinucleidæ, although the specialization has gone less far than in these.

Horizon and Locality. — Upper Leptæna Limestone; Kallholn.

Family **Acidaspidæ** BARRANDE.

Genus **Acidaspis** MURCHISON.

Several attempts have been made at a sub-division of this genus and the name of the genus itself in its broader sense and even the name of the family has been a matter of controversy. The term *Acidaspis* was introduced by MURCHISON in his Silurian System (p. 658) in 1839, and in the same year EMMRICH in De Trilobitis (p. 35) proposed the name *Odontopleura*. During the following years the latter name was commonly used by German authors. It was also employed by BARRANDE in his earlier papers but in 1852 this scientist adopted MURCHISON's name and pointed out that this apparently was the older one,[1] since it was quoted in De trilobitis. Since then the term *Acidaspis* has been commonly accepted until later years.

There is, however, an earlier name still, viz. *Ceratocephala* WARDER, which was proposed by WARDER in 1838, but rejected by CORDA (1847) and BARRANDE (1852) because the name *Ceratocephalus* had previously been used for a genus of plants. CORDA (Op. cit.) pointed out also that WARDER had figured his type specimen — an imperfectly preserved cephalon — in an inverted position and described the occipital spines as antennæ. This name was not adopted, even by American authors,

[1] Later on VOGDES (1917, p. 49) has pointed out that a copy of MURCHISON's work was presented to the Geological Society London, January 9, 1839 — which would indicate that the book was published early in January 1839 — and that EMMRICH's paper bears the date, April, 1839.

until CLARKE in 1892 in Notes on the genus Acidaspis advocated its use.[1]

In this paper CLARKE proposed a sub-division of the genus. Pointing out that the respective type-species of *Acidaspis, Odontopleura, Ceratocephala* as well as of *Selenopeltis* CORDA, and *Dicranurus* CONRAD, belong to different groups of the genus, he retained all these terms (*Ceratocephala* in a restricted sense) as designating sub-divisions of the genus *Ceratocephala* s. lat. and as a 6th sub-division he recognized *Ancyropyge* CLARKE. His classification was in the following years accepted by several other authors, mostly American, who, however, raised the sub-divisions to generic rank, and as a consequence of this some of them have adopted BURMEISTER's family name Odontopleuridæ, since this name apparently was proposed erlier than the term Acidaspidæ.

The latest writers upon this subject, viz. RAYMOND (1916) and RUD. and E. RICHTER (1917) have accepted the groups *Selenopeltis, Dicranurus* and *Ancyropyge* as restricted by CLARKE, but pointed out that with regard to the groups *Acidaspis, Odontopleura*, and *Ceratocephala* his classification — based solely on the structure of the occipital ring, whether spineless, bispined or unispined — is not a natural one.

RAYMOND considers the groups to have generic value, and in his proposed classification (Op. cit.) he continues to use also the three latter names as designating separate genera but alters the definitions and limits of these and defines them as follows: *Odontopleura,* glabella oval in outline; the pleural lobe of each segment of the thorax has a narrow, strongly elevated median ridge. *Acidaspis,* glabella roughly triangular in outline, tapering towards the front; the pleural lobe of each segment is divided by a linear furrow into a low anterior and an elevated posterior ridge. *Ceratocephala,* free and fixed cheeks anchylosed, eyes far forward and far from the glabella; the pleural lobe of each thoracic segment is divided by a shallow median furrow into equally elevated portions.

RUD. and E. RICHTER[2], who regard the groups as sub-genera, use the name *Acidaspis* (MURCH.) BARR. as designating the genus (giving as their reason that the conception of the genus was not created until BARRANDE did it). Like CLARKE but contrary to RAYMOND they base their classification on the characters of the occipital ring, but take also several other characters into consideration and propose the following new sub-genera: *Leonaspis*, type *A. Leonhardi* BARR., *Pseudomonaspis,* type A. *Brighti* MURCH., *Primaspis*, type *A. primordialis* BARR., *Miraspis,* type *A. mira* BARR., and *Radiaspis,* type *A. radiata* GOLDF., and they have also a sub-genus *Ceratocephala* WARD., type *A. (Ceratocephala) goniata* WARD.

[1] VOGDES had earlier (1877) urged the claims of WARDER's name, but had not in his later papers used it himself.

[2] These authors, when publishing their paper, were apparently unacquainted with RAYMOND's paper on the subject.

Sub-genus *Leonaspis* corresponds partly to CLARKE's sub-division *Odontopleura,* but includes also a part of his sub-division *Acidaspis* (the rest of which is referred to *Pseudomonaspis)* and is defined as follows: Occipital ring smooth or with a single tubercle, or a single spine emanating from the tubercle; anterior branch of facial suture parallel to the median line of the body, diverging from the eye-ridge; »outer cheek-triangle» consequently forming a distinct and large triangle; thoracic pleuræ without or with weakly developed anterior spine. The authors remark that the name *Odontopleura* cannot be used for this group, since EMMERICH's type-species *O. ovata* has two occipital spines (Cf BEYRICH, 1846, p, 18).[1]

Sub-genera *Pseudomonaspis*, *Primaspis*, *Miraspis*, *Radiaspis Ceratocephala* and *Dicranurus* form the group Miraspinæ, which is defined as follows: Facial suture bending strongly towards the glabella, closely following the eye ridge; »outer cheek-triangle» consequently narrow, band-like, disappearing; occipital ring often swollen, always (except in *Pseudomonaspis*) with one pair of spines, between the spines the single *Leonaspis* tubercle generally occurs also; anterior pleural spine often strongly developed.

The sub-genus *Pseudomonaspis* is characterized as: Aberrant sub-genus in which a single spine, which has nothing to do with the *Leonaspis* tubercle, emanates from the swollen occipital ring characteristic for the group. In addition to the type-species, *A. Grayi* BARR. and *A. quinquespinosa* SALTER-LAKE are referred to it.

Their sub-genus *Ceratocephala* corresponds to *Trapelocera* CORDA-NOVÁK (and to BARRANDE's *A. vesiculosa* group) and to *Ceratocephala* s. str. CLARKE, when *Miraspis, Primaspis* and *Radiaspis* are eliminated and the name restored to the group for which CLARKE originally (Op. cit., 1892, p. 93) used this name. It corresponds also on the whole to RAYMOND's genus *Ceratocephala* though it is differently defined.

Neither RAYMOND's nor RUD. and E. RICHTER's classification seems to me quite satisfactory. The characters upon which the former bases his classification do not appear to be happily chosen, at least not as regards his genera *Acidaspis* and *Odontopleura.* It is true that in all hitherto described species, which appear to belong to the *Acidaspis Brighti* group, the shape of the glabella is about the same, but there are other forms, e. g. *A. deflexa* LAKE (LAKE, 1896, p. 239, Pl. VII, fig. 7; REED, 1906, p. 113, Pl. XV, fig. 15), which have a triangular glabella tapering towards the front, whose affinities evidently are not with this group but with species, which in the outline of the glabella agree with *O. ovata* and by RAYMOND are referred to *Odontopleura.* As regards the characters of the inner parts of the thoracic pleuræ, these vary considerably in apparently closely related species. Only in a comparatively small number of those, which RAYMOND evidently considers referable to *Odontopleura,*

[1] It does not agree with this group in the other characters mentioned in the definition either.

the strong principal ridge is really centrally situated. It appears to be much more usual that the anterior band is considerably broader than the posterior one, which often is quite inconspicuous (BARRANDE has in several cases described it as rudimentary or scarcely discernible). The anterior band on the other hand may be as wide or wider than the principal ridge and is often raised into a low ridge, which in some cases is separated from the higher principal ridge by a broad groove, in others by a quite narrow furrow. Of the type of *Acidaspis* only the cephalon is known and with regard to the characters of the thoracic pleuræ RAYMOND bases his diagnosis on the American species *A. anchoralis* MILL. and *A. O'Nealli* MILL. Of the former species the thorax seems never to have been figured, of the latter MILLER (1875, p. 87, fig. 9) has figured an entire individual, but his figure is unsatisfactory and does not show the construction of the inner parts of the pleuræ. RAYMOND does not give a figure nor a detailed description of these portions. It seems, however, as if we were entitled to assume that they are similarly constructed as in *A. cincinnatiensis* MEEK (MEEK, 1873, p. 167, Pl. XIV, fig. 3), which species also RAYMOND refers to *Acidaspis*. According to MEEK's description and figure the thoracic pleuræ of this species have each a strong principal ridge separated by a narrow furrow from a more slender, depressed anterior ridge, and behind the principal ridge is a narrow flat posterior band. The difference between these pleuræ and those of several of the species which RAYMOND refers to *Odontopleura* seems thus to be very slight. Besides, we do not even know whether *A. Brighti* and the apparently very closely allied *A. Grayi* BARR. agree with the American species mentioned above in the characters of the pleuræ. In *A. asteroidea* REED (REED 1914, p. 31, Pl. V, figs. 3—7), which in the general characters of the cephalon recalls *A. Brighti* and *A. Grayi,* the strong principal ridge on the pleuræ seems to be centrally situated and both the anterior and the posterior bands are flattened.

The species referable to *Ceratocephala* as defined by RAYMOND differ strongly from the types of *Acidaspis* and of *Odontopleura* and resemble each other closely in nearly all characters, and are apparently closely allied, but then there are also forms which in some characters show a great likeness to these, but differ distinctly in others. *A. terribilis* REED (REED 1914, p. 36, Pl. VI, figs. 7—10) resembles them in the chief characters of the cephalon, but the thoracic pleuræ and the pygidium are differently constructed. This species cannot be included in the genus *Ceratocephala* as defined by RAYMOND, and it seems really doubtful whether its affinities are with this group, but obviously it cannot either be placed in any of the other genera proposed by him.

It appears quite probable to me that RAYMOND is right that *Acidaspis Brighti, Odontopleura ovata,* and *Ceratocephala goniata* ought not to be regarded as co-generic, and that the three generic names thus could be retained in their original value, but then the genera must be properly defined and limited. In any case it seems very inappropriate to refer to *Odontopleura* all the species, under consideration here, which cannot be included in any of the other genera. The greatest part of the various described members of the family RAYMOND refers to this genus, and among these are several which do not seem to be more closely related to *Odontopleura ovata*, than this is to *Acidaspis Brighti*. Also some of the species which he places in *Acidaspis* differ very much from the type-species of this genus.

As regards *Odontopleura* he remarks, however, that it is quite possible that the species, which he has grouped under this genus can and will be arranged in other sub-genera and genera. As seen from the above, this has been done by RUD. and E. RICHTER, but the type-species does not seem to be referable to any of their sub-genera. It belongs evidently to the group Miraspinæ, and the only sub-genus to which it in accordance with the definitions of the sub-genera could be referred is *Miraspis* (which is regarded as typical sub-genus of the group), but it appears to differ as much or more from the type-species *A. mira* than do the forms referred to *Primaspis* and *Radiaspis*. There are several other Acidaspids, which do not fit in any of their sub-genera. *A.* (*Odontopleura*) *bowningensis* ETHR. jun. and MITCH. (ETHERIDGE and MITCHELL, 1896, p. 696, Pl. L, figs. 1—3, Pl. LII, fig. 5), *A. girvanensis* REED (REED, 1914, p. 33, Pl. V, figs. 8—10, Pl. VI, figs. 1—3), and *A. evoluta* TQT (Cf. below p. 238, Pl. VI, figs. 5—6) for instance, agree with the members of their sub-genus *Leonaspis* in having the occipital ring smooth or with a median tubercle, but differ from them in several other characters, e. g. in the course of the anterior branches of the facial sutures, which, as in the Miraspinæ, converge anteriorly, so that the »outer cheek-triangeles» become very narrow. It seems also rather doubtful to me — especially if *Primaspis* and *Radiaspis* are regarded as distinct sub genera -- whether such forms as *A. Grayæ* ETHR. jun., *A. hystrix* WYV. THOMS., and *A. lalage* WYV. THOMS. (Cf. REED, 1906, pp. 114—119, Pls. XV—XVI) can be placed together with *A. Dufrénoyi* BARR. (BARRANDE, 1852, p. 741, Pl. XXXVIII, figs. 25—26) and *A. Prevosti* BARR. (BARRANDE, 1852, p. 739, Pl. XXXIX, figs. 33—41) in the sub-genus *Miraspis*, and whether it is justifiable to group *A. quinquespinosa* SALTER-LAKE (LAKE, 1896, p. 240, Pl. VII, fig. 3—4) as done by RUD. and E. RICHTER (and by RAYMOND too) together with *A. Brighti* and *A. Grayi* BARR.

There are among the various Acidaspids described several other species, than those mentioned above, which it might be difficult to place in any of the sub-genera proposed by RUD. and E. RICHTER. The proposed sub-genera seem also to be of rather different value and it would perhaps be better to give some of them generic rank. Their paper is, however, only a preliminary report, in which, as it seems, chiefly the Bohemian and German species are taken into consideration. Presumably the main work will be based upon a closer examination of the various described forms, and give more distinct definitions and limits of the groups, and it appears quite probable that the authors will also suggest new ones.

Of the species found in the Leptæna Limestone *A. evoluta,* at least, cannot, as already mentioned, be referred to any of their groups, and the true position of the other species seems also doubtful. As it seems to me inappropriate, under the circumstances, to introduce any new sub-generic or generic terms here or to attempt any closer appraisement of the ranks of the groups, I think it best for the present to refer all the species to the same genus, and to use the most commonly accepted generic term, *Acidaspis.* The older name *Ceratocephala* seems never except in CLARKE's paper of 1892, to have been used in this broader sense, and it would only cause confusion to use it at present in this sense — which would involve a change in the family name — since it appears probable that it will prove correct to regard *Ceratocephala* in a restricted sense as a distinct genus.

Distinguishing Characters of the Species.

1. Occipital ring without spines, with a single, median tubercle. 2d and basal lateral glabellar lobes completely circumscribed by furrows. Free and fixed cheeks not anchylosed. Eye lobes placed far back. *A. evoluta* TQT.

Occipital ring bispined 2.

2. Occipital spines gently curved, very long. 2d and basal lateral glabellar lobes confluent. Free and fixed cheeks (probably) not anchylosed. Eye lobes placed far back. *A. Clevei* n. sp.

Occipital spines straight. 2d and basal lateral lobes distinctly separated. Free and fixed cheeks anchylosed. Eye lobes placed at about the middle of the cheeks 3.

3. Glabella nearly all occupied by the gibbous central lobe, lateral glabellar lobes minute, much depressed below the surface of the median one, distinctly separated from this *A. bispinosa* M'COY.

Central lobe of glabella gently convex transversally, only slightly raised above the lateral lobes, lateral lobes of moderate size, the 3d one confluent with the central lobe within *A. laticapitata* n. sp.

Acidaspis evoluta TÖRNQUIST. Pl. VI, figs. 5—6, 9?.

1884. *Acidaspis evoluta,* TÖRNQUIST, p. 28, Pl. I, fig. 24.

Specific Characters. — Cephalon transverse, semielliptical in outline, more than twice as wide as long with middle part projecting behind base of cheeks, surrounded in front and laterally by wide flattened border, which grows narrower anteriorly and is marked off by shallow furrow.

Glabella sub-cordate in outline, reaching to anterior border furrow, depressed convex, about seven ninths as long as wide, its greatest width at about middle of basal lateral lobes; lateral lobes but little depressed below central lobe, completely circumscribed, except anterior pair. Central lobe of glabella sub-cylindrical, more than one third the width of glabella at base, slightly contracted between 2d pair of lateral lobes, expanding a little in front, moderately convex in both directions, rather strongly bent down in front, its anterior end broadly rounded, the anterior lateral expansions coalescing with or indistinctly marked off from anterior ends of eye ridges. Anterior pair of lateral glabellar lobes very small, sub-oval with the longer axes directed obliquely forwards, imperfectly separated from central lobe, without independent convexity; 2d pair considerably larger than anterior pair, rather strongly convex, sub-circular or subovate in outline, with the longer axes directed obliquely outwards and forwards; basal pair moderately convex, large, about half the length and two sevenths the width of glabella, sub-oval in outline, slightly pointed anteriorly and with the longer axes slightly oblique to the median line of the cephalon. Anterior pair of lateral glabellar furrows short, beginning at the anterior ends of the axial furrows, curving inwards and upwards and then backwards, rather strongly impressed in front, but soon growing very shallow and dying out before reaching following pair; 2d pair beginning in axial furrows nearly at the same places as anterior pair, strongly impressed slightly curved and directed obliquely inwards and backwards to about middle of 2d pair of lateral lobes, then growing shallower curving posteriorly and joining basal pair; basal pair strongly impressed in their antero-lateral parts, which are directed inwards and slightly backwards, shallower behind, where they curve posteriorly and join the occipital furrow as rather shallow rounded furrows. Axial furrows strong and deep in their posterior parts, growing narrower and shallower outside 2d pair of lateral glabellar lobes to end in very shallow pits in front of these, converging anteriorly, arched outwards but not in regular continuous curves being bent inwards at basal lateral furrows.

Occipital furrow well marked, rather broad behind central lobe of glabella, becoming narrower and more deeply impressed behind basal glabellar lobes, nearly transverse in the middle, curving slightly backwards at sides. Occipital ring very broad in the middle, measuring from back to front along the median line more than one third the length of glabella, narrowing towards the sides, its lateral extremities, which reach somewhat further outwards than base of glabella, becoming mere points; it is strongly arched transversely, gently rounded longitudinally and bears a minute median tubercle situated about one third the distance from the posterior to the anterior margin and a pair of small, transverse sub-oval, posteriorly indistinctly defined occipital lobes behind basal glabellar lobes; its posterior margin is nearly transverse in the middle but curves strongly forwards at sides.

Fixed cheeks very strongly convex longitudinally, descending very steeply behind eye lobes to posterior border furrow, their anterior slopes longer and more gentle; their inner portions forming elongated, curved, rounded rolls, lying opposite the lateral glabellar lobes, very narrow and pointed anteriorly, increasing in width posteriorly to about half that of the basal glabellar lobes, separated from eye ridges and eye lobes by strong furrows. Eye ridges of moderate, nearly uniform width, rounded, gently curved. The portion of the fixed cheek lying between the eye ridge, the anterior branch of the facial suture and the anterior border furrow is very steeply bent downwards, very narrow, elongated sub-triangular in outline, widest opposite antero-lateral angles of glabella, where its width is scarcely more than that of the eye ridge; its surface is gently concave and smooth, except just at the outer edge, forming a shallow groove or furrow outside the eye ridge. Posterior wing of fixed cheek very narrow from back to front, extended laterally. Posterior border of fixed cheek very narrow at axial furrow, expanded laterally, rounded, marked off by rather strong furrow, which dies out a little before reaching the posterior branch of the facial suture. Eye lobes (not preserved) apparently small (possibly elevated) and situated very far backward, lying behind the middle of basal glabellar lobes, and distant from glabella about one sevenths the width of latter.

Free cheeks sub-triangular in outline, with outer margins moderately arched outwards and forwards, descending abruptly from eyes to lateral border furrow. Lateral border rather broad, thickened but flattened on the upper side and posteriorly depressed below the surface of the base of the genal spine, on its lower edge furnished with series of (more than 9, probably about 12) equidistant, rather stout spines (imperfectly preserved) which are directed nearly straight downwards. Lateral border furrow broad and shallow, ending in shallow pit just in front of base of genal spine; from this pit a short shallow groove runs obliquely inwards to the posterior extremity of the eye, and behind the groove the surface of the free cheek slopes upwards and forms a direct continuation of the surface of the genal spine. Genal spines (imperfectly preserved) rounded, broad-based, tapering, directed obliquely outwards and backwards. Anterior branches of facial sutures slightly arched outwards, rather strongly converging anteriorly; posterior branches running nearly straight outwards from eyes to near base of genal spine, then bending nearly straight backwards to cut posterior margin of cephalon at slightly acute angles.

Thorax (imperfectly known) with convex, cylindrical axis, which occupies less than one third the width of the thorax and is of uniform width on the 5 anterior segments (the posterior ones are not preserved); axial rings bent forwards in middle and at sides but without defined lateral nodules, gently rounded longitudinally. Pleuræ with inner portions straight and horizontally extended; outer portions bent obliquely downwards but not arched backwards; inner part of pleura with narrow low anterior ridge and broad, more strongly elevated sub-median ridge, which latter is separated from the anterior ridge by moderately strong furrow and bordered posteriorly by a very narrow, depressed posterior band; anterior ridge produced into short, obliquely bent down, free spine; sub-median ridge slightly broadening and bending a little backwards near outer extremity, where it rises into a prominent knob, and beyond this produced into long, stout free spine, which is rather strongly bent downwards.

Surface of cephalon, except in the furrows, ornamented by closely set, rather large tubercles of different sizes. Surface of thoracic axial rings and sub-median ridges of pleuræ ornamented with more sparingly distributed and somewhat larger tubercles than those on cephalon; anterior ridges of pleuræ with single row of 6—8 equal and equidistant tubercles.

Dimensions. — This species seems to reach relatively large dimensions. In TÖRNQUIST's type specimen the length of the cranidium along the median line is 10 mm. and the width between the eye lobes 11,5 mm.; in another incompletely preserved specimen — the largest which has come under my notice — the approximate length of the cranidium is 11 mm.; the smallest cranidium observed has a length of about 4,5 mm.

Remarks. — In addition to the cranidia of this species described by TÖRNQUIST, there are now available one imperfect cephalon with 5 imperfectly preserved thoracic segments attached from Kallholn in the Museum of the Geological Survey, one cephalon from Östbjörka in the Upsala Museum and another from Lissberg in the Museum of the University of Stockholm. This material has enabled me to give the above fuller description. None of the cephala are complete. In all of them the eye lobes are broken off, and this fact makes it seem probable that the eyes were elevated. The genal spines are also wanting except in the specimen from Kallholn in which the basal part of one of the spines is preserved. In the portion of the thorax observed the axis and the inner parts of the side lobes are fairly well preserved, but the free spines are mostly broken off, only a portion of one of the long stout spines, formed by the prolongation of the sub-median ridges, and one of the small, anterior, spines being preserved.

A fragmentarily preserved pygidium from Unskarsheden in the State Museum of Natural History appears to belong to this species. It is broadly semicircular in outline, marginally spinose, more than twice as wide as long (excluding spines). The axis is rather wide, its width at the anterior margin being rather more than one third that of the entire pygidium, slightly tapering posteriorly to the broadly rounded extremity, not reaching the posterior margin; it is composed of 3 axial rings — of which the third is very obscurely defined behind — and a very short terminal piece; the 1st axial ring is very prominent, the rest of the axis depressed convex; each axial ring is ornamented by a single row of tubercles. The side lobes are flattened and horizontally extended; on each there are traces of a strong ridge running from the 1st axial ring obliquely backwards. As in other species of the genus the ridges seem to have been produced backwards into rather stout spines, and between these stouter spines there have been 4 apparently rather slender marginal spines of which the bases are preserved on the specimen. The antero-lateral portions of the pygidium are very badly preserved but there seems to be room for 2 or 3 small spines on each side.

Affinities. — As pointed out by REED the affinities of this species seem to be with *A. semievoluta* REED (REED, 1910, p. 214, Pl. XVII, figs. 1—3), *A. convexa* REED (REED, 1896 p. 425 Pl. XXI, fig. 6) and *A. girvanensis* REED (REED, 1914, p. 33, Pl. V, figs. 8—10, Pl. VI, figs. 1—3). Especially *A. semievoluta* appears to be very closely related to our species; possibly it is identical; the formation (Dufton Shales) in which it occurs is nearly homotaxial to the Upper Leptæna Limestone. To judge from the figures it seems to differ somewhat in the shape of the glabella, which is relatively broader in front and more contracted at base; further the inner portions of the basal lateral glabellar furrows appear to be directed more inwards and the central lobe of the glabella to be more strongly contracted between the 2d pair of lateral lobes, and the lateral border of the free cheek is said to be raised. The specimens are, however, preserved in shales, and these differences may partly perhaps only be due to the fact that they are pressed. The fragmentary pygidium from Unskarsheden described above as probably belonging to *A. evoluta*, seems, as far as it is preserved, to agree fairly well with that of *A. semievoluta*.

In *A. convexa* the glabella is comparatively narrower than in our species, the basal lateral glabellar lobes are longer and narrower, the 2d pair is smaller, the 1st pair scarcely indicated, and there is a small nodule at the posterior end of the rounded ridge formed by the inner portion of the fixed cheek; further the eye ridges seem to be lower and straighter, the occipital lobes more pronounced and the posterior branches of the facial sutures appear to have a different direction.

A. girvanensis seems to differ in the shape of the glabella (which is truncate in front) in the more distinctly marked off anterior glabellar lobes, the broader fixed cheeks, the more backwardly directed genal spines, the ornamentation of the surface of the cephalon, the more distinct lateral nodules on the thoracic axial rings and in the more backwardly directed pleural spines.

TÖRNQUIST (Op. cit. p. 29) has mentioned that REMELÉ had given the verbal information that our species and the one reported by REMELÉ in 1882, p. 653 as *Odontopleura* nov. sp. were identical. This, however, can evidently not be the case, since, according to the author last mentioned, the occipital ring of the latter species is furnished with a stout occipital spine.

Horizon and Localities. — Upper Leptæna Limestone; Lissberg in Gulleråsen, Östbjörka, Kallholn, Unskarsheden?

Acidaspis Clevei n. sp. Pl. VI, fig. 1.

Specific Characters. — Cranidium transverse, exclusive of occipital ring and postero-lateral portions of fixed cheeks (which latter are not preserved on the specimen but probably were produced laterally) trapezoidal in outline; occipital ring projecting on posterior margin; the anterior border (only a fragment preserved) seems to have been nearly straight, narrow and upturned and is marked off from the glabella by a narrow furrow, which is shallow in the middle but grows deeper laterally. Glabella somewhat less than two thirds as long as wide, widest a little in front of base, narrowing anteriorly, truncate in front, gently convex. Central lobe of glabella separated from lateral lobes by weak longitudinal grooves, sub-cylindrical, somewhat longer than wide at base, slightly narrowing anteriorly, suddenly expanded in front into small lateral projections, which coalesce with the eye ridges. Anterior lateral glabellar lobes obsolete. 2d and basal pairs of lateral glabellar lobes depressed below central lobe, coalescing laterally; bi-composite lobes obliquely sub-ovate or rounded sub-triangular in outline, narrowing anteriorly, notched on the insides by basal glabellar furrows, extending rather more than four fifths the length of central lobe, their greatest width about half that of latter, their surface gently convex sloping steeply downwards postero-laterally. Anterior lateral glabellar furrows obsolete; 2d pair deeply impressed, very short, directed obliquely inwards; inner extremities of basal pair situated a little behind mid-length of glabella, forming a deep pit on each side — in the longitudinal groove, which separates the bi-composite lateral lobe from the central lobe of the glabella — from which a short, very shallow, rather broad groove runs obliquely outwards and backwards about half-way across the bi-composite lateral lobe. Axial furrows narrow, not strongly impressed, curving steeply downwards posteriorly.

Occipital furrow weak, almost obsolete and transverse behind central lobe of glabella; its side portions (not distinctly discernible on the specimen) seem to have been more strongly impressed and directed obliquely forwards. Median portion of occipital ring measuring from back to front along the median line about two fifths the length of the glabella, strongly arched from side to side, with low, rather large median tubercle near anterior margin and two very long, broad-based, tapering, diverging occipital spines (not completely preserved), which are directed obliquely upwards from their bases and gently curved in the vertical plane. (The longer of the spine-portions preserved has about twice the length of the cranidium along the median line, describes an arc of about 90°, and its posterior end, which has grown very thin, points somewhat downwards). Lateral portions of occipital ring (not completely preserved) seem to have been very short and narrow, deeply depressed below the median portion and the basal lateral glabellar lobes, and slightly concave.

Portions of fixed cheeks inside eye ridges sub-triangular, sloping very steeply downwards with slightly convex surface to axial furrows. Eye ridges long, prominent, nearly straight, making angles of about 45° to median line of cranidium, bounded on their insides by distinct, narrow furrows. Eye lobes (not preserved) apparently situated very far back. Antero-lateral portions of fixed cheeks (outside eye ridges) narrow, strongly bent upwards, with their edges slightly recurved, forming very narrow ridges separated by narrow, deep impressions or broad furrows from the anterior portions of the eye ridges, posteriorly becoming confluent with the eye ridges. Anterior branches of facial sutures posteriorly following edges of eye ridges to a little in front of middle of glabella, then bending nearly straight forwards but very soon bending more inwards again to cut the anterior margin at about 45°.

Test of cranidium ornamented, except in the furrows and grooves, by relatively large, irregularly scattered tubercles of two or three sizes.

Remarks. — The above description is drawn up from a single small cranidium (measuring along the median line a little less than 4 mm) from Arfvet in the Upsala Museum. It is not quite complete, the posterior portions of the fixed cheeks (including the palpebral lobes), the extremities of the occipital spines and nearly the whole of the anterior border being broken off, but otherwise it is well preserved.

The specimen was collected by the late professor P. T. CLEVE, after whom I have named the species.

Affinities. — This species seems to be related to *A. kuckersiana* SCHMIDT (SCHMIDT, 1885, p. 4, Pl. I, figs. 2—3) and *A. furcata* LINRS. (LINNARSSON, 1869, p. 65, Pl. I, fig. 18), which both, however, occur on a considerably lower stratigraphical horizon. The former differs in the characters of the occipital spines, which are straight and seem to be nearly horizontal and more slender than in our species; further the occipital furrow appears to be more strongly impressed, and there is no median tubercle on the occipital ring. LINNARSSON's species differs in the shape of the bi composite lateral lobes, whose anterior and posterior portions — the 2d and basal glabellar lobes — are nearly of the same shape and size and separated by scarcely discernible grooves, which run at right angles to the median line of the cranidium; the pits at the inner ends of these grooves seem further to be less conspicious than the corresponding ones in our species, and to judge from the figure the occipital spines diverge more strongly and their basal portions (the only parts preserved) appear to be a little convex inwardly.

The small imperfect cranidium described by RAYMOND (1910 b, p. 234, Pl. XXXIX, fig. 15) as *Ceratocephala Narrawayi* bears also a rather close resemblance to our species, but differs in its deep occipital furrow, broader (from back to front) occipital ring and in the occipital spines, which appear to be nearly straight, and whose bases are more widely separated. Further the 2d pair of lateral glabellar furrows seem to be more strongly developed and the pits, which represent the basal pair, to be placed farther back.

In the general characters of the cranidium our species (as well as the other species mentioned above) much resembles the species which R. and E. RICHTER (1917) refer to their sub-genus *Radiaspis* although it differs in some features, e. g. in the ornamentation of the test, the curved occipital spines, and the straight eye ridges. It recalls also the species which have been referred to *Dicranurus*, viz. *A.* (*Dicranurus*) *hamatus* CONR. (HALL, 1859, p. 371, Pl. LXXIX, figs. 15—19) and *A.* (*Dicranurus*) *monstrosa* BARR. (BARRANDE, 1852, p. 750, Pl. XXXVII, fig. 34; 1872, p. 77, Pl. VII, figs. 1—2, Pl. XI, figs. 19—22, Pl. XV, figs. 1—2). As already mentioned above the occipital spines are not completely preserved on our single specimen, but although arched they do not appear to have been spirally curved, as in the species mentioned, or they have at any rate reached a considerably greater length and grown rather thin before they begin to curl underwards. In the characters of the occipital spines it appears to have agreed more closely with *A. longispina* MITCHELL (ETHERIDGE Junr. and MITCHELL, 1896, p. 715, Pl. LIII, fig. 10, Pl. LIV, figs. 1—5). This latter, however, agrees in most characters both of the cephalon, thorax and pygidium so closely with the species referred to *Dicranurus* that it seems as if it ought to be placed with them.[1] In all these species the portion of the fixed cheeks inside the eye lobes seems, however, to be prominent and the lateral lobes of the glabella to be more distinctly separated from the central lobe than in the cranidium of our species. As long as we are unacquainted with the other parts of the carapace of the latter it seems impossible to decide whether it may be placed with either the *Dicranurus*- or the *Radiaspis*-group.

Horizon and Locality. — Upper Leptæua Limestone; Arfvet.

Acidaspis (Ceratocephala?) laticapitata n. sp. Pl. VI, fig. 4.

Specific Characters. — Cephalon transversely sub-oval in outline, nearly twice as wide as long, strongly bent down in front and at sides, flattened on top. Cranidium with nearly straight anterior margin — only arched forwards a little just in the middle — projecting slightly in front of free cheeks.

Glabella sub-cordate in outline with the anterior margin very slightly arched forwards in the middle, wider than long, its greatest width at

[1] ETHERIDGE and MITCHELL seem inclined to believe that it may be referable to the group *Selenopeltis,* and as pointed out by them the pygidium much resembles that of *A.* (*Selenopeltis*) *Buchi* BARR. *Dicranurus*, however, seems to have a similar pygidium (Cf. RAYMOND 1916, p. 138; HALL, 1859, Pl. LXXIX, fig. 19). The cephalon and the thorax of *A. longispina* differ strongly from those of *A.* (*Selenopeltis*) *Buchi,* and it is evident that the authors as regards the characters of the cephalon have confused *Selenopeltis* and *Dicranurus.* According to them *A.* (*Selenopeltis*) *Buchi* would have occipital spines which curl underwards, but as is well known this is a characteristic of *Dicranurus,* whereas *Selenopeltis* has a spineless occipital ring.

middle of basal lateral lobes, reaching to anterior border furrow, nearly coalescing in the middle at sides with fixed cheeks, gently convex transversally, more strongly convex longitudinally with the anterior half strongly arched downwards, lateral lobes slightly depressed below central lobe. Anterior lateral glabellar lobes obsolete; 2d pair coalescing with central lobe internally, rather small, directed obliquely outwards and forwards, with bluntly rounded antero-lateral ends, extending about one fourth the length of glabella, their anterior extremities placed at a distance from occipital furrow about equal to three thirds the length of glabella; basal pair large, about half the length and fully one quarter the width of glabella, separated from central lobe by shallow grooves, projecting a little behind base of latter, slightly oblique, their antero-lateral ends almost coalescing with the fixed cheeks. Central lobe of glabella elongated subquadrangular in outline, slightly contracted at level of 3d lateral furrows and expanded in front into small lateral projections, which coalesce with the eye ridges. Anterior lateral glabellar furrows obsolete; 2d pair strongly impressed, wide at their antero-lateral extremities, narrowing within, short, directed obliquely inwards and backwards; basal pair somewhat longer than 2d pair and directed more backwards, narrow and rather shallow at their antero-lateral extremities, wider and deeper within, connected with occipital furrow by narrow shallow grooves. Axial furrows rather shallow, strongest at their junction with occipital furrow and in front just behind lateral projections of central lobe of glabella, almost obsolete outside anterior halves of basal glabellar lobes.

Occipital furrow rather shallow and nearly transverse behind central lobe of glabella, much more deeply impressed and curving slightly forwards behind basal lateral lobes. Occipital ring composed of a rather broad (longitudinally) median portion behind the central lobe of glabella, a pair of narrower occipital lobes, and a very narrow depressed posterior band, which narrows to mere points at sides and is rather strongly and evenly arched transversally and gently rounded longitudinally. The median portion seems to have borne two nearly erect and slightly diverging spines, which on internal casts are represented by a pair of broad-based, high, conical tubercles, whose bases are a little separated; between the latter, and situated a little in front of them, is a rather small, rounded median tubercle. Occipital lobes moderately convex, elongate, with their longer axes directed obliquely outwards and forwards and slightly downwards, projecting at sides slightly outside base of glabella and rather obscurely defined from inner portions of fixed cheeks, depressed much below surface of median portion and in front separated from latter by short deep furrows but posteriorly connected with this by narrow necks.

Fixed cheeks narrow, arched outwards, their width outside basal glabellar lobes about half that of latter, narrowing anteriorly, acutely pointed in front, strongly convex longitudinally, sloping rather strongly downwards laterally, swollen except their outermost portions, which in front and behind the eye lobes form narrow, depressed, somewhat concave bands with slightly elevated edges. Eye ridges prominent, of moderate width, nearly straight. Eye lobes (badly preserved) small, elongated, situated far forwards, their middle points a little in front of mid-length of cephalon; each seems to have consisted of a narrow, crescentic palpebral lobe and an elevated, in both directions gently convex eye. Portion of fixed cheek outside eye ridge exceedingly narrow, slightly concave. Posterior border of fixed cheek narrow, rounded, increasing in width and height laterally, directed slightly forwards, marked off by distinct furrow. The facial sutures seem to be in a state of symphysis, but their course is marked by very fine raised ridges, which appear to be formed by the edges of the fixed cheeks; outside (underneath) the ridges there seem to be very fine impressed lines, which probably represent the suture lines; anterior branches strongly converging anteriorly, and only very slightly diverging from eye ridges; posterior branches directed nearly straight backwards from eyes, posteriorly they seem to curve a little inwards to cut the posterior margin of the cephalon just inside the genal spines. Free cheeks (badly preserved) of moderate size, rounded, somewhat parabolic in outline — when seen from above crescentiform — enlarged outwards and overhanging the genal spines, steeply bent down; the inner (upper) half of the surface inside the border gently convex, nearly vertically inclined, posteriorly, apparently, merging into the spine; the outer half slightly concave — most so anteriorly — and somewhat less steeply inclined; border thickened, widest in the middle at sides, narrowing anteriorly and posteriorly, its edge studded with series of small, slender spines. The genal spines are broken off on the specimens, but were apparently broad-based, placed at the inner posterior extremities of the free cheeks just inside the margin, and directed upwards.

Surface of cephalon ornamented with coarse tubercles of different sizes; on the central lobe of the glabella a little in front of its middle are two very large ones placed near each other, and behind these there are on each side a row of large tubercles and along the median line a row of smaller ones; on the anterior portion of the central lobe and on the other parts of the cephalon the tubercles seem to be more irregularly scattered.

Dimensions. — The type specimen (cephalon) measures from back to front along the median line just over 5 mm and its greatest width is 9 mm; another fragmentarily preserved specimen seems to have reached about the same dimensions; a third cephalon measures along the median line 3 mm.

Remarks. — The material on which this new species is founded consists of portions of four individuals from Kallholn in the Upsala Museum.

The specimens are rather badly preserved, but the type specimen is, with the exception of the genal spines, nearly complete.

The second specimen is a smaller cephalon, in which one of the cheeks and the genal spine of the other are broken off. As mentioned above, the facial sutures seem to be in a state of symphysis in this species, the free cheek seems, however, to be broken off along the suture line, but this may perhaps only be a contingency.

The third specimen shows the posterior and middle portions of the hollow inner surface of the cranidium, and in it the two rows of large tubercles (represented by pits on the specimen) on the central glabellar lobe are very distinct.

The fourth specimen, a portion of a minute cheek, is the only one in which the spines on the border are preserved.

Affinities. — In several respects the cephalon of this species resembles the typical members of the group *Ceratocephala* s. str., but the general outline is somewhat different, especially owing to the shape of the outer portion of the cheeks, whose outer margin is arched outwards (and downwards) but not forwards, and the 2d pair of lateral glabellar lobes are more distinctly defined from the basal pair and from the fixed cheeks but coalesce with the central lobe of the glabella. Its affinities seem, however, to be with these species, but until the other parts of its carapace are known it is not possible to decide how close the relationship really is. Possibly it is more closely related to *A. terribilis* REED. As already mentioned above (p. 236), this latter agrees closely with the typical *Ceratocephala* in the chief characters of the cephalon but has quite differently constructed thoracic pleuræ and pygidium, which makes it seem rather doubtful whether it can be placed in the same group (whether we consider this to be of generic or sub-generic rank). The cranidium of *A. terribilis* differs from that of our species in the shape of the 2d pair of lateral glabellar lobes, in having both this and the basal pair distinctly separated from the central lobe of the glabella and from the fixed cheeks, in having the eyes reduced (they appear to be absent or are very small), the eye ridges weak and short, the inner portions of the cheeks wide, and the outer portions narrow and with the margins arched forwards and overhanging in front.

Horizon and Locality. — Upper Leptæna Limestone; Kallholn.

Acidaspis (Ceratocephala?) bispinosa McCoy. Pl. VI, figs. 2—3.

1846. *Acidaspis bispinosus,* McCoy, p. 45, Pl. IV, fig. 7.
1853. *Acidaspis bispinosus,* SALTER, Pl. VI, figs. 4—6, (text) p. 4.
1854. *Trapelocera? breviloba,* ANGELIN, p. 38, Pl. XXII, figs. 16—16 a.

Specific Characters. — Cephalon transverse, its greatest width in front of its middle. Anterior border of cranidium rounded, marked off by distinct narrow furrow; its middle portion very narrow, nearly straight; its side portions growing thicker rather abruptly and curving somewhat upwards and rather strongly backwards.

Glabella sub-ovate in outline, longer than wide, nearly all occupied by the central lobe, which is very strongly convex in both directions, sub-ovate in outline, rather narrowly rounded and slightly overhanging the anterior border in front, truncate at base, its greatest width a little in front of its middle, about one and a third times the basal width, the so-called antero-lateral expansions of the central lobe very small, much depressed below the surface of the central lobe proper and generally separated from this by faint grooves and almost coalescing with the eye ridges and with the ridges formed by the inner portions of the fixed cheeks. Lateral glabellar lobes much depressed below the central lobe, separated from this by distinct, though shallow, smooth furrows, which are continued backwards half-way across the occipital ring; anterior pair minute, rather smaller than the larger of the tubercles which ornament the test of the cephalon, considerably lower than those and more oval in outline, placed just behind the antero-lateral extensions of the central lobe and separated from these by minute smooth pits; 2d pair small, elongated sub-oval in outline, gently convex, separated from 1st pair by deep, rounded pits and from basal pair by more elongated deep pits; 3d pair of about the same shape as 2d pair, about twice as large. Axial furrows weak in the middle, anteriorly rather narrow but growing very wide outside posterior portions of basal glabellar lobes, at whose bases they curve strongly inwards and downwards to end in the deep pits formed by the side portions of the occipital furrow.

Median portion of occipital furrow nearly transverse, narrow and shallow, becoming nearly obsolete at sides before reaching the smooth longitudinal grooves which separate the central lobe of the glabella from the lateral glabellar lobes; its side portions behind basal lateral lobes of glabella deeply impressed, directed slightly forwards. Median portion of occipital ring projecting considerably behind the cheeks, rather narrow (from back to front) convex, bearing two relatively stout, slightly diverging, strongly upturned spines, whose bases are a little separated; on the median line behind the spine bases, and situated a little in front of them, is a rather strong, rounded tubercle; lateral portions of occipital ring narrower than median portion, sloping rather steeply downwards laterally and projecting a little outside base of glabella, elongated sub-oval in outline with the longer axes directed obliquely outwards and forwards, very indistinctly defined from inner swollen portions of cheeks; sometimes the posterior part of the lateral portion of the occipital ring is slightly depressed forming a narrow, rounded band separated from the anterior part, the occipital lobe, by a weak furrow, but generally the two parts seem to be almost confluent, at least internally.

Cheeks large, facial suture apparently in a state of symphysis. Eye lobes situated near the centre of the cheeks, rather large (for the genus), sub-oval, seem to have been prominent (only their bases are preserved on the specimens examined). Eye ridges relatively broad and strongly raised, nearly straight, bounded on both sides by strong furrows. A low, rather broad depressed ridge, the so-called »posterior eye-ridge», running in a slight downward curve backwards from the eye lobe connects this with the base of the genal spine; it is generally rather distinctly defined on the inside, but very obscurely defined on the outside anteriorly, becoming more elevated and better defined as it approaches the genal spine. From the posterior end of the eye, starting a little inside the ridge, a faint furrow follows a backward and inward curve to its junction with the posterior border furrow. The inner portion of the cheek, bounded on the outside anteriorly by the eye ridge and posteriorly by this furrow, is convex, sub-crescentiform, acutely pointed in front. Behind the eye and between the furrow just mentioned and the »posterior eye-ridge» is a small triangular area with slightly depressed surface, which slopes rather steeply downwards laterally. Outer portion of cheek broadly crescentiform in outline, descending abruptly to border, enlarged outwards and overhanging the base of the genal spine. Lateral border of cheek rather broad, elevated, rounded, armed with a series of small marginal spines, which are directed obliquely downwards and — with the exception of the hindermost ones — forwards. Lateral border furrow broad and shallow, growing narrower anteriorly, separated from posterior border furrow by »posterior eye ridge». Posterior border of cheek very narrow near occipital ring, growing rapidly wider laterally, gently rounded, almost horizontally extended to a little inside genal spine, then bending abruptly downwards, defined by sharp, narrow furrow, which grows shallower as it approaches the »posterior eye ridge»; its posterior margin directed somewhat backwards. Genal spines (not completely preserved) not very stout, rapidly tapering, slightly diverging, directed obliquely upwards. Anterior branches of facial sutures represented by narrow impressed lines running close to the furrows which bound the eye ridges on the outside. Of the posterior branches no traces are distinguishable but it seems probable that they originally cut the posterior borders of the cheeks at the angulations between their inner horizontal and their outer declined portions (Cf. above).

Surface of cephalon ornamented by closely set, small granules and irregularly distributed, rather coarse tubercles varying in size and prominence. The largest tubercles occur on the glabella and on the inner, swollen portions of the cheeks, the very largest ones are found on the latter; rather large ones occur also on the eye ridges, and smaller ones on the inclined portions of the cheeks and on the lateral borders. On the occipital ring and on the posterior borders of the cheeks there are no tubercles (with the exception of the large median occipital tubercle) only granules.

Dimensions. — In McCoy's type specimen the length of the cephalon along the median line seems to have been a little over 7 mm and in the specimen figured by SALTER about 6 mm. In the largest specimens from Kildare, which I have examined — which are pressed and incompletely preserved — the corresponding length seems to have been between 8 and 9 mm. In the cephalon from the Leptæna Limestone figured by ANGELIN as *Trapelocera? breviloba* the length along the median line is not quite 5 mm.

Remarks. This species was founded by McCoy (1846, p. 45, Pl. IV, fig. 7) on a fragment of the cephalon[1], showing really only the larger part of one of the cheeks and the bases of the occipital spines. To judge from the upper figure given by him in natural size the specimen was apparently much pressed and is moreover on this figure, which otherwise seems to be correct, not represented in dorsal aspect, but seen obliquely from the side. On account of this the lower, enlarged figure — which apparently is meant to show the original shape of the cephalon (in an unpressed condition) and in which the missing portions are partly restored in outline — is rather misleading; McCoy himself has remarked (in the explanation of the plate) that it represents the cephalon rather too short in relation to the width.

SALTER's (1853, Pl. VI, figs. 4—6, text p. 4) description and especially his figures of the cephalon of this species are also somewhat misleading as to its true characters. This is evidently partly due to the fact that his type specimen — which I have had the opportunity of briefly examining in the Museum of Practical Geology in London — is badly preserved and pressed. His figures 4 and 4*, which — especially the latter — are rather schematical, are, however, in some respects really incorrect. The eye lobes for instance are placed to much inwards and the outer portions of the cheeks are too wide and too much enlarged forwards. In the specimen the latter are very steeply bent down and appear as narrow stripes when the specimen is seen in dorsal aspect, and they do not protrude in front of the glabella. Moreover his description seems scarcely full enough for all purposes.

The above description, based on several cephala, collected by the writer and now in the Upsala Museum, from the typical locality, the Chair of Kildare in Ireland, may therefore be advantageous. The specimens are in a more or less fragmentary condition and more or less pressed, so that it has been impossible to decide quite definitely the relation between the length and the width of the cephalon, but the length along the median line seems to have been somewhat more than half the greatest width. In the better preserved specimens it is seen distinctly that the glabella is

[1] As seen from the text (Op. cit. p. 45) McCoy's original diagnosis of the species was drawn up from this specimen. The other entire specimens, which he described lower down on the same page belong apparently to *A. Jamesi* SALT. (Cf. SALTER, 1853, text to Pl. VI, p. 5).

truncated behind, but in some of the more strongly pressed examples it appears rounded, though not so strongly or so evenly rounded as in SALTER's figures, which as already mentioned are rather schematical.

ANGELIN's species *Trapelocera? breviloba*, founded on a fragmentary cephalon from the Leptæna Limestone of Osmundsberg, is undoubtedly identical with *Acidaspis bispinosa* McCoy, and since the latter name is older ANGELIN's specific term, which dates from 1854, must evidently be dropped. ANGELIN's description is, as usual, very brief and his figures are bad, but his type specimen (figured below, Pl. VI, figs. 2—3), which is in the State Museum of Natural History at Stockholm, agrees with the above diagnosis of *A. bispinosa* in all particulars as far as it is preserved. It is the only specimen of this species known from the Leptæna Limestone.

Affinities. — CLARKE (1892, p. 93) placed this species in the group *Ceratocephala* in its most restricted sense and R. and E. RICHTER (1917) seem also to include it in their sub-genus of the same name, which corresponds to this group. It resembles the typical members of the group in having the fixed and free cheeks anchylosed and the eyes placed far forwards and far from the glabella, in the development of a strong ridge, which connects the eye lobes with the base of the genal spine, in having two straight occipital spines, and to some extent in the general outline of the cephalon, although its greatest width seems to lie farther back. It differs from these species very strongly in the characters of the glabella with its large swollen central lobe and minute, depressed lateral lobes, and it appears rather doubtful whether it really ought to be referred to the same group. The cephalon (which is the only portion known as yet) does not, however, show any greater resemblance to any other described species.

Horizons and Localities. — Upper Leptæna Limestone; Osmundsberg (Dalarne). Kildare Limestone; Chair of Kildare Ireland.

Acidaspis sp. ind. a. Pl. VI, fig. 8.

Remarks. — A small fragmentary pygidium, only about 1,5 mm long, from Amtjärn in ISBERG's collection in Lund shows some peculiar features and seems to represent a new species of *Acidaspis*. Both the internal cast and the impression are preserved, though neither is complete.

It is semicircular in outline, about twice as wide as long (excluding spines), and provided with at least 5 pairs of rather stout marginal spines. The axis is broad, its anterior width being about half that of the entire pygidium, rather slightly tapering posteriorly to the broadly rounded extremity, which does not quite reach the posterior margin; it seems to be composed of 3 axial rings and a very short terminal piece; the 1st axial ring is very prominent, rounded longitudinally and strongly arched transversally; the rest of the axis is depressed convex and the posterior axial rings are very obscurely indicated. The side lobes are flattened except anteriorly, where the surface on each side is raised into a large, prominent, sub-conical, somewhat oblique boss, which supports a nearly erect, slender spine (only the impression preserved). The bosses, which seem to correspond to the raised ridges found on the pygidial side lobes in other species of *Acidaspis*, are somewhat oblique and reach from the axial furrows to the margin of the pygidium and are immediately continued by a pair of marginal spines, which seem to be somewhat stouter than the rest. It has not been possible to decide whether these spines are the 2d or the 3d pair. There are 3 pairs behind them and at least one pair (not drawn on the figure, Pl. VI, fig. 8) in front of them, but the front edges of the side lobes are badly preserved and it seems as if there might have been one anterior pair of smaller spines or small pointed lateral projections. Of the distinctly observed spines the anterior ones are directed obliquely outwards and backwards at an angle of about 46° to the median line of the pygidium, the following ones successively more and more strongly backwards. The surface is badly preserved but it seems as if each of the axial rings was ornamented with a single row of relatively large tubercles; those on the 2d ring are most distinct on the specimen.

Horizon and Locality. — Lower Leptæna Limestone; Amtjärn.

Acidaspis? sp. ind. b. Pl. VI, fig. 7.

Remarks. — There is a somewhat defective hypostoma — measuring about 3 mm in length — from Kallholn in ISBERG's collection in Lund, whose true generic position in uncertain. In most of its chief characters — especially in the lobation of the central body — it shows, however, a certain likeness to several of the different described Acidaspid hypostomata. It seems therefore probable that it belongs to a species of this genus, possibly to *A. evoluta*.

The hypostoma is about three fourths as long as wide in front, slightly narrowing posteriorly, with nearly straight lateral margins, rounded postero-lateral angles and sub-truncate posterior end; the anterior end is not perfectly preserved, but the front margin seems to have been straight. The central body is somewhat wider than it is long, strongly convex, except the antero-lateral ends of the posterior lobe, which are much depressed; its greatest width lies across these at about one third the length of the body from the anterior end; the front end is moderately arched forwards and seems to have reached the anterior margin of the hypostoma; the posterior end is more bluntly rounded; the middle furrows are rather long, oblique, and forming deep pits or grooves inside the depressed antero-lateral ends of the posterior lobe, then gradually growing narrower and shallower proximally and dying out before meeting in the middle. The anterior wings are very short, triangular and rather strongly inclined. The border, which embraces the sides — behind the anterior wings — and the posterior end is slightly rounded, rather narrow and marked off by a continuous furrow, which is rather weakly marked in front outside the depressed anterior ends of the posterior lobe of the body, then suddenly becoming wide and deep, but growing shallow again in the middle behind the body.

Horizon and Locality. — Upper Leptæna Limestone; Kallholn.

Family **Lichadidae** CORDA.

According to the interpretation given by REED (1902, p. 64) of the structure of the Lichad cranidium, the large anterior pair of lateral glabellar lobes, which by earlier writers (BEYRICH, BARRANDE etc.) were regarded as homologous to the 1st pair in other trilobites, are of composite nature and consist of the fused 1st and 2d pair; the previously so-called 2d lateral glabellar furrows and lobes are homologous to the 3d furrows and lobes respectivly in other less modified genera; and the small lobes at the base of the glabella found in most species of the family belong to the occipital segment and are genetically of the nature of occipital lobes. REED (Op. cit.) has pointed out several features which argue very convincingly in favour of this hypothesis — the disproportionable size of the so-called 1st lateral glabellar lobe, the occasional presence of a more or less distinct furrow across this lobe or a notch at its inner side in various non-allied species etc. REED's hypothesis seems to have been accepted by most later writers on the subject, and in this paper the nomenclature of the parts of the cranidium is based on it.

In the sub-division of the Lichadidae most modern writers have, in the main, followed the works of GÜRICH (1901) and REED (1902), several of them, however, giving their sub-generic or sectional groups generic rank. As pointed out by REED (Op. cit., p. 81) some of these groups are not so isolated as others, and all are not perhaps of equal value. Still they appear in the main to be as well defined — even if, as seems only natural, in some cases transitional forms can be recognized — as several other groups of trilobites[1], which generally have been regarded of generic value, and it appears to me justifiable, and on the whole the most practical thing to do, to rank, at least most of them, as genera. It must be

[1] Knowing only the carapace of these forms, as we do, it is of course impossible to know how far the differences found in this really indicate, or rather are accompanied by, important differences in the soft portions of the body, and how far the terms genus and species, as used with regards to these fossil forms, correspond to the conception of these terms when living forms are under consideration.

remembered, however, that the term *Metopolichas* cannot — as has been done by some American authors — be used as the generic designation for the group for which it was introduced by GÜRICH (as a substitute for the preoccupied name *Metopias* EICHW., used in the same sense by SCHMIDT in 1885), since this includes the genotype of *Lichas, L. laciniatus* WHLBG. Only if it should prove necessary to refer the type of *Metopolichas, Lichas (Metopias) Hübneri* EICHW. (EICHWALD 1842, p. 62, Pl. III, figs. 21—22. SCHMIDT 1885, p. 65, Pl. I, figs. 13—14; 1907, p. 37, Pl. II, figs. 6—7) to a distinct genus can the term be kept, but this seems hardly probable, since, as far as can be judged from the descriptions and figures available, it appears to agree closely with *L. laciniatus* both in the characters of the cephalon and of the pygidium.

In the Leptaena Limestone the following genera (or groups) are represented: *Trochurus* BEYR. (*Cordyocephalus* CORD., *Plusiarges* GÜRICH), *Dicranogmus* CORD. (*Liparges* GÜRICH), *Platylichas* GÜRICH, *Dicranopeltis* CORD. (*Trachylichas* GÜRICH), *Lichas* DALM. s. str (*Metopolichas* GÜRICH) and *Amphilichas* RAYM. (*Platymetopus* ANG., *Paralichas* REED, *Acrolichas* FOERSTE).

Owing to the uncertainty attaching to CORDA's species GÜRICH (Op. cit. 1901) would substitute the names *Plusiarges* for *Cordyocephalus, Liparges* for *Dicranogmus* and *Trachylichas* for *Dicranopeltis.* It is, however, quite clear which species CORDA regarded as the types of these genera, although he described two of them under other specific names than those earlier given to them. CORDA's names have also been revived by REED (1902) and used by other writers too.

Cordyocephalus is however, as pointed out by FOERSTE (1917 p. 254) antedated by *Trochurus* BEYR. This name was originally applied by BEYRICH in 1845 (p. 31) to a composite and artificial species consisting of the cranidium of a *Staurocephalus* (*St. Murchisoni* BARR. 1846) and the pygidium of a Lichad. Of this heterodox species, which was called *Tr. speciosus,* he figured only the pygidium, however, and the name *Trochurus* (wheel) alludes to the general appearance of this, which therefore evidently must be regarded as the type. Moreover, his attention having been called to his error privately by BARRANDE, BEYRICH in 1846 (pp. 8, 10, Pl. I, fig. 1) definitely designated the pygidium as the type of his species and described and figured the proper cranidium for this. It is true that BEYRICH in this paper of 1846 referred the species to the genus *Arges* GOLDF. (1839) and declared that his genus *Trochurus* did not exist, but this does not seem to be reason enough for dropping the name, since firstly GOLDFUSS's name, being preoccupied, cannot be used anyhow, and secondly his type species and the species in question belong to different genera (or groups). *Cordycephalus* was not defined by CORDA until 1847 (p. 139, Pl. VII, fig. 4) and founded on the same species, which, however, was given a new specific name (*C. flabellatus*). BAR-

RANDE described the same species in 1846 (p. 54) as *Lichas palmata* owing to BEYRICH's error in his original description of *Trochurus speciosus*.

The generic term *Acrolichas* was proposed by FOERSTE in 1919 (p. 72) for the American species, which had been referred to *Amphilichas*. In a later paper (1920) he refers to this genus also an Irish species, viz. PORTLOCK's *Lichas hibernicus*. In the structure of the cranidia these species are practically identical with the typical species of *Amhilichas*, but the pygidia are quite dissimilar to those, which SCHMIDT (1885, p. 52, Pl. VI, fig. 10; 1907, p. 26, Pl. II, fig. 14, text-figs. 3, 12; 1885 p. 55, Pl. VI, figs. 16—17) attributed to the type species of this genus, *Amph. lineatus* ANG. and to *Amph. Holmi* SCHMIDT. It seems, however, very probable that SCHMIDT was misstaken in associating the pygidia with the cranidia of these species and that the East Baltic and Swedish forms referred to *Amphilichus* have pygidia of the same type as those of the species which FOERSTE refers to *Acrolichas*. A good many cranidia of *Amph. lineatus* as well as a very great number of other *Amphilichas* cranidia have been found in the Leptæna Limestone in Dalarne and also several pygidia of the »*Acrolichas*» type, but not a single pygidium resembling those, which SCHMIDT attributed to *Amph. lineatus* and *Amph. Holmi*. In the East Baltic Area *Amphilichas* — although represented by several species — seems to occur much more sparingly. Of the pygidia which SCHMIDT attributed to the former species only two have been found at the same stratigraphical horizon and at the same localities as the cranidia (one is from a lower horizon than the cranidia and another had been found in a boulder). Only two cranidia of *Amph. Holmi* were known to SCHMIDT, and the two pygidia which he referred to this species had been found at the same locality as one of the former. The two portions of the body seem never, in either case, to have been found in such a position as to indicate that they originally belonged to the same individual. SCHMIDT associated them by reason of the similarity in the style of ornamentation. This, however, does not seem to be proof enough, since several species of Lichadidæ belonging to different groups or genera show great resemblance in the ornamentation of the test.

The pygidia recall in their general characters those of several species of *Homolichas* SCHMIDT. It seems rather probable to me that the pygidia attributed to *Amph. lineatus* are referable to *Hom. angustus* BEYR. (SCHMIDT, 1885, p. 108, Pl. IV, figs. 18—23), which species has been found at the same localities as two of these pygidia. The incomplete pygidium referred to this species by ROEMER (1861, p. 76, Pl. VIII, fig. 8 b; cf. SCHMIDT, 1885, p. 108) seems, to judge from the figure as far as it is preserved, to agree rather closely with them.[1] The tubercles on

[1] Cf. SCHMIDT's figures in his paper of 1907 (Pl. II, fig. 14, text-figs 3, 12). The figure given by him in 1885 (Pl. VI, fig. 10), which has generally been reproduced as the typical *Amphilichas* pygidium, is a reconstruction and according to SCHMIDT (1907, p. 26) himself not correct.

the cranidium of *Hom. angustus* appear partly to be coarser, but otherwise to be rather similar to those which occur on the smaller cranidia of *Amph. lineatus* (on the larger cranidia of this species the tubercles seem to have vanished) and, since, as stated by ROEMER (Op. cit. p. 77), the pygidium of the former species is not so coarsely tuberculated as the cranidium, it seems very likely that it agrees in the style of ornamentation with SCHMIDT's specimens.

The only pygidium known from the East Baltic Area, which seems referable to a species of *Amphilichas*, is the one which SCHMIDT (1885, p. 122, Pl. V, fig. 26) wrongly attributed to *Lichas* (*Platylichas*) *cicatricosus* LOVÉN (LOVÉN, 1845, p. 56, Pl. I, fig. 8).[1] On the strength of the similarity of the ornamentation SCHMIDT (Op. cit. pp. 122, Pl. V, fig. 25) associated with this pygidium two small cranidia, which, however, do not appear to belong to the same species as this, but to a species of *Platylichas* (Cf. below p. 288). They came from the same horizon but not from the same locality as the pygidium and do not at all correspond to it in size. — This, as it seems, composite species, *Lichas cicatricosus* SCHMIDT non LOVÉN, REED (1902, pp. 73, 82) used as the type of his sub-section *Metalichas*, to which he originally referred in addition to the type, *Lichas* (*Amphilichas*) *hibernicus* PORTL. (pygidium non cranidium), *L.* (*Dicranogmus*) *æqualis* TÖRNQ., and with a mark of interrogation *L. St. Matthiæ* SCHMIDT. He has later (1914, p. 30) recognized that the cranidia, which had been attributed to *Amph. hibernicus* by PORTLOCK and others really belong together with the pygidium and thorax forming the original type of PORTLOCK's species, and has referred this to *Amphilichas*. TÖRNQUIST's species *Lichas æqualis* seems, as far as can be judged without knowing the pygidium, to belong to *Dicranogmus* (Cf. below p. 260). It appears thus as if the genetic group *Metalichas* did not exist.

Genus **Trochurus** BEYRICH.

Trochurus Törnquisti GÜRICH. Pl. VII, figs. 1—2.

1884. *Lichas palmatus,* TÖRNQUIST, p. 30, Pl. I, figs. 26—27.
1901. *Lichas* (*Plusiarges*) *Törnquisti,* GÜRICH, p. 526.

Specific Characters. — Cranidium, when viewed from above, sub-semielliptical in outline, very convex, strongly protuberant in front. Axial furrows deep and strong anteriorly, becoming shallower outside basal lateral glabellar lobes, then growing somewhat deeper again outside occipital ring, very strongly and rather evenly arched upwards, describing in the horizontal plane a gently convex curve from antero-lateral extre-

[1] That it does not belong to this species has already been pointed out by REED (1902, p. 73). It differs from LOVÉN's form in several important characters (Cf. below p. 280, text-fig. 19).

mities of central glabellar lobe to basal lateral glabellar furrows, then another gently convex curve around extremities of basal lateral lobes and a third very slight curve around extremities of occipital lobes. Preglabellar furrow narrow, distinctly impressed, rather gently and evenly arched forwards. Anterior border of cranidium very narrow in the middle, gently increasing in width towards the sides, flattened. Glabella very gibbous, overhanging anterior margin of cranidium, Anterior lateral glabellar furrows deep, rather narrow, curving from anterior margin of glabella upwards and backwards, and just at first rather strongly inwards, then becoming sub-parallel to opposite outer extremities of third pair of lateral furrows, and then converging slightly posteriorly to the inner extremities of these furrows; beyond these points the joint furrows are continued a short way inwards and backwards as rather broad, shallow, smooth grooves, which may be connected across central lobe of glabella by a very narrow and weak impression, which marks off the short, depressed posterior portion of this lobe from the gibbous main portion. 2d pair of lateral glabellar furrows obsolete. Basal pair of lateral furrows as strong as anterior pair, curving from axial furrows inwards and slightly backwards and upwards, meeting anterior pair at rather acute angles. Central lobe of glabella widest at anterior margin, where its width is about five eighths that of the entire glabella at its middle, rapidly narrowing to about four fifths its anterior width, then becoming nearly parallel-sided for the greatest part of its length, but tapering slightly again posteriorly, where it forms the median third of the glabella at the junction of the anterior with the basal lateral glabellar furrows; its main portion very strongly convex, protuberant beyond frontal margin of cranidium and raised highly above lateral lobes; the posterior portion, between basal lateral lobes depressed, very gently convex in both directions. Bi-composite lobes large, rather strongly convex, when viewed in dorsal aspect sub-triangular in outline, when from the side or in an oblique position — so that the entire lobe is visible — sub-ovate or pear-shaped, acutely angular behind, the longer axes slightly oblique to the median line of the glabella; their surfaces generally slightly depressed between the more highly raised central and basal lateral lobes. Basal lateral lobes considerably smaller then bi-composite lobes, more strongly convex, narrowly sub-elliptical or sub-ovate in outline, with the longer axes nearly at right angles to median line of glabella.

Occipital furrow rather narrow, distinctly impressed, deeper at sides, than in middle where it is gently arched forwards, dividing at sides, one division passing in front of the other behind the occipital lobes. Occipital lobes of moderate size, sub-triangular to sub-ovate in outline with the longer axes directed slightly backwards, the surface rather strongly raised but flattened on top and sloping rather strongly downwards laterally and posteriorly. Main portion of occipital ring rather wide in the middle, growing very narrow laterally behind occipital lobes, strongly arched transversally. Fixed cheeks (incompletely preserved) with very narrow anterior portions and wider, convex, rather strongly inclined posterior portions. The palpebral lobes (not preserved) were apparently placed close to the glabella opposite the lateral extremities of the basal lateral glabellar furrows and seem to have been small. Posterior border of fixed cheeks narrow, increasing slightly in width laterally, marked off by wide, but not very deep furrows. Anterior branches of facial sutures sub-parallel or very slightly converging anteriorly; posterior branches curving from the eyes outwards and backwards.

Surface of test, except in furrows and grooves, thickly covered with tubercles of different sizes; on nearly all parts rather large, but no very large, ones occur, the largest on the depressed posterior portion of the central glabellar lobe.

Dimensions. — In the type specimen the distance between the anterior and posterior margins of the glabella is just over 7 mm. and the greatest width of the glabella is 8,5 mm. In the other specimens observed the distance between the anterior and the posterior margins is from a little over 2 mm. to 6 mm. and the greatest width of the glabella from 2,5 mm. to approximately 7,2 mm.

Remarks. — TÖRNQUIST (1884, p. 30, Pl. I, figs. 26—27) has previously figured and briefly described the cranidium of this species as *Lichas palmatus* BARR. The specific name *Törnquisti* was later on proposed by GÜRICH (1901, p. 526), who pointed out that the form from the Leptæna Limestone, although evidently closely related to the Bohemian form, could quite well be distinguished from this.

In addition to the cranidia from Boda (now in the Lund Museum), which TÖRNQUIST had at disposal, there are now available two cranidia from Kallholn, one in the Upsala Museum the other in ISBERG's collection in Lund and two others from Osmundsberg in the latter collection. The specimens examined are of rather different sizes, and to judge from them the convexity of the glabellar lobes does not seem to alter with age in the same way and to the same degree as it does according to BARRANDE (1852, p. 600) in *Tr. speciosus* BEYR. (*Lichas palmata* BARR.). The only difference in this respect between smaller and larger specimens is that in the former the hindmost portion of the central glabellar lobe is more depressed and the portion just in front more distinctly raised.

This species is evidently represented in the Kildare Limestone at Kildare in Ireland too. In the collection of the Geological Survey of Ireland in Dublin the writer has had the opportunity to examine some cranidia from this locality, which agree very closely in character with those from the Leptæna Limestone. Their bi-composite lateral glabellar lobes seemed to be somewhat more triangular in outline than those of the Swedish specimens, but that they are referable to the same species seems to be beyond doubt.[1]

[1] The specimens were labelled *Lichas laxatus* M'COY and pasted on the same piece of cardboard as some cranidia and pygidia of this species.

Affinities. — This species seems to be very closely related to *Tr. speciosus* BEYR. (*Lichas palmata* BARR.), (BARRANDE, 1852. p. 599, Pl. XXVIII, figs. 1—13), but, as GÜRICH has pointed out (Cf. above) not to be identical. To judge from the specimens hitherto known it reaches much smaller dimensions than BEYRICH's species. In the latter the convexity of the glabellar lobes varies much, so that in this respect the full grown individuals and the young ones show great differences. In our species on the other hand this does not seem to be the case — the relatively slight variation in this respect in the posterior portion of the central glabellar lobe, mentioned above, need not be taken into consideration here, since it is chiefly the convexity of the anterior and middle portions of this lobe and of the bi-composite lobes, which varies so much in *Tr. speciosus* — and on the whole it seems to bear a considerably greater likeness to the former than to the latter, but it differs from all in some respects. To judge from BARRANDE's figures and description and from a specimen in the Upsala Museum[1], the main portion of the central glabellar lobe of the Bohemian species is in the larger specimens somewhat more gently rounded, in the smaller ones as strongly — or even more strongly — but not so evenly convex as in our species, the hindmost portion of this lobe is more depressed and more distinctly marked off from the main portion — also in larger specimens —, the bicomposite lateral glabellar lobes are less swollen — this is especially the case in the smaller specimens — and as a consequence of this the anterior half of the glabella is more triangular in outline, and further, the fixed cheeks are not so steeply bent down.

Horizons and Localities. — Upper Leptæna Limestone; Boda, Kallholn, Osmundsberg. Kildare Limestone; Chair of Kildare (Ireland).

Genus **Dicranogmus** CORDA.

Dicranogmus æqualis TÖRNQUIST. Pl. VII, figs. 3—4.

1884. *Lichas æqualis,* TÖRNQUIST, p. 32, Pl. I, figs. 29—30.
1901. *Lichas (Enarges) æqualis,* GÜRICH, p. 527.

Specific Characters. — Glabella well defined in front and anterolaterally, posteriorly confluent with the fixed cheeks, wider than long, the length along the median line being about four fifths the width between lateral extremities of basal lateral furrows, gently narrowing anteriorly, truncate in front, moderately convex, slightly overhanging in front; its anterior margin slightly arched upwards in middle. Anterior pair of lateral glabellar furrows very narrow and shallow for a little less than half their

[1] This specimen, which is of medium size, shows, as a matter of fact, the points of difference more strongly than any of the figures given by BARRANDE.

length from front margin of glabella to basal lateral furrows, thence distinctly impressed and slightly increasing in strength to basal lateral furrows and continued backwards by very shallow grooves to occipital furrow, at first (counting from their origin in preglabellar furrow) slightly converging posteriorly for a short distance, then curving gently but distinctly outwards to about half-way from anterior margin of glabella to basal lateral furrows, then making a slight bend and continuing backwards diverging almost imperceptibly posteriorly; 2d pair of lateral glabellar furrows obsolete; basal pair of moderate strength throughout, curving from axial furrows slightly upwards and backwards to meet anterior pair at angles of about 70°; from the point of junction of the furrows on each side a weak groove curves obliquely inwards and backwards, but dies out before meeting its fellow or the occipital furrow. Central lobe of glabella about twice as long as wide at base, where it is widest, narrowest a little behind, or more correctly speaking above, the front margin, slightly narrower at front margin than in middle, its anterior portion between weak anterior parts of 1st lateral furrows without independent convexity, its posterior portion growing gradually more distinctly raised above the lateral lobes to about the level of basal lateral furrows, behind this decreasing in height posteriorly; postero-lateral parts of central lobe slightly depressed and anteriorly separated from main portion by weak grooves, which makes the lobe appear to grow narrower posteriorly. Bi-composite lobes nearly twice as long as wide, sub-ovate in outline, narrowing anteriorly, rather acutely angular behind, their greatest width about equal to that of central lobe across its middle; the surface gently rounded. Basal lateral glabellar lobes short, their length, measured along the inside, being about equal to half the middle width of central lobe, the surface very slightly raised and confluent with surface of fixed cheeks.

Anterior border of cranidium narrow, of about uniform width, gently arched upwards in middle and sloping down at sides, nearly transverse in front of central glabellar lobe, bending backwards at sides, marked off by rather strong furrow. Occipital furrow rather deep and broad, and straight in its central portion, dividing laterally, the divisions narrower and shallower than the central portion. Occipital ring of moderate width, strongly arched transversally, slightly rounded longitudinally, with minute median tubercle placed somewhat nearer posterior than anterior margin; occipital lobes present, of moderate size, sub-ovate in outline, with the longer axes directed outwards and slightly backwards, protruding a little in front of central portion of occipital ring; their surfaces very gently rounded, sloping downwards laterally and posteriorly. Fixed cheeks (imperfectly preserved) convex, narrow in front, apparently becoming much broader posteriorly, confluent with basal lateral glabellar lobes.

Surface of test of cranidium, except in the furrows, closely set with tubercles of different sizes; where the ornamentation is distinctly discernible (on the specimens available) none of the tubercles are large, but it appears as if there might have been a large one on each side at the base of the central glabellar lobe.

Remarks. — The above description is drawn up from the original specimens already described by TÖRNQUIST (1884, p. 32), viz. two cranidia in the Museum of the Geological Survey from Lissberg in the village of Gulleråsen, these being the only representatives of the species known as yet. In both the specimens the fixed cheeks are incompletely preserved, but otherwise the type specimen (also figured below Pl. VII, figs. 3—4) is very well preserved, except that it, being an internal cast, does not show the ornamentation very clearly. On the other specimen — which in other respects too is tolerably good — the test is partly preserved. [In the one of TÖRNQUIST's figures (Op. cit., Pl. I, fig. 29), where the cranidium is seen in dorsal aspect the tubercles are evidently drawn from the latter specimen].

Affinities. — SCHMIDT (1885, p. 32) referred this species to his supplementary group (which in the main corresponds to *Platylichas*), GÜRICH (1901, p. 527) referred it to *Euarges* and REED (1902, pp. 75, 82) to *Metalichas* (Cf. above p. 257). It differs, however, in several important characters from the typical members of all these genera or groups, and as TÖRNQUIST (Op. cit. p. 32) has already pointed out its affinities seem to be with BARRANDE's species *Lichas simplex* (= *Dicranogmus pustulatus* CORD.; BARRANDE 1852, p. 608, Pl. XXVIII, figs. 14—15) which is the genotype of *Dicranogmus* (also the type of *Liparges* GÜRICH). One of the characteristics of BARRANDE's species is that the anterior portions of the anterior lateral glabellar furrows are obsolete and the central lobe of the glabella is consequently confluent with the bi-composite lateral lobes anteriorly. It is true that in our species the furrows are discernible all the way to the front margin of the glabella, but anteriorly they are very narrow and the glabellar lobes without independent convexity. — In the Bohemian species the hindmost portions of the anterior lateral glabellar furrows seem, as TÖRNQUIST has already pointed out, to be considerably stronger than in ours, the glabella is more gibbous, and the larger of the tubercles, which cover the surface, appear to be comparatively greater.

Horizon and Locality. — Upper Leptæna Limestone; Lissberg in Gulleråsen.

Genus **Platylichas** GÜRICH.

Distinguishing Characters of the Species.

Anterior border of cranidium produced in front into a marginal extension. 1.

Anterior border of cranidium not produced in front. 2.

1. Marginal extension more than two thirds as long as the glabella, rounded in front. *Pl. planifrons* ANG.

Marginal extension less than one third as long as the glabella, sub-triangular. *Pl. nasutus* WIG.

[Marginal extension not preserved. *Pl. Wegelini* HOLM in Mus.]

2. Cranidium gently or flattened convex. 3.

Cranidium strongly convex, or at least steeply bent down in front. 4.

3. Glabella rather narrowly rounded in front. Basal lateral glabellar furrows well developed. *Pl. robustus* n. sp.

Glabella broadly rounded in front. Basal lateral glabellar furrows obsolete. *Pl. bottniensis* WMN?

4. Anterior portion of cranidium semi-elliptical in outline. Central lobe of glabella raised above bi-composite lobes. *Pl. latus* TQT.

Anterior portion of cranidium sub-triangular in outline. Bi-composite lateral glabellar lobes more highly raised than central lobe of glabella. *Pl. angulatus* n. sp.

[Pygidium only known. *Pl. cicatricosus* LOVÉN.]

Platylichas planifrons ANGELIN. Pl. VI figs. 11, 12, 14—23; Pl. VII, fig. 6?, 9.

1854. *Platymetopus planifrons* ANGELIN, p. 73 (pars), Pl. XXXVIII, fig. 3 (non figs. 3 a—3 b).
1884. *Lichas planifrons* TÖRNQUIST, p. 35, Pl. I, fig. 34.

Specific Characters. — Cranidium sub-triangular in outline with the anterior border produced into a long, broad, slightly upturned marginal extension. The latter about three fourths as long as the glabella, with rounded anterior and lateral margins, in some specimens forming a little more than two thirds of a circle, in others — the relation between its length and its width being rather different in different specimens — part of an ellipse with the longer axis along the median line of cephalon; its surface flattened, except the postero-lateral portions, which slope gently downwards, and in the middle in front where it is generally raised into a small, low, indistinctly defined knob; along the outer margin the test is recurved forming a narrow doublure widest in the middle in front, gradually narrowing laterally and posteriorly, its surface gently rounded and tuberculated like the upper surface and not sharply marked off from this — the outer edge of the extension being rounded. Side portions of anterior border growing rapidly very narrow from base of extension, with gently rounded dorsal surface and steeply inclined, longitudinally striated, not tuberculated, outer edge.

Glabella well defined in front and anteriorly at sides, posteriorly confluent with fixed cheeks, wider than long, the length along the median line being about seven ninths the (greatest) width between antero-lateral extremities of bi-composite lobes, narrowing anteriorly, its anterior portion being broadly sub-triangular in outline, flattened on top, slightly bent down in the middle in front, anteriorly sloping rather steeply downwards laterally, posteriorly very gently. Central lobe of glabella clavate, expanded rather suddenly transversally in front to rather more than twice its basal width; antero-lateral expansions overhanging nearly the entire bi-composite lobes, very narrow (longitudinally), the relative width somewhat varying, however, in different specimens; anterior outline arched rather strongly forwards, though not forming a regular curve, but being nearly straight or slightly arched backwards in the middle of each side; neck of central lobe gradually narrowing posteriorly to a little in front of its middle, its width at this place being about half its anterior width, then decreasing slightly in width for a short distance, then suddenly expanding at base again to about its anterior width; in a few specimens this wider posterior portion has a slight independent convexity. Bi-composite lateral lobes with slight independent convexity, large, about four sevenths as wide as long, their longer axes directed obliquely outwards and forwards, pointed in front, their antero- and postero-lateral sides straight, insides rounded. Basal lateral lobes very short within, decreasing rapidly in length towards the sides and coalescing with fixed cheeks. Anterior lateral furrows distinctly impressed throughout, not very wide, generally widening outside base of central lobe, curving from their points of origin in axial furrows at first upwards and inwards and very slightly backwards a little more than half way to median line of glabella, then making a rather sudden, but not sharp, bend and continuing in a more backward direction for about an equal length, then curving, at first slightly, but soon strongly, outwards to their junction with basal lateral furrows, and finally nearly straight backwards to occipital furrow. In several specimens — somewhat better pronounced in casts than in testiferous ones — there is on each side an extremely slight notch in the outer wall of the anterior furrows a little behind the points where they bend backwards; these notches probably represent the inner ends of the 2nd pair of lateral glabellar furrows. Basal lateral furrows rather narrow, not deeply, but very distinctly impressed, growing shallower just before meeting anterior pair, nearly straight (in the horizontal plane) and directed at 45° à 50° to the median line of glabella.

Preglabellar furrow (anterior border furrow) narrow and not deeply, but very distinctly impressed in the middle, growing wider and deeper towards the sides, arched rather strongly forwards and upwards, but not in a regular continuous curve, its side portions being nearly straight in the middle, or very slightly arched backwards and near the extremities, bending more strongly backwards than within and generally slightly upwards to pass into the axial furrows. Anterior portions of axial furrows deep and strong, running obliquely backwards and upwards and slightly outwards along antero-lateral sides of bi-composite lateral glabellar lobes, then bending obliquely inwards at an angle of about 110° and following the postero-lateral edges of these lobes for about two fifths their length before merging into basal lateral glabellar furrows. It is difficult to discern where the axial furrow ends and the basal lateral glabellar furrow begins, but generally there is a slight bend in the compound furrow[1] to indicate the place, the outer portion (the axial furrow) being wider and often very slightly arched backwards, growing narrower within and curving rather strongly upwards from the sides, the inner portion (the lateral glabellar furrow) being narrower, of more uniform width, straighter, more horizontal and directed somewhat more strongly backwards. Outside basal lateral glabellar lobes the axial furrows seem generally to have entirely disappeared, but in a few specimens they appear to be represented by extremely weak grooves, which run in slight outwardly convex curves backwards to the occipital furrow adjacent to which they become broader and more distinctly impressed — these posterior portions are discernible in several specimens. Posteriorly the axial furrows become strong again and run in gently convex curves obliquely outwards and backwards along postero-lateral portions of occipital lobes and nearly straight backwards outside main portion of occipital ring.

Occipital furrow somewhat broader and deeper than anterior lateral glabellar furrow and nearly transverse in centre, becoming narrower at sides where it divides to include the occipital lobes. Occipital ring rather wide, narrowing at sides, gently arched transversally, gently rounded longitudinally in the centre, growing more flattened laterally, the surface — except the surface of the occipital lobes — sloping gently towards the front, with small, indistinctly defined median tubercle placed rather close to posterior margin; its posterior margin gently curved forwards in middle and at sides; occipital lobes not reaching quite as far outwards as main portion of occipital ring, elongated sub-ovate in outline with pointed extremities and the longer axes directed outwards and slightly backwards, the surface slightly raised and, excepting the inner anterior portions, sloping postero-laterally.

Anterior portions of fixed cheeks in front of eye lobes very short and narrow, forming somewhat unevenly rounded, anteriorly tapering rolls, their surface confluent with that of palpebral lobes, sloping steeply downwards towards anterior border, separated from this by weak grooves, which run from the points where the anterior border furrow merges into the axial furrows, just in front of anterior extremities of 1st lateral glabellar furrows, obliquely outwards and backwards to facial sutures, and continue beyond these on free cheek below lower eyelids. Posterior portions of fixed cheeks rather wide, narrowing anteriorly, confluent with basal lateral glabellar lobes; the greatest part of the surface gently convex, sloping gently downwards towards palpebral lobes and postero-laterally towards inner portions of posterior borders and towards small sub-triangular flattened areas, which are situated in front of the broad outer portions of the border, marked off on the inside from the convex

[1] That only the inner part of this can be regarded as lateral glabellar furrow and that the outer part is a portion of the axial furrow has, with regard to other allied species, been pointed out by SCHMIDT (1885 pp. 10, 12, 115, 119).

parts by narrow grooves and bounded antero-laterally by the posterior branches of the facial sutures towards which their surface slopes very gently upwards. Along the facial sutures from the palpebral lobes to these flattened areas the edges of the fixed cheeks are — at least in some specimens — bent upwards forming narrow rims, which adjacent to the palpebral lobes are rather high and conspicuous, but decrease rapidly in height. Palpebral lobes large and prominent, nearly as wide as long, rounded at the outside, flattened on top and gently bent upwards, their middle points situated a little farther back than middle of glabella; palpebral furrows strong, originating in axial furrows at the points where these bend inwards, running obliquely backwards and outwards — their general direction a little more outwards than anterior portions of axial furrows — at first slightly arched outwards, then somewhat more strongly inwards, and — at least in some specimens — continued behind palpebral lobes, inside upturned edges of convex portion of fixed cheeks, by proximally rather strong, distally rapidly weakening grooves. Posterior borders of fixed cheeks flattened, exceedingly narrow at axial furrows, rapidly increasing in width for about half their length, then growing parallel-sided and here broader than occipital ring, marked off by distinct furrows; their posterior margins directed straight outwards. Anterior branches of facial sutures converging anteriorly at about 90°, cutting anterior margin at a distance from each other about equal to the width of glabella between antero-lateral extremities of central lobe; posterior branches running from palpebral lobes obliquely outwards and backwards at about 50° to 55° to median line of glabella, but curving more strongly backwards near posterior margin of cephalon, which they seem to cut at slightly acute angles.

Free cheeks (fragmentarily preserved) rather narrow, with broadly rounded outer margins, produced posteriorly into relatively short, broad-based, tapering, pointed spines which curve obliquely backwards and outwards; postcephalic margin forming a continuous curve from extremity of spine to facial suture. (Eyes not preserved). Lower eyelids relatively high, marked off anteriorly and laterally by distinct furrows, which are continued by weak grooves running obliquely backwards and inwards towards the facial sutures and the posterior border furrows but dying out or becoming extremely weak before reaching these. These furrows and grooves represent evidently the lateral border furrows and are continued in front of the eye lobes on the fixed cheeks and connected with the anterior border furrow. Posterior border furrows distinctly impressed, narrow, gently curved, converging posteriorly with post cephalic margin, dying out at base of genal spines. Portions of free cheeks lying between the grooves just mentioned and the facial sutures with slightly raised surface sloping upwards to eye lobes; the other portions (borders and genal spines) with flattened or very gently convex surface and seemingly horizontally extended, except the narrow antero-lateral portions in front of and outside eye lobes, which are bent gently downwards. Doublure of free cheeks marked by rather course striae, which anteriorly are sub-parallel to the margin and posteriorly run backwards in outwards convex curves.

Hypostoma very large, sub-pentagonal in general outline, obtusely pointed in front and with the posterior margin excavated by a broad, rather deep, rounded notch; widest at about the level of posterior furrow, where the width is somewhat greater than the length along the median line. Anterior edge nearly vertically inclined, very narrow, with slightly concave surface, growing wider and flattened postero-laterally and finally merging into the broad, obliquely truncated anterior wings, which are situated comparatively very far back -- the front of the body being strongly extended forwards. Central body sub-pentagonal in outline, gently convex, generally somewhat wider than long, the length, however, in a few specimens being equal to or slightly greater than the width, marked posteriorly by pair of strong middle furrows beginning in lateral furrows a little behind anterior wings and running obliquely inwards and backwards rather more than two thirds the way to the median line of central body, generally bending a little more strongly inwards near extremities; in several specimens (natural casts) the furrows are seen to divide at these points, one division, which is always distinctly marked having the direction just mentioned, the other, which is very narrow and shallow, but — in the specimens where it is most distinctly marked — slightly longer than the former, curving first nearly straight backwards, then obliquely inwards. Posterior and lateral furrows broad and rather deep; the former very gently arched backwards; the latter nearly straight, starting just above middle of anterior wings, converging posteriorly and continued behind posterior furrow about half-way to posterior margin, in front meeting anterior furrows at slightly obtuse angles. Anterior furrows narrower and shallower than the other ones, growing weaker anteriorly and dying out at margin about half-way between their lateral extremities and anterior extremity of central body, marking off at each side a narrow slightly, raised border, which grows narrower and finally disappears anteriorly. Lateral borders wide, rather strongly convex anteriorly, growing more flattened posteriorly, with rounded outer margins. Posterior border wide, its anterior portion separated from lateral borders by the prolonged lateral furrows, swollen, appearing to form a posterior lobe of the central body; its posterior portion depressed, sometimes separated from anterior portion by weak groove, deeply and widely notched in the middle behind; postero-lateral extremities of border broadly rounded.

Thoracic segments (only fragments preserved) with broad convex axis, seemingly about as wide as side lobes, separated from pleuræ by strong axial furrows. Pleurae horizontally extended, with weak remote fulcrum, their outer portions gently curved backwards with pointed extremities; pleural furrows deeply impressed, long, diagonal.

Pygidium wider than long, its length along the median line being rather more than five sevenths the greatest width, found between extremities of anterior pair of pleurae. Axis rather strongly convex, one third to two fifths the entire length of pygidium along median line, occupying a little more than one third its width at anterior margin, tapering posteriorly to narrowly rounded or obtusely pointed extremity, which is somewhat better defined in the middle behind than at sides; crossed anteriorly by 3 axial ring furrows, of which the two first ones are very distinctly impressed and continuous across the entire width of the axis, the third one is less sharply defined and sometimes on the surface of the test (it is stronger in casts) not continuous or extremely weak across the middle of the axis. Axial furrows rather narrow, strongly impressed, continued posteriorly and bounding the long post axial piece, but dying out before reaching posterior margin; converging rather rapidly posteriorly at sides of axis, then more strongly to about middle of pygidium, and from here very slightly to a little behind middle of post axial piece, where the width of latter is generally about one third (in a few specimens only about one fourth) the frontal width of axis, from here they diverge posteriorly, at first very slightly, towards their extremities generally more strongly. Post axial piece gently convex and distinctly raised above side lobes anteriorly, growing more flattened and sloping downwards posteriorly to a little behind its middle; its posterior portion gently bent upwards and generally lying on the same general plane as adjacent portions of third pair of pleurae, coalescing with these posteriorly; its posterior margin deeply sinuate. Side lobes with a flattened area in front adjacent to axial furrows, which tapers posteriorly and generally dies out before reaching level of extremity of axis, outside and behind this area the surface becomes gently concave; consisting of 3 pairs of furrowed pleurae, separated by strong interpleural furrows and with relatively long, acutely pointed, backwardly directed free ends. Bands of pleurae internally with slightly raised surfaces, growing flatter distally. Anterior pair of pleurae somewhat shorter than following ones, extending a little behind middle of pygidium, sub-triangular in outline, with slightly rounded antero-lateral angles, the lateral margins nearly straight making angles of about 80° to front edge, the inner posterior margins nearly straight to near axial furrows and making angles of about 45° to front edge, then curving a little more strongly inwards. 2d pair of pleurae nearly reaching level of middle-point of posterior margin of pygidium, sub-lanceolate in outline with the longer axes directed at about 20° to median line of pygidium. 3d pair of pleurae somewhat triangular in outline, not defined on the inside posteriorly. Basal pair of free ending points shorter and broader than the others, apparently partly formed by postero-lateral portions of axial region, pointing straight backwards; the distance between their extremities about equal to four fifths frontal width of axis. Pleural furrows about equalling interpleural furrows in strength, growing shallower posteriorly, not reaching extremities of pleurae. The two anterior pairs originating in axial furrows very close to anterior margin of pleurae; 1st pair gently curved, sub-parallel to 1st pair of interpleural furrows; 2d pair very soon growing sub-median, nearly straight or slightly arched outwards in the middle; 3d pair beginning in axial furrows much farther back than preceeding pair of interpleural furrows, directed nearly straight backwards for the greatest part of their length, curving slightly inwards posteriorly. Doublure of pygidium very wide, marked by numerous rather fine, concentric, equidistant striae (corresponding to ridges on the ventral surface of the test).

Surface of cephalon and pygidium ornamented, except in the furrows, with rather large, conical or pointed tubercles, with smaller ones between them. The tubercles are very crowded on the anterior marginal extension — where the largest ones occur — placed rather close together on the anterior portions of the glabella and on the median portion of the occipital ring, generally more sparingly distributed on the other parts of the cranidium. On the free cheeks the tubercles are rather closely set but relatively small. On the pygidium the largest tubercles occur on the axis and the inner portions of the side lobes, towards the margins they grow smaller and more crowded. Both the size, height and frequency of the tubercles vary, however, a little in different specimens, which fact probably chiefly — but as it appears not altogether — depends on the state of preservation; on well preserved internal casts the tubercles seem as a general rule to be relatively higher and larger than on the surface of the rather thick test. Thoracic axis and pleurae covered by relatively small tubercles of the same kind as those on the cephalon and pygidium. On the hypostoma, the surface of the body and the inner portions of the borders are marked by small, rather deep and rather closely set pits, and between the pits are indistinctly marked, anastomosing, and often discontinued ridges, which are sub-concentric to the anterior end and on the antero-lateral portions of the hypostoma broken up into small, irregularly shaped granules; the marginal portions of the borders are marked by a series of anastomosing ridges sub-parallel to the margin, rather coarse at sides, growing finer anteriorly and behind, where pits also occur.

Dimensions:	I	II	III	IV
Length of cranidium to base of extension	32,0 mm.	27,0 mm.	20,0 mm.	9,0 mm.
» » marginal extension	18,0 »	16,0 »	12,5 »	5,0 »
Width » » »	22,0 »	20,5 »	14,5 »	6,5 »
Greatest width of glabella	33,0 »	29,0 »	20,0 »	8,5 »
Length of central lobe	26,0 »	22,0 »	16,5 »	7,0 »
Greatest width of d:o	29,0 »	26,0 »	18,0 »	8,0 »
Width of d:o across narrowest part . . .	7,0 »	5,5 »	4,5 »	2,0 »
» » » » base	15,5 »	12,0 »	9,5 »	4,0 »
Length of bi-composite lobe	16,5 »	13,5 »	9,1 »	4,0 »
Width » » » »	9,0 »	5,0 »	5,0 »	2,3 »

Dimensions:	V	VI	VII
Length of hypostoma	37,0 mm.	41 mm.	12,5 mm.
Width » »	38,0 »	42 »	13,0 »
Length » central body	27,5 »	30 »	9,0 »
Width » » »	26,5 »	31 »	9,0 »

	VIII	IX	X
Length of pygidium (approximately)	70,0 mm.	58 mm.	20,0 mm.
Width » d:o between ends of 2d pleurae	—	68 »	—
Length » axis (articulating half-ring not included)	22,0 »	17 »	6,0 »
Width » » at front end	27,0 »	20 »	7,0 »
» » post axial piece across narrowest part	9,5 »	—	1,7 »

Remarks. — The pygidium of this species was originally figured and described by ANGELIN in 1854 (p. 73, Pl. XXXVIII, fig. 3) and associated with a cranidium under the name of *Platymetopus planifrons*. The cranidium was not figured but according to the brief diagnosis given, it cannot have belonged to our species. However, since ANGELIN did not figure the cranidium, I think we have a right to assume that the specimen (or specimens) on which he based his diagnosis was badly preserved, and it seems possible that he misinterpreted its characters. At any rate it is rather improbable that, if a cranidium of the same species should be found, we could recognize it as such: The name *planifrons* must therefore be kept for the species to which the pygidium belongs, which ANGELIN figured under this name. The hypostomata which ANGELIN (Op. cit. p. 73, Pl. XXXIII, figs. 3 a, 3 b) with marks of interrogation referred to this species do not belong here but to two different species of *Amphilichas*, one of them probably to *Amph. dalecarlicus* (Cf. SCHMIDT, 1885, pp. 29, 53; and below).

This species is very common at Kullsberg. A good number of specimens have been collected at Furudal too and it has also been found at Amtjärn and Sinksjön. No entire specimen has been found, but a very great number of cranidia, hypostomata and pygidia and associated with these a few fragments of free cheeks and of thoracic segments. The rostrum is not known; to judge from the shape of the anterior marginal extension it cannot have been narrow and band-like as in most other Lichadidæ, but must have been something like that of *Lichas platyrhinus* SCHMIDT (SCHMIDT, 1907, p. 34, Pl. II, figs. 1—4, text-fig. 5), a large, broad plate rounded in front and deeply emarginated behind.

Variations. — On the whole most of the specimens of the different portions agree rather well in characters, although they vary a little in some features. The convexity of the cranidium, the anterior outline of the glabella and the dimensions and shape of the anterior marginal extension are a little different in different specimens; sometimes the glabella is more pointed in front, sometimes more broadly rounded; in some specimens the lateral margins of the extensions are rather strongly arched outwards, in others very slightly so. The pygidia show some slight differences in the course of the axial furrows, and in some hypostomata the anterior lobe of the central body is a little more convex and somewhat more produced in front than in others.

There are, however, a few specimens (of different types), which show some more striking differences, and which perhaps ought not to be referred to this species at all, but most of them are very incompletely preserved and it appears doubtful whether the differences really can be considered as being of specific value.

In the typical cranidia the anterior marginal extension increases in width from the base to about the middle and its basal width is about two thirds the greatest width of the glabella. In the cranidium from Furudal figured below on Pl. VII, fig. 6, the extension tapers rather rapidly from the base and seems (it is fractured at the sides at base) to have been indistinctly marked off from the narrow side portions of the border; on the one side the edge is not preserved, but on the other it can be seen distinctly that it is rounded and the outermost edge slightly recurved. The anterior portion of the extension is not preserved and in other characters the specimen, as far as it is preserved, agrees well with the typical cranidia of the species. Possibly the extension is only deformed, but it does not appear probable that this is the case.

In another cranidium — from Kullsberg in the Upsala Museum — in which only the posterior portion of the extension is preserved (but both sides of this), the latter is only about half as wide at base as the glabella across its broadest portion, gently convex transversally and distinctly tapering anteriorly, though not as strongly as in the cranidium from Furudal just mentioned and it is more distinctly marked off from the side portions of the border than in this. The specimen differs also from the typical cranidia in the shape of the glabella, which is very broadly rounded, almost truncated, in the middle in front.

Finally there are some fragmentary cranidia and pygidia from Kullsberg in ISBERG's collection in Lund and one incomplete cranidium and a fragment of another from the same locality in the Upsala Museum, which are much more coarsely tuberculated than the typical specimens. The tubercles are both more closely set and relatively larger and higher. Associated with the other portions there are, in ISBERG's collection, two hypostomata, which also are tuberculated; the tubercles are rather closely set on the front end and along the antero-lateral margins of the central body; they are rather coarse — with smaller ones occurring between the larger ones — and of the same types as those on the cranidium and pygidium, growing smaller proximally; on the inner and posterior portions of the body and on the inner portions of the lateral borders they are very small; on the posterior border and the marginal portions of the lateral borders no tubercles seem to occur, but on the latter the usual raised ridges are to be seen. In other characters the hypostomata seem to agree with those of the typical form, except that, at least in one of the specimens, the middle furrows are directed more strongly backwards to near their posterior ends, where they turn sharply inwards. The cranidia appear to have differed more. They are more strongly convex transversally and the antero-lateral extensions of the central glabellar lobe are wider (longitudinally). Only in one of the specimens a portion of the anterior marginal extension is preserved, and this — it is broken off near the base — is strongly convex posteriorly and relatively narrow, but does not seem to be very distinctly marked off from the side portions of the anterior border, which latter are very narrow distally and increase rapidly in width proximally. The pygidia do not, except in the coarser ornamentation, appear to differ from the typical ones in any characters of any importance; they are, however, pressed and badly preserved. All the specimens in question here occur in an unusually dark limestone. Most of them are very large, considerably larger than any of the corresponding portions of the typical form, which have come under my notice. The larger size cannot, however, conceivably account for the coarser tuberculation, since one of the cranidia is quite small, its length to the base of the marginal extension being approximately 9 mm. Moreover, the form appears to differ from the typical *Pl. planifrons* also in other characters, and it seems probable that the discovery of more complete specimens will determine the necessity of refering it, if not to a separate species, at least to a distinct variety; perhaps it may be referable to *Pl. validus* LINRS. (Cf. below).

Affinities. — *Pl. validus* LINRS. (LINNARSSON, 1869, p. 66, Pl. I, figs. 19—20) appears to be closely related to our species. In this too the anterior border of the cranidium seems to have been produced into an anterior marginal extension which, however, is broken off on the few cranidia as yet known and only the side portions of the border are preserved. These are considerably longer than in our species and widen gradually anteriorly. Probably the anterior extension was short and indistinctly marked off from the side portions of the border or else it must have been comparatively very narrow, anyhow it must have been rather different from that of the typical cranidia of our species. As in these the cranidium is flattened in the middle posteriorly, but it is more strongly bent downwards at sides especially anteriorly and the flattened postero-lateral areas of the fixed cheeks are wider and more sharply marked off from the inner portions. It further differs in the course of the preglabellar furrow, which is arched backwards in the middle, in the wider (longitudinally) antero-lateral extensions of the central glabellar lobe and in the ornamentation of the surface. Both on the cranidium and on the pygidium the tubercles are placed very close together and rather evenly distributed on all portions; probably they were very high, all, except a few minute ones, seem to be broken off on the specimens. The pygidium appears to be very like that of our species, but it is too incompletely preserved to allow a detailed comparison. The coarsely tuberculated form from Kullsberg described above agrees, as far as can be judged from the portions preserved, much better with *Pl. validus* than does the typical form of *Pl. planifrons* and, as is already mentioned, it does not seem improbable that it is referable to the former species.

Horizon and Localities. — Lower Leptæna Limestone; Kullsberg, Furudal, Amtjärn, Sinksjön.

Platylichas Wegelini HOLM in Mus. Pl. VII, fig. 5; Pl. VI, fig. 13?

Remarks. — There is a fragmentarily preserved cranidium from Furudal in the old collection of the State Museum of Natural History, which appears to represent a new species of *Platylichas* or perhaps only a variety of the foregoing. On the specimen is noted that it was collected by WEGELIN and professor HOLM has labelled it with the specific name of *Wegelini*.

The anterior portion of the cranidium is broken off, but on one side a rather long portion of the anterior border is preserved. This increases gradually in width and curves upwards anteriorly, which indicates that it has been extended in front. The anterior extension must, however, either have been short and indistinctly marked off from the side portions of the border, or else, if it has been of the same type as in *Pl. planifrons*, it must evidently have been much narrower at base than in the typical cranidia of that species. It differs further from *Pl. planifrons* in the following characters; the antero-lateral margins of the cranidium and of the glabella do not converge so strongly anteriorly; the antero-lateral portions of the glabella are bent more strongly downwards; the anterior lateral glabellar furrow is more strongly and more evenly curved, and curves at first from its point of origin in the axial furrow somewhat forwards — instead of nearly straight inwards and upwards; the central glabellar lobe is somewhat less contracted between the posterior portions of the bi-composite lobes and its antero-lateral extensions are relatively broader (longitudinally) and curve more strongly backwards; the bi-composite lateral glabellar lobes are relatively shorter and broader and do not reach quite as far back, and as a consequence of this the basal lateral glabellar lobes are relatively somewhat longer. The test, which is badly preserved, seems to have been very finely granulated or pitted.

Possibly the free cheek figured below on Pl. VI, fig. 13 belongs to this species. The surface of this is covered with small granules of somewhat different sizes. In other characters it seems to agree with the free cheek of *Pl. planifrons,* except that the surface is more indistinctly raised behind the eye lobe and that its antero-lateral portion is more gently inclined. The specimen — which is in the Museum of the Geological Survey — has been collected by V. SCHMALENSÉE and is labelled Osmundsberg. The appearance of the rock in which it occurs is very like that of the Leptæna Limestone at Sinksjön and it appears probable that it is from this locality (Cf. above pp. 131, 164). It is associated with a fragmentary hypostoma which also may belong to this species, although it does not seem to differ from the hypostoma of *Pl. planifrons*.

Dimensions:

Greatest width of glabella	30,0	mm.
» » » central glabellar lobe	28,0	»
Width of do. across narrowest portion	7,0	»
Basal width of do.	13.0	»
Length of bi-composite lobe	15,5	»
Width » » » »	9,0	»

Horizon and Localities. — Lower Leptæna Limestone; Furudal, Sinksjön?

Platylichas nasutus WIGAND. Pl. VII, figs. 7—8.

1888. *Lichas nasuta* WIGAND, p. 69, Pl. VIII, figs. 7 a—7 b.

Specific Characters. — Cranidium sub-triangular in outline. Anterior border very narrow outside antero-lateral extremities of central glabellar lobe, gradually increasing in width and curving upwards anteriorly and produced in front into a short, sub-triangular, obtusely pointed, slightly upturned extension, which is rather strongly convex transversally, or rather, compressed from the sides, slightly rounded longitudinally and with a rounded outer edge; length of extension rather less than one fifth that of entire cranidium.

Glabella well defined in front and at sides anteriorly, confluent with fixed cheeks posteriorly, wider than long, the length along the median line being about three fourths the greatest width, between postero-lateral extremities of bi-composite lobes, broadly rounded in front, but with the anterior margin arched slightly backwards just in the middle, flattened posteriorly and in middle, its anterior slope very gentle, antero-lateral slopes moderately strong. Central lobe of glabella clavate, expanded in front to more than twice its basal width and overhanging nearly the whole of bi-composite lobes, narrowest between posterior portions of latter, where the width is only a little more than half that at occipital furrow; antero-lateral extensions rather narrow (longitudinally); its posterior portion between basal lateral lobes with slight independent convexity. Bi-composite lobes with slight independent convexity, nearly twice as long as wide, pointed in front, with rounded inner margins, straight lateral and nearly straight postero-lateral margins, their longer axes directed obliquely outwards and forwards. Basal lateral glabellar lobes short, increasing in length towards the sides and coalescing with fixed cheeks. Anterior lateral glabellar furrows distinctly impressed throughout, not very wide, widening outside base of central lobe, running in nearly even inwards-forwards convex curves from axial furrows to outside narrowest part of central lobe, then curving rather strongly outwards to junctions with basal lateral furrows, and finally running nearly straight backwards to occipital furrow. 2d pair of lateral glabellar furrows obsolete. Basal pair narrow, distinctly impressed, growing shallower just before reaching anterior pair, nearly straight and directed at about 65° to median line of glabella. Preglabellar furrow (anterior border furrow) rather narrow, shallow in front, growing deeper at sides, rather strongly arched upwards and forwards, but just in the middle in front arched slightly backwards. Axial furrows distinctly impressed, but not wide, anteriorly and outside occipital ring, obsolete outside basal lateral glabellar lobes; their anterior portions running obliquely backwards, upwards and slightly outwards along antero-lateral edges of bi-composite lobes, then bending obliquely inwards and running along postero-lateral edges of lobes, as it seems, for about two fifths their length, and finally merging into basal lateral glabellar furrows. [A slight bend in each of the compound furrows seems to indicate the place were the glabellar furrow begins].

Occipital furrow of moderate strength, nearly transverse in centre, dividing at sides and bounding the occipital lobes. Main portion of occipital ring (incompletely preserved) rather wide, narrowing at sides, gently arched transversally and gently rounded longitudinally. Occipital lobes elongated sub-ovate in outline, with pointed lateral extremities and the longer axes directed outwards and slightly backwards; their surfaces gently raised, sloping downwards postero-laterally.

Anterior portions of fixed cheeks posteriorly confluent with palpebral lobes, short and narrow, rather strongly convex transversally, narrowing and sloping steeply downwards anteriorly, separated from anterior border by weak oblique furrows, which form the continuations of the preglabellar furrow (Cf. above p. 265). Posterior portions of fixed cheeks (incompletely preserved) rather wide, narrowing anteriorly, gently convex, sloping both posteriorly, anteriorly and laterally, but with their outermost portions in front of posterior borders, flattened and marked off from inner convex portions by weak grooves. In front of these flattened areas the edges of the fixed cheeks are bent upwards and marked off by distinct furrows, which anteriorly merge into the palpebral furrows. Palpebral lobes (imperfectly preserved) large and prominent, flattened on top, their middle a little behind middle of glabella. Palpebral furrows rather strong, weakest in the middle, originating in axial furrows at the points where these bend inwards and running in slightly sigmoidal curves backwards and slightly outwards. Posterior border of fixed cheek (only the inner portion preserved) rather narrow at axial furrow, widening laterally, gently rounded, marked off by distinctly impressed furrow. Anterior branches of facial sutures converging rather strongly anteriorly; posterior branches curving from palpebral lobes obliquely outwards and backwards.

Surface of cranidium (badly preserved), except in the furrows, covered with tubercles of different sizes, all rather small, but the larger ones, at least, rather high and conical.

Dimensions. — The dimensions of the largest cranidium found in the Leptæna Limestone (I) and the dimensions given by WIGAND (1888, p. 70) of the type specimen (II) are:

	I		II
Length of cranidium	30,0 mm.	(approximately)	16 mm.
Greatest width of glabella	25,0 »		—
Length of central lobe	19,0 »		11 mm.
Greatest width of do.	23,5 »		12 mm.
Width of do. accross narrowest part	6,0 »		—
Basal width of do.	11,0 »		—
Length of bi-composite lobes	12,0 »		—
Width » » » »	6,5 »		—
Length » marginal extension	6,0 »		3 mm.

Remarks. — This species is represented by two cranidia from the Amtjärn Quarry in the Upsala Museum. Probably two fragmentary hypostomata and a portion of a badly preserved pygidium from the same locality and in the same collection belong also to this species. All the specimens are from the shaly limestone, which forms the lowest part of the Lower Leptæna Limestone, and in which no other Lichadidæ have as yet been found. One of the cranidia is rather well preserved, though not quite complete, and the above description is nearly entirely drawn up from this; the other, which is considerably smaller, is very badly preserved.

WIGAND's type specimen (a cranidium) was found in Mecklenburg in a boulder of so-called »Backstein» Limestone, which name, as is well known, indicates the appearance, but not the geological age of the rock. On the whole the cranidium from the Leptæna Limestone described above agrees well with WIGAND's (1888, Pl. VIII, figs. 7 a—7 b) figures, but differs slightly in some features, chiefly in the relations between length and width of some portions. It seems, however, as if the figures were not quite reliable in this respect, since the dimensions are not the same as in the table of measures which he has given in the text (p. 70). Our specimen, on the other hand, agrees rather closely with this in the relative dimensions.

The hypostomata from the Amtjärn Quarry are, as far as they are preserved, very like those of *Pl. planifrons*, but the middle furrows on the central body seem to be less oblique in direction.

The fragmentary pygidium from the same locality, which appears to belong to *Pl. nasutus,* recalls also, as far as it is preserved, that of *Pl.*

planifrons but the anterior and 2d pleuræ are more curved and their free ends relatively shorter and directed more backwards.

Affinities. — This species seems to be closely related to *Pl. planifrons,* but differs in the characters of the anterior marginal extension, in the anterior outline of the glabella, and in the course of the anterior lateral glabellar furrows, whose anterior portions are more evenly curved and bend distinctly backwards laterally. Further the bi-composite glabellar lobes are more oblique to the median line of the body and the lateral portions of the cranidium are more gently inclined. The pygidium which appears to belong to this species differs also in some respects, as already mentioned above.

Of the forms provisionally referred above (pp. 271—272) to *Pl. planifrons,* though differing in some respects from the typical form, none appears to have had an anterior marginal extension of the same character as that of *Pl. nasatus* and they do not agree with this in the other characters just mentioned.

Pl. Wegelini differs in the more strongly inclined antero-lateral portions of the cranidium, in the direction of the antero-lateral margins of the cranidium and glabella, in the broader bi-composite lateral glabellar lobes, and in the ornamentation of the test; its anterior border seems to have been extended in front but the extension can apparently not have had, at least not quite, the same character as that of *Pl. nasutus.*

In *Pl. validus* LINRS. (LINNARSSON, 1869, p. 66, Pl. I, figs. 19—20) the cranidium is more strongly convex than in our species, the course of the anterior lateral glabellar furrows and the direction of the bi-composite lateral glabellar lobes are different, and the anterior marginal extension had probably a different character.

Horizons and Localities. — Lowest part of Lower Leptæna Limestone; Amtjärn Quarry.

Outside Dalarne the species has been found in a boulder of »Backstein» Limestone in Mecklenburg.

Platylichas robustus n. sp. Pl. VII, figs. 10—11.

Specific Characters. — Cranidium gently convex, flattened on top posteriorly, the anterior slope steeper than the lateral ones; its anterior margin evenly and strongly arched forwards. Anterior border of moderate, nearly uniform width, slightly rounded, bent gently downwards in front but not at sides, where it curves gently upwards posteriorly, separated from glabella by rather deep, narrow furrow, which is continued at sides by short, distinctly impressed, though shallow, obliquely backwards directed furrows separating the lateral portions of the border from the fixed cheeks.

Glabella well defined in front and at the sides anteriorly, posteriorly confluent with fixed cheeks, somewhat wider than long. Central lobe of glabella clavate, expanded in front to about twice its basal width and overhanging bi-composite lobes, narrowest between posterior portions of latter where the width is less than half that at occipital furrow, suddenly expanded at base again; antero-lateral entensions rather wide (longitudinally) within, tapering laterally, the extremities pointed and directed obliquely backwards. Bi-composite lobes with slight independent convexity, rather more than two thirds as wide as long, obtusely pointed in front, with irregularly rounded inner-anterior margins and nearly straight lateral and postero-lateral margins, their longer axes directed obliquely outwards. Basal lateral glabellar lobes very short within, increasing rapidly in length laterally and coalescing with fixed cheeks. Anterior lateral glabellar furrows distinctly impressed throughout, most deeply adjacent to axial furrows and inside posterior portions of bi-composite lobes, not very wide, running from axial furrows in gently forwards convex curves inwards and upwards a little more than half-way to median line of glabella, then making a rather sudden, but not sharp bend and curving convergingly backwards for about an equal length, then curving at first slightly but soon more strongly outwards to junction with basal lateral furrows, and finally backwards and slightly outwards to occipital furrow. 2d pair of lateral glabellar furrows obsolete. Basal pair rather shallow within, growing deeper distally, nearly straight, running from their inner extremities obliquely outwards, forwards and slightly downwards to merge into the somewhat broader axial furrows, which continue in a more downward and somewhat more outward direction along the outer two fifths of the postero-lateral edges of the bi-composite lobes and then make a sudden bend and run obliquely forwards, downwards and slightly inwards to anterior border furrow.

Occipital furrow broad and deep and nearly straight behind central glabellar lobe, dividing at sides; the divisions considerably narrower than the median portion. Main portion of occipital ring gently arched transversally, broad in the middle; the side portions considerably narrower, scarcely tapering laterally; the surface slightly rounded, sloping gently downwards anteriorly. Occipital lobes elongated and irregularly sub-oval in outline with pointed lateral extremities, directed obliquely outwards, their surfaces slightly raised and sloping postero-laterally.

Anterior portions of fixed cheeks posteriorly confluent with palpebral lobes, short and narrow, sloping steeply downwards anteriorly, flattened within, the antero-lateral portions steeply inclined. Posterior portions of fixed cheeks of moderate width, narrowing anteriorly, gently convex; the outermost portions in front of the borders (only a fragment preserved) seem to have been more flattened, but not very distinctly marked off from the inner portions. The palpebral lobes seem to have been comparatively short and marked off from the inner portions by strong slightly sinuate furrows. Posterior borders of fixed cheeks (only the inner portion preserved) rather narrow at axial furrows, widening laterally, slightly rounded, marked off by rather wide, shallow furrows. Anterior branches of facial sutures sub-parallel from palpebral lobes to anterior border, then bending obliquely inwards; the posterior branches seem to have had about the same course as in the foregoing species.

Surface of cranidium, except in the furrows, covered by conical tubercles of different sizes; most of these are very small, and even the larger ones are relatively small and not very high.

Dimensions:

Length of cranidium	48,0	mm. (approximately)
Greatest width of glabella	44,0	»
Length of central lobe	39,0	»
Greatest width of do.	42,0	»
Width of do. across narrowest part . .	9,0	»
» » » at base	21,0	»
Length of bi-composite lobes	21,5	»
Width » » » »	15,0	»

Remarks. — The above description is drawn up from a large cranidium from Sätra in the Upsala Museum. The surface is rather weathered, the test only preserved on some portions. With the exception of the palpebral lobes and the postero-lateral portions of the fixed cheeks it is nearly complete and otherwise rather well preserved and shows the characters clearly. Attached to the anterior border of the cranidium is a fragment of the rostrum, which shows that this was narrow and band-like as in other Lichadidæ, in which the anterior border is not produced in front. The anterior and posterior borders of the rostrum are raised into narrow rims and between these the surface is marked by an irregular network of impressed lines surrounding raised, broken ridges and irregularly shaped granules.

Associated with the cranidium is a hypostoma, which apparently belongs to the same species. Possibly it belongs to the same individual. It is partly covered by the cranidium — but it is not in its natural position, but lies upside-down and with the wrong end foremost in relation to this — so that only a portion is visible. It is apparently of the same type as that of *Pl. planifrons*, but as in the cranidium the anterior outline is rounded, and the ornamentation of the test, though otherwise similar, is coarser.

The species is also represented by a fragmentary and badly preserved cranidium from Kullsberg in the Upsala Museum, which is somewhat smaller than the one from Sätra.

Affinities. — Of previously described species *Pl. margaritifer* NIESZK. (SCHMIDT, 1885, p. 118, Pl. V, figs. 17—24) from the East Baltic Borkholm Formation seems to resemble our species most closely. This geologically much younger species is apparently a much smaller form. It differs in the convexity and shape of the glabella, which is much more abruptly bent down in front and more broadly rounded anteriorly, and to judge from the figures the central lobe of the glabella does not expand so much at base and the tubercles on the surface do not seem to be conical. The hypostoma is also more broadly rounded in front and the middle furrows appear to begin nearer its antero-lateral corners and the lateral borders seem to expand more suddenly.

Horizon and Locality. — Lower Leptæna Limestone; Sätra, Kullsberg.

Platylichas bottniensis WIMAN? Pl. VII, fig. 19.

1907 a. *Lichas bottniensis* WIMAN, p. 107, Pl. VII, fig. 16.

Remarks. — A small fragmentary and badly preserved cranidium in the Museum of the Geological Survey seems to belong to this species. Its entire length seems to have been about 8 mm. On the whole it agrees, as far as it is preserved, very closely with the type specimen, but the anterior portion is a little more strongly bent down, and as a consequence of this, the anterior outline is somewhat more broadly rounded; the postero-lateral slope of the fixed cheeks and occipital lobes is also somewhat steeper. These differences are, however, very slight and do not seem to be of specific importance, still the state of preservation renders the identification somewhat doubtful.

The specimen is probably from Kullsberg. It belongs to an old collection and is kept in a small cardboard box together with several other specimens of Leptæna Limestone from different localities (according to an accompanying label collected by Linnarsson). It has no special label, but is apparently broken off from a larger specimen of rock, labelled Glistjärna, which is the name of the small village situated on the slope of the Kullsberg hill.

Horizons and Localities. — Our specimen is in all probability from the Lower Leptæna Limestone at Kullsberg. The type specimen was found in a boulder of North Baltic Chasmops Limestone.

Platylichas cicatricosus LOVÉN. Pl. VII, fig. 17; text-fig. 19.

1845. *Lichas cicatricosus* LOVÉN, p. 56, Pl. I, fig. 8.
1854. *Lichas cicatricosus* ANGELIN, p. 74 (pars), Pl. XXXVIII, figs. 6 b (non figs 6, 6 a).

Specific Characters. — Pygidium broadly semielliptical in outline, with gently rounded antero-lateral angles, about five ninths as long as wide. Axis strongly convex, about half the length of pygidium and anteriorly somewhat less than one third its width, gently tapering posteriorly, rounded behind with the apex obtusely pointed and the surface sloping steeply downwards to post axial piece; with 3 axial ring furrows — the third one incomplete or weak in the middle — and a fourth one indicated faintly, behind which is a short terminal piece. Axial furrows of moderate strength and nearly straight at sides of axis, curving inwards at its extremity, produced behind it and at first having about the same strength as anterior portions and converging rather strongly posteriorly, then suddenly growing weak and curving slightly outwards, not reaching margin of pygidium. Post axial piece distinctly raised above side lobes anteriorly adjacent to axis, posteriorly on the same general plane as these. Side lobes flattened with the marginal portions bent gently downwards, except posteriorly; composed of 3 pairs of furrowed pleuræ ending in short, backwardly directed, free points, third pair incompletely defined within. Interpleural and pleural furrows of about equal strength; the former slightly sigmoidally curved near margin; the latter not reaching margin. Anterior pair of pleuræ narrow, of nearly uniform width for their inner halves, then increasing gently in width to remote fulcra, beyond these tapering rapidly to recurved free points; their pleural furrows directed slightly backwards and nearly straight to near the blind ends, where they bend a little more strongly backwards. Anterior interpleural furrows directed nearly straight outwards for about half their length, then curving obliquely backwards. 2d pair of pleuræ broader than anterior pair; 2d pleural furrows beginning in axial furrows close to anterior interpleural furrows, soon growing nearly median with 2d interpleural furrows nearly parallel to them and making angles of about 50° to anterior margin of pygidium. 3d pair of pleuræ much broader than preceeding ones, coalescing with posterior portion of post axial piece within; their pleural furrows beginning in axial furrows nearly opposite, or a little behind apex of axis, nearly straight and directed somewhat more strongly backwards than 2d interpleural furrows to about half-way to margin, then curving obliquely inwards, not reaching out-turned posterior extremities of axial furrows, but, at least sometimes, connected with these by slight depressions which posteriorly bound the gently raised anterior portions of the inner pleural bands from the more depressed marginal portions.

Fig. 19. *Platylichas cicatricosus* LOVÉN, Pygidium. Probably the type specimen from Vestanå. Enlarged nearly 3 times. State Mus. Nat. Hist.

Test of pygidium, except in the furrows, closely covered with rather low tubercles of different sizes.

Dimensions. — In the most complete pygidium known the length is a little over 6 mm. and the greatest width about 11 mm. In another pygidium (probably LOVÉN's type specimen) the length is a little over 8 mm. (if the length of the articulating half-ring is included about 8,5 mm.).

Remarks. — This species was founded by LOVÉN (1845, p. 56, Pl. I, fig. 8) on a fragmentary pygidium from Vestanå, which had been presented to the State Museum of Natural History by C. H. WEGELIN.

The pygidium — as it appears the same specimen — was again figured by ANGELIN (1854, Pl. XXXVIII, fig. 6 b), and associated with a cranidium (Op. cit., Pl. XXXVIII, figs. 6—6 a), which, as has already been pointed out by SCHMIDT (1885, p. 122; 1907, p. 44) does not belong to this species but probably to *Lichas affinis* ANG. (Cf. below p. 302).

The pygidium figured above (text-fig. 19) is probably the original type specimen. It belongs to the old collection in the Museum just mentioned, and on a label accompanying the specimen is noted that it has been collected by WEGELIN, but not at which locality it has been found, Dalarne being the only locality name on the label. The utmost tips of the third pair of free ending points are not preserved, so that these appear to be rather obtuse, which is also the case both in LOVÉN's and in ANGELIN's figures. LOVÉN stated that the type specimen measured 9 mm. in length. The pygidium figured above is somewhat shorter — including the articulating half-ring about 8,5 mm. — and it differs from LOVÉN's figure in some minor details. It seems probable, however, that LOVÉN only gave approximate measures, and also that his figure is not quite correct.

In addition to the one just mentioned there is now available one other somewhat smaller, nearly complete pygidium from Lissberg in the Museum of the Geological Survey. In this the posterior, recurved portions of the 3d pair of pleural furrows are weaker than in the former — possibly owing to the state of preservation — and the lateral portions of the interpleural furrows are more slightly, though distinctly[1], sigmoidal.

The pygidia which SCHMIDT (1885, p. 122, Pl. V, fig. 26; 1907, p. 44, text-figs. 14—14 a) referred to this species are, as pointed out above (p. 257), of quite another type and apparently referable to *Amphilichas*. The cranidia which he (1885, p. 122, Pl. V, fig. 25) associated with these pygidia seem on the other hand to be referable to a species of *Platylichas*. Rather similar, though apparently not specifically identical, cranidia (figured below, Pl. VII, figs. 28—30) have been found in the Upper Leptæna Limestone at Kallholn and it is not impossible that these belong to the true *Pl. cicatricosus* LOVÉN, but since this seems rather improbable they will be described below under a distinct specific name (*Pl. angulatus*). It appears on the whole more probable that a small cranidium from Lissberg which will be described and figured below (p. 288, Pl. VII, fig. 15) as *Platylichas* sp. ind. a, belongs to LOVÉN's species. This is, however, also open to doubt, more so since there has been found at the same locality another small pygidium (Cf. below p. 289, Pl. VII, fig. 18) which may belong to the same species as the cranidium.

TÖRNQUIST (1884, p. 33) has stated that *Pl. cicatricosus* occurs at Furudal. The specimen on which he based this statement is a very fragmentary pygidium. Both this and a fragmentary pygidium from Kullsberg (Cf. below Pl. VII, fig. 16) in the Upsala Museum resemble, as far as they are pre-

[1] This is not seen in the figure of the specimen given below (Pl. VII, fig. 17), which in this feature is not correct.

served, in most characters those described above, but they differ in some features. Moreover they are from a lower stratigraphical horizon. It appears probable that they belong to *Pl. latus* TQT and that this and *Pl. cicatricosus* are closely allied. Possibly the former ought only to be regarded as a variety of the latter (Cf. below pp. 285, 286, 289).

Affinities. — The pygidium of *Pl. Grayi* FLETCH. var. *scoticus* REED (REED, 1906, p. 100, Pl. XIV, figs. 5—10) recalls that of our species, but it is relatively longer and narrower, the axis seems to be narrower in relation to its length, the 3d axial ring furrow to be well marked throughout and the 4th one to be somewhat more distinct; the furrows on the side lobes are directed more strongly backwards, at least the middlemost ones, the 1st interpleural furrows are nearly straight, and the 3d pleural furrows do not curve round.

Horizon. and Localities. — Upper Leptæna Limestone; Vestanå, Lissberg.

Platylichas latus TÖRNQUIST. Pl. VII, figs. 12—14, 16?

1884. *Lichas laxatus* (var. *dilatata*), TÖRNQUIST, p. 31(32).
1884. *Lichas laxatus* var. *lata*, TÖRNQUIST, Pl. I, fig. 28.

Specific Characters. — Cranidium strongly convex — more so in the smaller than in the larger specimens — bent down anteriorly, its anterior margin broadly rounded and arched slightly upwards in centre. Anterior border narrow, widening a little at sides, slightly rounded and bent steeply downwards in the middle, growing more flattened and horizontally extended at sides. Anterior border furrow very shallow and narrow — somestimes obsolete — in the middle, increasing in strength laterally.

Glabella wider than long, strongly convex in an antero-posterior direction, the anterior downward slope commencing less than half-way from occipital furrow to anterior margin. Central lobe of glabella with independent convexity, which is strongest just in front of the middle, becoming slight posteriorly, the postero-lateral portions generally with a slight convexity of their own, forming proximally indistinctly defined rounded nodules; clavate, expanded in front to rather more than twice its basal width; antero-lateral expansions rather narrow, pointed, overhanging bi-composite lobes for nearly their full width; neck of central lobe rather wide anteriorly, narrowing posteriorly for about half its length to less than one third the frontal width of lobe, then becoming parallel-sided or widening slightly posteriorly for a very short way and then expanding again at base. Bi-composite lobes with slight independent convexity, irregularly sub-ovate in outline, narrowing posteriorly, with pointed anterior extremities and the longer axes directed obliquely forwards and outwards, slightly notched on their insides some distance behind their middle by a slight bend or widening of the anterior lateral glabellar furrows. Basal lateral glabellar lobes small, sub-triangular, with obtusely pointed or sub-truncated inner ends, gently convex, sloping slightly downwards laterally and coalescing with fixed cheeks or very indistinctly marked off from these. Anterior lateral glabellar furrows deeply impressed, narrow (on casts wider), curving from their anterior points of origin at first inwards, upwards and very slightly forwards a little less than half-way to median line of glabella, then convergingly backwards for a somewhat greater distance, then curving, at first very slightly but soon strongly, outwards to junction with basal lateral furrows and either meeting occipital furrow at these points, or continuing a very short way nearly straight backwards before meeting this [variations in this respect are not only seen in different specimens, but even on the two sides of the same one). 2d lateral glabellar furrows apparently represented by the notches on the inner sides of bi-composite lobes mentioned above. Basal lateral glabellar furrows deeply impressed, wider than anterior ones, generally growing wider and shallower just before meeting those, nearly straight, directed obliquely outwards and forwards. Axial furrows deep and narrow anteriorly and outside occipital ring, obsolete or almost obsolete outside basal lateral glabellar lobes, starting anteriorly in small pits at the points of junction between preglabellar furrow (anterior border furrow) and anterior lateral glabellar furrows and running backwards and upwards in a slightly outwards convex curve — most strongly bent at the points where the palpebral furrows branch off — for about two thirds the way to occipital furrow, where they merge into the basal lateral glabellar furrows, which continue in a more inward direction. Outside the basal lateral glabellar lobes the axial furrows seem either to have disappeared entirely, or to be represented by very weak, narrow grooves — discernible in several specimens — which run nearly straight backwards to the anterior lateral divisions of the occipital furrow.

Occipital furrow deeply impressed, not very wide, nearly transverse in centre, dividing at sides. Main portion of occipital ring of medium, nearly uniform width in centre, gradually narrowing laterally behind occipital lobes, extending at sides a little beyond latter, strongly arched transversally, slightly rounded longitudinally; a tubercle somewhat larger than most of the other ones on the cranidium, is placed in the median line somewhat nearer the posterior than the anterior margin, and on each side of this on the posterior edge of the occipital ring is a still larger one. Occipital lobes elongated sub-oval in outline, with the longer axes directed obliquely outwards and backwards, sloping steeply downwards postero-laterally with slightly rounded surface.

Fixed cheeks (imperfectly preserved) curving very steeply downwards both anteriorly and posteriorly from the level of palpebral lobes; anterior portions narrow, short, rounded transversally; posterior portions much broader, widening posteriorly, sloping gently downwards laterally. The palpebral lobes (only a fragment preserved) seem to have been rather large and to have reached relatively far backwards; palpebral furrows of moderate strength, sigmoidally curved, continued by distinct furrows inside raised lateral edges of fixed cheeks. Posterior borders of fixed cheeks very narrow at axial furrows, increasing at first rather rapidly in width laterally, then growing narrower again and curving forwards, marked off by strong furrows. Anterior branches of facial sutures short, converging relatively strongly anteriorly; posterior branches curving from palpebral lobes obliquely outwards and backwards.

Surface of cranidium, except in the furrows, covered with tubercles of different sizes, all rather small, although some in relation to the surrounding ones large and prominent.

Dimensions. — In all the specimens, in which the respective portions are preserved, the greatest width of the glabella is about equal to the distance along the median line between the anterior and the posterior margins; in the largest specimen observed it is nearly 11 mm. and in the smallest one it is 6 mm.

Remarks. — TÖRNQUIST (1884, pp. 31—32) referred this form to *Lichas laxatus* McCOY, though he regarded it as a distinct variety. It differs, however, so much in several characters from the typical form of this species (Cf. McCOY, 1846, p. 51, Pl. IV, fig. 9; SALTER, 1848, p. 340; Pl. VIII, figs. 4—6) that it appears to be necessary to regard it as a distinct species.

In addition to the cranidia from Furudal recorded by TÖRNQUIST there are now available a few others from Kullsberg in the Upsala Museum and in ISBERG's collection in Lund and one from Sätra in the Upsala Museum.

It appears probable that a small, fragmentary pygidium from Kullsberg in the Upsala Museum and an imperfect pygidium from Furudal, which TÖRNQUIST (1884, p. 33) recorded as belonging to *Pl. cicatricosus* are referable to *Pl. latus.* As already mentioned above (p. 282) these pygidia resemble, as far as they are preserved, that of *Pl. cicatricosus* rather closely, but the axis is broader in relation to the side lobes and more convex, the axial furrows converge more strongly behind the axis, the 3d pair of pleural furrows seem to curve only very slightly inwards posteriorly, and the tubercles appear to be relatively higher, the larger ones, at least on the side lobes, more scattered with a greater number of minute ones, but fewer tubercles of medium size between them.

Affinities. — This species differs from *Pl. laxatus* McCOY (McCOY, 1846, p. 51, Pl. IV, fig. 9; SALTER, 1848, p. 340, Pl. VIII, figs. 4—6) by the strong deflection of the anterior portion of the cranidium; the narrower, more indistinctly marked off, and in the centre steeply inclined anterior border; the relatively broader and shorter glabella; the wideness of the median portion of the central glabellar lobe; the more oblique and, in relation to the median portion of the central lobe, narrower bi-composite lobes;

and the generally greater convexity of the cranidium. The pygidia, which seem referable to this species are quite different from that of McCoy's species. It does not appear to me as if the two species were especially closely allied.

The cranidium of our species bears a much stronger resemblance to those of *Pl. Grayi* FLETCH. (FLETCHER, 1850, p. 237, Pl. XXVII, fig. 8, Pl. XXVII bis, figs. 3—3 b) and *Pl. Grayi* var. *scoticus* REED (REED, 1906, p. 100, Pl. XIV, figs. 5—10). To judge from the descriptions and figures available the anterior border of the cranidium seems in both these forms to be horizontally extended or at least not steeply bent down in front, and the glabella seems in the former to be more gently convex in a longitudinal direction and in the latter its anterior portion seems to be more abruptly deflected and more overhanging in front than in our species, which in other characters — the shape of the central and bi-composite glabellar lobes and the course of the glabellar and axial furrows — seems to be intermediate between the typical *Pl. Grayi* and variety *scoticus*. The fragmentary pygidia mentioned above, which seem to belong to our species, recall also the pygidia attributed to *Pl. Grayi* var. *scoticus* (REED, Op. cit., Pl. XIV, figs. 8—9), but they appear to have been considerably wider and shorter and to have had somewhat differently shaped pleuræ; the axis is wider both in relation to its own length and to the entire width of the pygidium; the 3d axial ring furrow is weaker — or interrupted — in the middle and the 4th one more faintly indicated; the interpleural and pleural furrows are not directed so strongly backwards and the 1st interpleural and the 3d pleural furrows make a distinct bend, whereas they appear to be straight or nearly straight in REED's form.

As already mentioned above, these pygidia are very like that of *Pl. cicatricosus* and probably this species and *Pl. latus* are very closely allied, possibly the latter ought only to be regarded as a variety of the former, but until the characters of the cranidium of this are definitely known this point cannot be decided (Cf. below p. 288).

Horizon and Localities. — Lower Leptæna Limestone; Furudal, Kullsberg, Sätra.

Platylichas angulatus n. sp. Pl. VII, figs. 28—30.

Specific Characters. — Glabella defined by distinct furrows except posteriorly at the sides, where it coalesces or almost coalesces with the fixed cheeks, wider than long, flattened posteriorly, curving steeply downwards anteriorly and overhanging front margin; its anterior outline sub-angular; its anterior margin broadly rounded. Central lobe of glabella with very slight independent convexity in middle, growing more flattened posteriorly, expanded in front and overhanging bi-composite lobes for nearly their full width, narrowing posteriorly to about two sevenths the anterior width at some distance behind the middle, then increasing slightly in width to inner extremities of bi-composite lobes, where it becomes abruptly wider and then continues posteriorly with nearly parallel sides to occipital furrow, where its width is about four sevenths the frontal width. Bi-composite lobes irregularly sub-ovate in outline, narrowing posteriorly and with the longer axes directed obliquely outwards and forwards, moderately convex transversally, distinctly, but not highly raised above central lobe, strongly convex longitudinally with their anterior third steeply curved down and overhanging front margin. Basal lateral glabellar lobes quadrilateral in outline, shortest on the inside, their surfaces very slightly rounded and sloping very slightly upwards laterally, almost confluent with the surfaces of the fixed cheeks, being marked off on the outside by extremely weak narrow impressions only. Anterior lateral glabellar furrows rather narrow, strongly impressed, growing narrower and shallower posteriorly behind junction with basal lateral furrows. 2d pair of lateral glabellar furrows obsolete, being represented only by very slight indentations in the inner margins of the bi-composite lobes at some distance behind their middle. Basal lateral glabellar furrows somewhat shallower than anterior ones, nearly straight and making an angle of about 65° with median line of glabella. Anterior border of cranidium narrow, rounded and bent downwards in front, growing flattened and bending outwards at sides. Anterior border furrow narrow and shallow in the middle, growing stronger laterally. Occipital furrow relatively deep and wide and straight in the middle, dividing at sides; the divisions narrower than the central portion. Main portion of occipital ring (imperfectly preserved) broad in the middle, narrowing laterally, strongly arched. Occipital lobes sub-triangular in outline, with gently rounded surface sloping steeply downwards posteriorly.

Anterior portions of fixed cheeks short and very narrow, posteriorly confluent with palpebral lobes, rounded transversally, curving steeply downwards anteriorly. Posterior portions of fixed cheeks (incompletely preserved) sloping steeply downwards (though less steeply than anterier portions) posteriorly with gently convex surface. Palpebral furrows sigmoidally curved, strong adjacent to axial furrows, weak at about the middle, growing stronger again posteriorly. The palpebral lobes seem to have been rather long and bent upwards. Anterior branches of facial sutures converging rather strongly anteriorly.

Surface of cranidium, except in the furrows and on the anterior border, covered by low, rounded tubercles of different sizes. All the tubercles are relatively small, except a single large one on the central lobe, situated on the median line somewhat nearer the anterior than the posterior margin where the surface begins to slope strongly downwards, possibly this large tubercle is the base of a small spine.

Dimensions. — In the two specimens observed the distance along the median line between the posterior and the anterior margins of the glabella is 1) 6,5 mm. 2) 5,5 + mm. and the greatest width of the glabella 1) 8,3 mm. 2) 7 mm.

Remarks. — The material on which this new species is founded consists of two cranidia from Kallholn in the Upsala Museum, In neither of them are the occipital ring and the free cheeks completly preserved, but otherwise they show the characters distinctly.

Affinities. — The cranidium of this species closely resembles the cranidia from the East and Middle Baltic Borkholm Formation which SCHMIDT (1885, p. 122, Pl. V, figs. 25 a—c) and WIMAN (1901, p. 170, Pl. V, figs, 8—9) described and figured as *Lichas cicatricosus* LOVÉN (Cf. above p. 282). In these, however, the strong downward slope of the anterior portion of the glabella commences nearer the occipital furrow; the central glabellar lobe is more contracted between the bi-composite lobes, and the anterior lateral glabellar furrows do not bend so strongly or so suddenly outwards at the bases of the latter, which are more strongly convex and raised more highly above the central lobe, and elliptical rather than ovate in outline; the anterior border is relatively broader and more pronounced and — at least in WIMAN's specimen, which I have been able to examine — tuberculated; and the central lobe of the glabella bears two large tubercles, which are placed nearer the anterior margin than is the single large tubercle in our species.

Horizon and Locality. — Upper Leptæna Limestone; Kallholn.

Platylichas sp. ind. a. Pl. VII, fig. 15.

Remarks. — An incompletely preserved cranidium from Lissberg in the Museum of the University of Stockholm recalls that of *Pl. latus,* but differs from this in some features. The posterior portion of the glabella is more flattened and the strong downward slope of its anterior portion commences considerably farther forwards; the fixed cheeks seem to slope less steeply downwards posteriorly; the anterior lateral furrows bend more suddenly outwards at the bases of the bi-composite lobes; these latter are relatively somewhat narrower; and the occipital ring bears a median tubercle, which, though rather small, is decidedly larger and higher than any of the other tubercles on the cranidium, which are of varying sizes but all small, none of them appearing especially large in relation to the surrounding ones. The cranidium is quite small, the distance between its anterior and posterior margins being about 6 mm. only, but it differs even more from the small cranidia of *Pl. latus* than from the larger ones, since the former as pointed out above (p. 283) are more convex than the latter.

The difference between the two forms ought not perhaps to be regarded as having specific, but only varietal importance. I have not, however, recorded this cranidium as representing a variety of *Pl. latus* because it appears probable that it belongs to *Pl. cicatricosus* (Cf. above). In the style of ornamentation of the test it resembles this (the pygidium), and its likeness to the cranidium of *Pl. latus* and the close resemblance between the pygidium, which appears to belong to the latter form, and that of *Pl. cicatricosus* favours this belief. Should this prove correct and the two forms be referred to the same species, the older name *cicatricosus* must of course be kept and TÖRNQUIST's form be called *Pl. cicatricosus* var. *latus*. However, further proofs are needed before we can be certain that the cranidium in question really is referable to *Pl. cicatricosus*. Possibly it may belong instead together with the pygidium which will be described below as *Pl.* sp. ind. b., which has been found at the same locality and which also shows a similar ornamentation.

Horizon and Locality. — Upper Leptæna Limestone; Lissberg.

Platylichas sp. ind. b. Pl. VII, fig. 18.

Remarks. — A small fragmentary pygidium, measuring about 5,5 mm. in length, from Lissberg in the Museum of the University of Stockholm shows some interesting features. In most of its characters it resembles as far as it is preserved the pygidium of *Pl. cicatricosus* (Cf. above p. 280) rather closely, but the axis is relatively somewhat longer and more tapering posteriorly, the 3d axial ring furrow stronger in the middle, the 4th one more distinctly marked at sides, the 2d interpleural furrow more curved, and the axial furrows do not bend outwards near their extremities. The most striking difference, which proves it to be referable to a distinct species, is, however, that the 3d pair of pleural furrows begin in the axial furrows close to the 2d pair of interpleural furrows, whereas in *Pl. cicatricosus* as well as in most other Lichadidæ, they begin at a marked distance from these. They reach also somewhat nearer the margin than in the species just mentioned and are directed a little more strongly backwards, curving slightly inwards and growing weaker near their extremities, and connected with the posterior ends of the axial furrows by very weak, ill-defined depressions, which separate the gently raised anterior portions of the inner pleural bands from the more flattened marginal portions.

It is possible, as remarked above, that this pygidium may belong to the same species as the cranidium from Lissberg described as *Platylichas* sp. ind. a, although I am more inclined to believe that the latter is referable to *Pl. cicatricosus,* and it is also quite conceivable that the former belongs to *Pl. angulatus,* the ornamentation of its test being similar to that of the cranidia designated above (p. 286) with this specific name.

Horizon and Locality. — Upper Leptæna Limestone; Lissberg.

Platylichas? sp. ind. c. Pl. VIII, fig. 42.

Remarks. — A small imperfectly preserved hypostoma from Kallholn in the Upsala Museum may belong to one of the species of *Platylichas* from the Upper Leptæna Limestone described above or possibly to *Dicranopeltis elegans* (See below p. 291).

The hypostoma is broader than long, widest a little behind its middle. The central body is defined at sides and posteriorly by strong furrows, gently convex, wider than long and seems to have been broadly rounded or very obtusely pointed in front (the anterior edge is not preserved); the sides are straight and converge posteriorly, the posterior margin is gently curved forwards in the middle and at the sides; it is marked at sides at about two thirds the length from the anterior end by a pair of short, nearly transverse, rather deep middle furrows, which expand and grow deeper at their inner extremities. The border is wide; the portion behind the central body is gently convex transversally and has the posterior margin excavated by a deep rounded notch; the lateral portions are rather strongly convex anteriorly, growing more flattened posteriorly. The marginal portions of the lateral borders are marked by weak striæ subparallel to the outer edge. On the other portions the surface is not well enough preserved to show the ornamentation clearly, but there seem to have been small pits and irregular impressed lines with ridges between them.

Horizon and Locality. — Upper Leptæna Limestone; Kallholn.

Platylichas sp. ind. d. Pl. VII, figs. 39—41.

Description. — Hypostoma about three fourths as long as wide, widest near front end, tapering rather rapidly posteriorly. Central body gently rounded, about three fifths as long as wide, the anterior margin very broadly rounded, the lateral and posterior ones forming a nearly continuous and even curve; marked at sides at about the middle by short, slightly oblique furrows, which are very shallow adjacent to the lateral furrows — in one of the specimens quite obsolete — but deepen and expand a little within. Lateral and posterior furrows wide and rather shallow. Anterior furrow narrower. No real anterior border present, only a narrow rim, which forms the front wall of the anterior furrow and which disappears, or almost disappears, in the middle. Anterior wings very narrow (longitudinally) and placed very far forwards. Lateral borders rather narrow, gently convex, growing more flattened posteriorly, where they merge into the posterior border. Posterior border rather broad (its relative width varying a little in different specimens), swollen adjacent to central body, flattening out towards margin; postero lateral extremities of border broadly rounded, with shallow, narrow notch between them. (Ornamentation not observed).

Remarks. — The material from which the above description is drawn up consists of 3 specimens from Kullsberg — in the Upsala Museum, the State Museum of Natural History, and in ISBERG's collection in Lund — the smallest measuring about 3 mm. in length, the largest approximately 8 or 8,5 mm. They seem to belong to a species of *Platylichas,* possibly to *Pl. bottniensis* (Cf. above p. 280, and below Pl. VII, fig. 19), in which species — especially in the form from the Leptæna Limestone, which seems referable to it — the cranidium is very broadly rounded in front.

Horizon and Locality. — Lower Leptæna Limestone; Kullsberg.

Genus **Dicranopeltis** CORDA.

Dicranopeltis elegans TÖRNQVIST. Pl. VII, figs. 27, 31; Pl. VIII, figs. 9—10.

1884. *Lichas elegans* TÖRNQUIST, p. 29, Pl. I, fig. 25.

Specific Characters. — Cranidium sub-triangular in outline, very convex. Anterior border of moderate, nearly uniform width, flattened, marked off by strong furrow; its anterior margin broadly convex. Glabella well defined, sub-pentagonal in outline, widest a little in front of middle of bi-composite lobes, flattened posteriorly, the anterior slope very convex and slightly protuberant. Central glabellar lobe widest at anterior margin, narrowing posteriorly to about one third its anterior width at junction of anterior with basal lateral furrows, where it occupies about one third the width of entire glabella, back of this point it widens a little and is almost coalescent with basal lateral lobes; this posterior portion is (at least in some specimens) very slightly raised above the anterior portion but not separated from this by any distinct furrow or groove; the anterior portion is very strongly curved longitudinally, transversally it is moderately convex in front and grows gradually more flattened posteriorly. Bi-composite lobes rather large, convex, nearly twice as long as wide, irregularly sub-elliptical in outline, with pointed extremities and the longer axes directed obliquely forwards and outwards. Basal lateral glabellar lobes very gently convex, quadrilateral in outline, rather wider than long, less than half the size of bi-composite lobes, not marked off sharply from central lobe. Anterior lateral glabellar furrows deep, rather narrow, converging posteriorly and describing an outwards concave curve from their anterior points of origin to junctions with basal lateral furrows, beyond which they are continued back to occipital furrow by slight, ill-defined grooves. 2d pair of lateral glabellar furrows obsolete. Basal pair of about the same depth and width as anterior pair and confluent with them along inner-posterior extremities of bi-composite lobes, from this point to their junction with axial furrows they are nearly straight and directed obliquely forwards. Axial furrows deep and strong anteriorly, becoming somewhat shallower posteriorly outside basal lateral glabellar lobes and occipital lobes; describing an outwards convex curve from their origination in preglabellar furrow to junction with basal lateral glabellar furrows, beyond which they describe a very slightly concave curve past outer extremities of basal glabellar lobes, and then another slightly convex curve outside occipital lobes.

Occipital furrow rather broad and deep and straight in the middle behind central lobe of glabella, dividing at sides; the divisions somewhat narrower than the middle portion. Main portion of occipital ring (imperfectly preserved) rather broad in middle, narrowing at sides behind occipital lobes, arched transversally, gently rounded longitudinally. Occipital lobes relatively large, sub-triangular, their lateral extremities reaching farther outwards than base of glabella, flattened, sloping downwards posteriorly.

Fixed cheeks strongly convex longitudinally, with very abrupt anterior slope and somewhat more gentle posterior slope, very narrow, bandlike in front of eye lobes, behind latter gradually increasing in width posteriorly to nearly half that of glabella at level of basal lateral furrows and sloping gently downwards towards the sides; their posterior margins curving gently forwards laterally. [Palpebral lobes not preserved]. Posterior borders of fixed cheeks very narrow increasing in width laterally, flattened, marked off by distinct, narrow furrows. Anterior branches of facial sutures converging rather strongly anteriorly; posterior branches curving from eye lobes backwards and slightly outwards.

Pygidium (imperfectly preserved) sub-semielliptical in outline, rather less than two thirds as long as wide. Axis extending less than half the length of pygidium and occupying anteriorly less than one third the entire width, narrowing posteriorly, strongly convex, with 2 rather narrow, slightly rounded axial rings — the 2d rather indistinctly defined behind in the middle — and a rather short terminal piece, which is bulbously swollen in the middle. Behind the axis is a long, tapering, pointed post axial portion, which anteriorly is gently convex and slightly raised above the side lobes, but posteriorly lies in the same general plane as these. Axial furrows deep, narrow, converging posteriorly, continued behind extremity of axis to posterior margin of pygidium bounding the post axial portion, decreasing somewhat in depth posteriorly. Side lobes flattened, horizontally extended, consisting of 3 pairs of completely defined, broad, furrowed pleuræ, all ending in free, backwardly directed points. Interpleural and pleural furrows deep, rather narrow, all about equally strong and nearly straight, except that the former grow very weak and bend slightly outwards just before reaching the margin. Anterior pair of furrows directed very slightly backwards, the following ones successively directed more and more strongly backwards. Anterior pair of pleuræ (imperfectly preserved) seemingly like 2d pair of moderate width and increasing in width to a little beyond middle. Free termination of anterior pairs of pleuræ relatively long. 3d pair of pleuræ broad, their outline almost a right-angled triangle; the free points approximate, shorter and more broad-based than those of preceeding pairs.

Surface of cranidium and pygidium, except in the furrows, covered with rounded tubercles of different sizes placed rather close together; the largest ones occur on the central and bi-composite glabellar lobes a little in front of their middle.

Dimensions. — In the type specimen (cranidium) the distance between the anterior and posterior margins is approximately 8 mm. (the specimen is not quite complete) and the greatest width of the glabella is a little over 7 mm. The other cranidia observed are somewhat smaller. In the only pygidium known the length (the articulating half-ring not included) is 5,3 mm. and the greatest width approximately 9 mm.

In addition to the cranidia on which TÖRNQUIST founded this species, there is available now a cranidium from Lissberg in the Museum of the Geological Survey, and in the same Museum is a somewhat incomplete pygidium from the same locality, Osmundsberg, as the type specimen.[1] That the pygidium belongs to this species seems to be beyond a doubt. It corresponds to the cranidia in size and agrees with them in the style of ornamentation, and — which seems to be evidence of greater importance — it is very like the pygidium of *Dicr. decipiens* WINCH. and MARCY (WELLER, 1907, p. 237, Pl. XXII, figs. 10—11), whose cranidium closely resembles that of our species.

Affinities. — As just mentioned this species shows a great likeness to *Dicr. decipiens* WINCH. and MARCY. The American species, which is of Silurian age (Niagaran), seems to reach larger dimensions than ours, the cranidium appears to be less convex, the glabella to be longer in relation to its width, and the grooves which run backwards from the points of junction between the anterior and basal glabellar furrows to converge instead of diverge posteriorly. The pygidium differs, to judge from the figure, in the more parallel-sided axis, the more curved 1st interpleural furrows, the considerably shorter free terminations of the two anterior pairs of pleuræ, and in the relatively narrow 3d pair of pleuræ.

The cranidium from the Keisley Limestone described and figured by REED (1896, p. 428, Pl. XXI, figs. 8—8 b) as *Lichas bulbiceps* PHILL. MS. seems also to be an allied form. This too is considerably larger than

[1] TÖRNQUIST states in the work cited above (1884, p. 30) that the species has been found at Boda and Gulleråsen, but does not mention Osmundsberg. In the explanation to the plate (p. 99) he states, however, that the specimen figured is from Osmundsberg and he has also labelled it himself with the name of that locality. Possibly Boda is (in the text) miswritten for Osmundsberg. The species does not seem to be represented from Boda in TÖRNQUIST's collection, or as far as I know in any other collection, though it does not seem at all unlikely that it may occur at that locality.

any of the cranidia of our species, which have come under my notice; its central glabellar lobe is less expanded in front and the antero-lateral expansions less pointed; the direction of the bi-composite glabellar lobes is less oblique to the median line of the glabella, and they reach farther forwards and downwards; further the distal portions of the basal lateral glabellar furrows are very weak. It appears probable to me that the pygidium from the same formation, which REED (Op. cit., p. 431, Pl. XXI, fig. 7) has called *Lichas bifurcatus* belongs to *Lichas (Dicranopeltis) bulbiceps*.[1] It resembles rather much both the pygidium of our species and that of *Dicr. decipiens.* It seems to have been more triangular in outline than the former, the free terminations of the 2d pair of pleuræ are much shorter (the anterior pleuræ are not preserved), the 3d pair of pleural furrows are directed more straight backwards and their extremities are connected by faint grooves with the prolongations of the axial furrows, which for the greater part of their length are straight as in our species, but somewhat less strongly converging posteriorly, but from the points where they are joined by the grooves just mentioned they bend inwards and converge about twice as rapidly as before; further there is according to REED (Op. cit.) a faint 3d ring furrow on the axis.

Horizon and Localities. — Upper Leptæna Limestone; Osmundsberg, Lissberg in Gulleråsen (Boda?).

Genus **Lichas** DALMAN s. str.

Distinguishing Characters of the Species.

Central lobe of glabella across its narrowest portion narrower than bi-composite lobes, the strong downward slope of its anterior portion commencing at about two thirds the distance from occipital furrow to anterior margin of glabella. Antero-lateral angles of pygidium slightly rounded; lateral margins of 1st pleuræ almost straight and nearly at right angles to anterior margins; posterior portions of axial furrows sub-parallel (or bent very slightly outwards). *L. laciniatus* WAHLBG.

[1] In the Museum of Practical Geology, London, there is, according to REED (Op. cit., p. 430), a similar pygidium from Kildare mounted with a cranidium of this species on a tablet labelled *L. bulbiceps* M. S. [There is, according to the same author (Op. cit.), also another tablet labelled with the same specific name on which a cranidium of the species is associated with a different (Lichad) pygidium]. REED is of the opinion that the affinities of the species, as represented by the cranidium, are with *Lichas verrucosus* EICHW. [In his paper of 1902, pp. 73, 82, he refers it to *Metopolichas* (= *Lichas* s. str.)], and gives (Op. cit. 1896, p. 431) as a reason for not referring the pygidium in question to this species that »no species allied to the latter has a pygidium with such characters». The pygidium he considers to be related to *Lichas (Platylichas) margaritifer* NIESZK. (In 1902, pp. 73, 82 he refers it to *Platylichas*). Both the cranidium and the pygidium in question seem, however, to agree more closely in characters with species of *Dicranopeltis* than with those just mentioned and appear to be referable to this genus and to the same species.

Central lobe of glabella everywhere wider than bi-composite lobes, the strong downward slope of its anterior portion commencing considerably nearer occipital furrow than anterior margin of glabella. Antero-lateral angles of pygidium rather broadly rounded, outer margins of 1st pleuræ forming rather even curves from fulcra to free points of pleuræ: axial furrows distinctly diverging posteriorly. *L. affinis* ANG.

Lichas laciniatus WAHLENBERG. Pl. VIII, figs. 14—18, 19?, 20; text-fig. 20.

1818. *Entomostracites laciniatus*, WAHLENBERG, p. 34 (pars), Pl. II, fig. 2* (non fig. 2).
1822. *Paradoxides laciniatus*, BRONGNIART, p. 35 (pars), Pl. III, fig. 3 (excl. cranidium).
1826. *Asaphus (Lichas) laciniatus*, DALMAN, p. 278 (pars) Pl. VI, fig. 1?[1]
1837. *Lichas laciniatus*, HISINGER, p. 17 (pars), Pl. III, fig. 7?[2]
1845. *Lichas laciniatus* α, LOVÉN, p. 55, Pl. I, fig. 7 a.
1845. *Lichas laciniata*, BEYRICH, p. 26, Pl., fig. 17.
1846. *Lichas laciniata*, BEYRICH, p. 6, Pl. I, fig. 5 b (fig. 5 a?).
1854. *Lichas affinis*, ANGELIN, p. 69 (pars), Pl. XXXVI fig. 2 a (non figs. 2, 2 b) Pl. XXXVIII, fig. 4 b (figs. 4—4 a?).
1854. *Lichas laciniatus*, ANGELIN, p. 69 (pars), Pl. XXXVI, fig. 1 (excl. pygidium), fig. 1 a.
1854. *Lichas conformis*, ANGELIN, p. 74, Pl. XXXVIII, fig. 5.
1896. *Lichas affinis*, REED. 427 (pars?).
1896. *Lichas conformis* var. *keisleyensis*, REED, p. 427, Pl. XXI, fig. 10.

Specific Characters. — Cephalon gently convex, sub-triangular in outline, much wider than long, broadly rounded in front; the anterior margin slightly arched upwards in the middle; the border surrounding it anteriorly and laterally very narrow and slightly rounded in the middle in front, growing flattened and rapidly increasing in width towards the sides, marked off in front of glabella by distinctly impressed, narrow furrow, very indistinctly marked off from anterior portions of cheeks, more distinctly along middle of fixed cheeks, though not by impressed furrows, more indistinctly again posteriorly.

Glabella flattened posteriorly, curved downwards in front, somewhat wider than long, broadly rounded in front, widest a little in front of middle, narrowing posteriorly to opposite posterior extremities of anterior lateral furrows, then becoming nearly parallel-sided, its basal width about four fifths the anterior and five sevenths the greatest width. Central lobe of glabella wide in front with obtusely pointed antero-lateral extremities, narrowing rapidly posteriorly to opposite middle of palpebral lobes, where its width is about one fourth that at its anterior margin and less than one third that of entire glabella, then generally widening slightly to opposite inner extremities of bi-composite lobes, and then suddenly expanding at base to rather more than half its frontal width and coalescing or almost

[1] DALMAN's figure seems to have been drawn from, at least two, different specimens, belonging to this species and to *L. affinis* (Cf. below, p. 299).
[2] HISINGER's figure is a copy of DALMAN's.

coalescing with basal lateral lobes; its anterior clavate portion rather strongly convex in both directions, the strong downward slope of the anterior portion commencing at about two thirds the distance from occipital furrow to anterior margin of glabella, the neck very slightly convex especially posteriorly where the surface is slightly depressed beneath the surfaces of the bi-composite lobes and that of the basal, expanded portion of the central lobe, the latter having a slight convexity of its own, which marks it off indistinctly also from the basal lateral lobes. Bi-composite lobes sub-oval in outline, pointed in front, about twice as long as wide, with a marked though not very strong convexity of their own, posteriorly coalescing with basal lateral lobes. Basal lateral lobes small, sub-quadrilateral in outline, flattened, sloping slightly downwards posteriorly, coalescing anteriorly with bi-composite lobes and indistinctly marked off internally from central lobe. Anterior lateral glabellar furrows rather strongly impressed, more deeply so on casts than on the surface of the test, rather wide in front, narrowing posteriorly, but widening again near their posterior extremities, curving from the points of junction of preglabellar and axial furrows inwards and backwards, nearly parallel to middle portions of axial furrows until in a line with middle of palpebral lobes, then curving slightly outwards, or running nearly straight backwards to inner extremities of bi-composite lobes and then making a sharp turn outwards and ending at about equal distances from occipital and axial furrows. 2d lateral glabellar furrows represented by slight indentations of anterior furrows into inner sides of bi-composite lobes at about the middle of their length, generally more distinct on interior casts, on the surface of the test sometimes only indicated by the smoothness of the test at these places. Basal lateral glabellar furrows obsolete, or in a few specimens represented by exceedingly weak and narrow depressions running from posterior ends of anterior furrows obliquely forwards towards axial furrows, but dying out before reaching these. Axial furrows of moderate strength, sigmoidally curved, describing a rather slight outwards convex curve around antero-lateral portions of bi-composite lobes, than a concave curve to posterior margin of cranidium.

Occipital furrow shallow, rather broad and nearly straight behind central lobe of glabella, dividing at sides, the anterior division on each side of about the same depth and nearly as wide as central portion, the posterior one narrower and deeper. Main portion of occipital ring rather broad in the middle, narrower, but not very narrow and nearly parallel-sided at sides behind occipital lobes, rather strongly arched transversally, with the surface slightly rounded and sloping gently downwards anteriorly, and with a small median tubercle — not much larger than the largest of the other tubercles of the test — placed near the posterior edge; extending much farther towards the sides than base of glabella, the distance between its lateral extremities being about equal to one and a half times the width of latter; its posterior margin slightly curved forwards in the middle and at the sides. Occipital lobes elongated sub-oval in outline, with pointed lateral extremities and the longer axes directed slightly backwards, produced at sides beyond base of glabella, but not reaching as far outwards as main portion of occipital ring, projecting slightly in front of latter, their surfaces slightly raised and sloping gently downwards postero-laterally.

Cheeks (imperfectly preserved) moderately convex. Eye lobes reniform — the palpebral furrows curving strongly outwards in the middle. Palpebral lobes broadly crescentic, convex transversally with steep inner and gentle lateral slopes, gently concave longitudinally, distinctly raised above adjacent portions of fixed cheeks. Palpebral furrows weak in the middle, where their anterior and posterior portions meet at nearly right angles, growing stronger anteriorly and posteriorly, continued on free cheeks by rather strong furrows, which mark off the comparatively high, lower eyelids. [Eyes not preserved]. Lateral borders of cheeks flattened, growing very wide and indistinctly marked off posteriorly; posterior borders of moderate width adjacent to axial furrows, increasing in width laterally, slightly rounded, marked off by distinct, though not very deep furrows, their posterior margins directed slightly forwards. [Genal angles not preserved]. Anterior branches of facial sutures diverging slightly anteriorly from eye lobes to near anterior border, then bending obliquely inwards and cutting anterior margin at a distance from each other about equal to width of glabella in front; posterior branches running from eye lobes obliquely outwards.

Rostrum narrow, band-like, not much wider than downbent edge of anterior margin, gently rounded, bent nearly straight downwards, with obliquely truncated lateral ends, surface marked by a few raised ridges parallel to margin. Similar ridges occur on the doublure of the fixed cheeks and on the edge of the anterior margin of the cephalon.

Pygidium sub-triangular in outline, obtusely pointed behind, about two thirds as long as wide. Axis extending fully one third the length of pygidium and anteriorly occupying rather less than one third the entire width of latter, tapering posteriorly, rather strongly raised, with flattened sides and obtusely pointed apex, the surface behind latter sloping steeply downwards to post axial piece; marked anteriorly by 2 or 3 axial ring furrows, of which the anterior one is rather strong and continuous across the axis, the 2d one weaker and interrupted in the middle, in most specimens a 3d furrow is represented by short and generally very weak side portions. Axial furrows of moderate strength, nearly straight at sides of axis, curving inwards gently at its extremity, prolonged behind this but not reaching margin of pygidium; the course of the prolongations vary in different specimens and even in the same one the furrow on the one side may have a somewhat different course than that on the other[1]: in their

[1] This latter condition may, however, perhaps be caused by pressure. I have noticed it chiefly in specimens from Västergötland preserved in shales or in specimens from the Leptæna Limestone, which in other features too show signs of pressure.

general course they diverge, though not very strongly posteriorly, and as a rule they seem to run at first nearly straight backwards or to diverge slightly posteriorly, then to take a turn obliquely outwards and finally to run more straight backwards again; the length of the differently directed portions varies, however, the difference in the directions may also be very slight, so that in some specimens the whole of the prelongations of the furrows behind the axis may be nearly straight. Post axial piece gently convex and raised above side lobes adjacent to axis, the surface sloping distinctly posteriorly to about the points, where the axial furrows take their outward turn; the posterior portion slightly keeled in the middle and here higher than adjacent portions of side lobes, laterally depressed below these. Side lobes flattened within, their outer portions very slightly, nearly imperceptibly bent down; consisting of 3 pairs of pleurae; the two anterior pairs completely defined, with straight outer margins, and ending in rather short backwards directed free points; 3d pair posteriorly confluent with post axial piece, without free points. Each pleura marked by strong pleural furrow not quite reaching the margin; anterior pair strongly, 2d pair more slightly curved, 3d pair beginning in axial furrows rather close to 2d pair of interpleural furrows and somewhat in front of apex of axis, nearly straight and directed slightly outwards for the greater part of their length, but curving gently inwards posteriorly and nearly joining axial furrows, in some specimens they seem even to be connected with these, though the hindmost portions are very weak. Lateral margin of 1st pleura nearly at right angle to anterior margin, fulcrum remote, its distance from axial furrow about equal to five sixths anterior width of axis, antero-lateral angle only slightly rounded. Pleural bands with slightly rounded surfaces; anterior bands of 3d pleurae more depressed than other pleural bands; tips of anterior pairs and hindmost portions of 3d pair of pleurae still more flattened. Doublure of pygidium comparatively narrow, widening posteriorly, concentrically striated.

Fig. 20. *Lichas laciniatus* WAHLBG. Pygidium. The original type specimen. Slightly reduced. Bestorp. Västergötland. Upsala Museum.

Surface of cephalon and pygidium, except in the furrows, ornamented with relatively sparsely distributed, rather large and medium sized, pointed tubercles, with a large number of small and minute ones between them.

Dimensions. — The dimensions of WAHLENBERG's type specimen (pygidium) are: length 18 mm., width 27 mm. In the largest pygidium from the Leptæna Limestone, which has come under my notice, the length is 30 mm., and in the smallest one about 12,5 mm. The dimensions of some cranidia from Borenshult (1) and Lissberg (2, 3) are: distance along the median line between anterior and posterior margins 1) 21 mm. 2) 16,5 mm. 3) over 30 mm., greatest width of glabella 1) 18 mm., 2) 14 mm.

Remarks. — There has been much uncertainty and confusion about this species which was founded primarily by WAHLENBERG (1818), who, under the name of *Entomostracites laciniatus,* figured a pygidium from Mösseberg (Bestorp) in Västergötland. DALMAN (1826, pp. 252, 279) reported the species both from Mösseberg and from Borenshult in Östergötland and gave also a figure of a pygidium (Op. cit. Pl. VI, fig. 1). Later on LOVÉN (1845, p. 55) pointed out that the original specimens belong to two somewhat different forms, which he described and figured as *L. laciniatus* α (Op. cit. Pl. I, fig. 7 a) and *L. laciniatus* β (Pl. I, fig. 7 b). The former had, according to him, been found at Borenshult, the latter both at this locality and at Mösseberg. Neither of the specimens figured by LOVÉN is, however, WAHLENBERG's type-specimen. Probably they are specimens referred to this species by DALMAN and the figure given by this author (Op. cit.) seems to be a restoration drawn from both of them. The original specimen (text-fig. 20) from Bestorp (Mösseberg) belongs to LOVÉN's form α (which LOVÉN only reported from Borenshult). It seems as if LOVÉN had not seen this and supposed it to belong to the same form (β) as DALMAN's specimen (or specimens) which had been found at this locality. ANGELIN, who (1854) referred the forms to separate species, apparently belived the same. The pygidium which he referred to his new species *L. affinis* belongs to *L. laciniatus,* but not the one which he attributed to WAHLENBERG's species. The cranidium from Borenshult described and figured by him (Op. cit. p. 69, Pl. XXXVI, figs. 2, 2 b) as *L. affinis* does not, however, seem to belong to the same species as the pygidium, which he associated with it, and is thus to be regarded as the real type-specimen of *L. affinis*.[1] To this species (*L. affinis*) the pygidium which ANGELIN attributed to *L. laciniatus* seems to belong, whereas the cranidium which he referred to the latter species really seems to belong to it. BEYRICH had earlier (1845, p. 26) pointed out that the two forms in question ought to be referred to different species and proposed that the name *L. laciniatus* should be kept for LOVÉN's form α (of which he gave a new description and a figure) and a new name be given the other although he apparently was unaware of the fact that WAHLENBERG's type-specimen belonged to the former. ANGELIN does not seem to have noticed this, at least he has not quoted BEYRICH.

The two species *L. laciniatus* and *L. affinis* have been found associated in the same beds at several localities and are undoubtedly closely allied. No entire individual is known of either, but the somewhat different ornamentation indicates which cranidia and pygidia belong to the same species. — Of *L. laciniatus* a great number of specimens has been found both in the Leptæna Limestone in Dalarne (especially at Lissberg), in the Brachiopod Shales in Västergötland and in the limestone belonging

[1] The cranidium from the Leptæna Limestone figured by ANGELIN (Op. cit. Pl. XXXVIII, figs. 4—4 a) as *L. affinis*, on the other hand, seems, as far as can be judged without seeing the original, to be referable to the same species as the pygidium, viz. *L. laciniatus.*

to the Brachiopod Shale Formation at Borenshult in Östergötland. It has further been found in the Keisley Limestone at Keisley in England.

The cranidia preserved in Limestone agree well in all features. Those from the Brachiopod Shales in Västergötland, which I have had the opportunity to examine, are much pressed, therefore it is difficult to be quite sure of their characters, but on the whole they seem to agree with the others. The cranidium from Västergötland figured by ANGELIN (1854, Pl. XXXVI, figs. 1—1 a) seems to differ slightly in the convexity and in the somewhat narrower bi-composite glabellar lobes; these differences may partly be due to pressure, but it does not appear improbable that the figure is incorrect. In the figure of the cranidium given by BEYRICH (1846, Pl. I, fig. 5 a) the bi-composite glabellar lobes are still narrower, and possibly the cranidium does not belong to *L. laciniatus*, but to *L. affinis*, although in other features it seems to agree better with the former.

The pygidia differ much, as already mentioned in the description, in the course of the posterior portions of the axial furrows. The large pygidium figured below on Plate VIII (fig. 18) and the one figured by BEYRICH (1846, Pl. I, fig. 5 b) represent two in this respect very different types, but there are a great many transition forms, and this difference does not appear to be even of varietal importance. In the light of this it is impossible to regard the pygidium from the Leptæna Limestone described and figured by ANGELIN (1854, p. 74, Pl. XXXVIII, fig. 5) as *L. conformis* ANG. as representing a separate species or even a distinct variety. ANGELIN's type specimen is in the State Museum of Natural History, and consists of the imprint of not quite the half of a pygidium. The axial furrow has about the same course as in BEYRICH's figure just mentioned, and otherwise it agrees, as far as it is preserved, closely with typical specimens of our species. ANGELIN's figure is quite unsatisfactory. The pygidium from Keisley (in the Sedgewick Museum in Cambridge) which REED (1896, p. 427, Pl. XXI, fig. 10) has described and figured as *L. conformis* var. *keisleyensis* is consequently referable to *L. laciniatus*, and, as far as I am able to judge, it does not seem to represent a distinct variety. REED has mentioned three points of difference between this and ANGELIN's figure of *L.* »*conformis*». Two of these depend only on the fact that ANGELIN's figure is incorrect, and the third does not seem either to be of any importance. According to REED, the axial furrows in the Keisley form do not completely pass into the furrows which mark out the sides of the post axial piece but curve inwards at the posterior end of the axis, »become less distinct, and do not quite meet in the centre.» What he regards as the posterior portions of the (real) axial furrows are, however, only weak grooves or wrinkles, not furrows in a proper sense. Similar, though generally still weaker, grooves are seen in several Swedish specimens too, but not in the best preserved ones, and it appears as if their existence was only caused by pressure. — In another pygidium from Keisley in the Sedgewick Museum, mentioned by REED

(Op. cit. p. 427) as *L. affinis* the prolongations of the axial furrows have about the same course as in the pygidium figured below on Plate VIII, fig. 18. — Of the specimens which TÖRNQUIST (Cf. TÖRNQUIST, 1884, p. 33) has attributed to *L. conformis* most are referable to *L. laciniatus*, one to *L. affinis*.

Some fragments of thoracic segments from Västergötland (associated with other portions of the carapace) and from Borenshult in the Upsala Museum belong evidently to this species. Most of the specimens are much pressed, and all in a very fragmentary condition. The axis seems to have been moderately convex and strongly tapering posteriorly; on some specimens it appears to have been considerably wider, on others (probably posterior segments) to be considerably narrower than the pleurae. The pleurae are straight and horizontally extended as far out as the fulcrum, which on some pleurae (apparently the anterior or middle-most ones) is situated about half-way out, and on others (posterior ones evidently) is very remote; the outer portions of the pleurae appear to be very slightly bent downwards, and are rather strongly curved backwards, tapering and ending in recurved points. The ornamentation is similar to that on the cephalon and pygidium.

Two somewhat different types of *Lichas* hypostomata have been found at Lissberg associated with cranidia and pygidia of this species and of *L. affinis*. It is difficult to decide which belongs to the former and which to the latter. One of them is, however, more broadly rounded in front and less convex than the other, and it appears most probable that this belongs to *L. laciniatus*. Its description is as follows: — Entire hypostoma gently convex transversally, sub-circular in outline, broadly rounded in front, with the posterior edge excavated by a broad and deep, rounded notch. Central body about as long as wide, with sub-parallel sides, rounded in front, truncate and very indistinctly defined behind, gently convex anteriorly, depressed behind the strong, gently curved middle furrows, which converge posteriorly at about 110° and extend about two thirds the way from lateral furrows to median line of body. Lateral borders rather wide and flattened posteriorly, narrowing and growing gently convex anteriorly. Anterior wings of moderate size, steeply inclined. Anterior border only represented by short, narrow side portions, marked off by narrow furrows. Posterior border wide, its surface almost confluent with that of central body anteriorly. Lateral furrows nearly straight and strongly impressed at sides of central body, produced a short distance behind it as shallow grooves, which curve slightly inwards near their extremities. Posterior furrow almost obsolete, only represented by slight transverse impression, except just at the sides adjacent to lateral furrows, where it is more strongly impressed. Surface, except in the furrows, ornamented with small rounded pits, and on the marginal portions of anterior and lateral borders marked also by rather fine, anastomosing ridges sub-parallel to margins.

Horizons and Localities. — Upper Leptæna Limestone; Lissberg, Boda, Osmundsberg (Dalarne). Brachiopod Shales; Bestorp on Mösseberg, Ålleberg (Västergötland, shale facies), Borenshult (Östergötland, limestone facies). Keisley Limestone; Keisley, England.

Lichas affinis ANGELIN. Pl. VIII, figs. 1—6, 7?, 8, 11—13, 21, 23?

1845. *Lichas laciniatus* β, LOVÉN, p. 55, Pl. I, fig. 7 b.
1854. *Lichas affinis*, ANGELIN, p. 69 (pars), Pl. XXXVI, figs. 2, 2 b (non fig. 2 a).
1854. *Lichas laciniatus*, ANGELIN, p. 69 (pars), Pl. XXXVI, fig. 1 (excl. cranidium).
1854. *Lichas cicraticosus*, ANGELIN, p. 74 (pars), Pl. XXXVIII, figs. 6—6 a (non fig. 6 b).
1884. *Lichas affinis*, TÖRNQUIST, p. 33, Pl. I, fig. 31.

Specific Characters. — Cephalon convex, broadly sub-triangular in outline, more than twice as wide as long, rounded in front, sides nearly straight; its anterior margin slightly arched upwards in centre; border surrounding it anteriorly and laterally very narrow and slightly rounded in the middle in front, growing flattened and rapidly widening towards the sides, becoming very wide, and slightly rounded again, posteriorly, marked off in front of glabella by distinctly impressed, narrow furrow, very indistinctly marked off in front of cheeks, more distinctly again, though not by impressed furrows, at sides of latter.

Glabella strongly convex longitudinally, 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 posteriorly, its basal width about five sevenths the greatest width and about four fifths that between antero-lateral extremites of central lobe. Central lobe of glabella very wide in front with pointed antero-lateral extremities, narrowing posteriorly to inner extremities of bi-composite lobes, where it occupies a little more than one third the entire width of glabella, then expanding and coalescing with basal lateral lobes, very strongly convex in both directions anteriorly; the neck more gently convex especially posteriorly, but everywhere raised above bi-composite lobes; the downward slope of the anterior portion commencing considerably nearer occipital furrow than anterior margin of glabella; the hindmost portion with slight convexity of its own, generally in transverse as well as in longitudinal direction, its lateral bounderies being thus indicated. Bi-composite lobes elongated sub-oval in outline, pointed in front, with marked, but not very strong independent convexity, posteriorly coalescing with the small basal lateral lobes. Anterior lateral glabellar furrows strong, curving from their anterior points of origin inwards and backwards nearly parallel to middle portions of axial furrows, but bending suddenly outwards and growing shallower near their extremities and generally ending somewhat nearer occipital than axial furrows, the outbent portions being as a rule very short. 2d lateral glabellar furrows represented by very slight (in some specimens not discernible) indentations of the anterior furrows into inner sides of bi-composite lobes at about the middle of their length. Basal lateral glabellar furrows entirely obsolete, or in a few specimens their inner portions represented by very weak and narrow grooves running from posterior extremities of anterior furrows obliquely outwards and forwards. Axial furrows of moderate strength, running from anterior border furrow (preglabellar furrow) at first backwards and slightly outwards to the points, where the palpebral furrows branch off, then in slight inwards convex curves to posterior margin of cephalon.

Occipital furrow broad, but not very deep, and nearly straight behind central lobe of glabella, dividing at sides, anterior divisions of about the same depth and nearly as broad as central portion, posterior ones narrower and deeper. Main portion of occipital ring rather broad, rather strongly arched transversally, gently rounded longitudinally; the distance between its lateral extremities about one and a half times the basal width of glabella; its posterior margin slightly arched forwards in middle and at sides. Occipital lobes sub-ovate in outline, with pointed lateral extremities, and the longer axes directed slightly backwards, produced at sides beyond base of glabella, but not reaching as far outwards as main portion of occipital ring, projecting slightly in front of latter; their surfaces slightly raised, sloping downwards postero-laterally.

Cheeks (imperfectly preserved) convex, sloping rather steeply downwards to border both anteriorly, posteriorly and laterally. Eye lobes large, their posterior extremities not quite reaching level of occipital furrow. Palpebral lobes sub-semicircular in outline, slightly concave in middle and with the marginal portions gently rounded, not raised above adjacent inner portions of fixed cheeks. Palpebral furrows weak in middle (almost obsolete on surface of test), strongly impressed anteriorly and posteriorly. Lower eyelid furrows strong. [Eyes not preserved]. Posterior borders of moderate width adjacent to axial furrows, widening laterally, gently rounded, marked off by distinct furrows, which grow wider and shallower towards the sides; their posterior margins directed slightly forwards. The genal spine (only a portion of the doublure preserved) seems to have been rather narrow and short. Anterior branches of facial sutures nearly parallel from eye lobes to near anterior border, then bending obliquely inwards to cut anterior margin at a distance from each other about equal to frontal width of glabella; posterior branches curving from eye lobes obliquely outwards and backwards.

Rostrum very narrow, gently rounded, with obliquely truncated lateral ends; its surface marked by a few coarse ridges parallel to margin. Similar ridges occur on the doublures of the free cheeks and on the edge of the anterior border.

Thorax (only the 6 posterior segments known) with moderately convex axis, which tapers rapidly posteriorly and occupies on the 6th segment from the posterior end about three sevenths and on the hindmost one about one third the width of entire segment. Axial rings gently rounded. Axial furrows narrow, distinctly impressed. Pleurae flattened, straight and horizontally extended as far out as fulcrum, which is rather weak, and on the middlemost segments situated a little more, on the hindmost ones a little less, than half-way out; extra-fulcral portions bent slightly backwards and somewhat more strongly downwards, ending in very short backwardly directed points. Each pleura marked by a strong, long, diagonal furrow.

Pygidium semielliptical in outline, about two thirds as long as wide; fulcrum on anterior edge distant from axis less than two thirds its width. Axis extending fully two fifths the length of pygidium, and anteriorly occupying rather more than one third its entire width, tapering posteriorly, rounded and indistinctly defined behind, moderately raised, with flattened sides and obtusely marked apex, the posterior slope from latter to post-axial piece generally more gentle than the lateral slopes; marked by one complete axial ring furrow, a 2d one which is very weak or interrupted in the middle, and with traces at sides of a 3d one. Axial furrows of moderate strength, nearly straight at sides of axis, curving gently inwards near its extremity, produced behind it, but not reaching margin of pygidium, and generally at first converging very slightly posteriorly, but soon bending outwards and diverging rather strongly to their blind ends; the prolongations behind the axis generally forming continuous, though not even, curves — the strongest curvature being near the posterior extremities — but in some specimens their anterior and posterior portions are nearly straight and meet at obtuse angles. Post axial piece obtusely keeled in the middle and slightly raised above side lobes, the surface sloping very gently posteriorly, the lateral slopes steeper. Side lobes with a flattened area in front adjacent to axial furrows, which tapers posteriorly and reaches a little behind extremity of axis; outside this flattened area the surface slopes gently downwards to lateral margins; consisting of 3 pairs of pleurae, the anterior ones completely defined, with curved outer margins and ending in very short free points, 3d pair posteriorly confluent with post axial piece, without free points. All pleurae marked by strong pleural furrows nearly reaching the margin; the two anterior pairs curved; those on the 3d pleurae beginning in axial furrow rather close to 2d interpleural furrows, nearly straight and diverging rather slightly posteriorly to near their blind extremities, where they generally bend more straight backwards or slightly inwards. Pleural bands gently rounded. Doublure of pygidium of moderate width, increasing in width posteriorly, concentrically striated.

Surface of test, except in the furrows, closely covered by rather high tubercles of different sizes; the greatest part of the tubercles can be characterized as medium-sized or rather small, whereas only comparatively few very small ones occur.

Dimensions. — The dimensions of an average sized cranidium are: distance along median line between anterior and posterior margins 14,5 mm., greatest width of glabella 12,5 mm.; in the largest one which has come under my notice, the distance between the anterior and posterior margins is approximately 27,5 mm. and the greatest width of the glabella is 24 mm. In an average sized pygidium the length along the median line is 15 mm. and the greatest width 23 mm.

Remarks. — In the Upper Leptæna Limestone this species seems to occur at least as commonly as the foregoing — it is even known from some more localities in Dalarne — but in the Brachiopod Shales more sparingly though it has been found in this formation at the same localities as that one. No entire individual has been found, but in the material available there are two cranidia, each of which has a fragmentary free cheek attached and one the rostrum also, one pygidium with 6 thoracic segments attached, and one detached free cheek.

In the figure of the type specimen given by ANGELIN (1854, Pl. XXXIV, fig. 2) the glabella tapers more posteriorly than in the specimens from the Leptæna Limestone and the bi-composite lobes are comparatively narrower. The type specimen itself I have not been able to find, but other cranidia from the same locality (Borenshult) agree very closely in these as in other features with those from the Leptæna Limestone, and I have no doubt as to the correct identification of the latter, moreover, since ANGELIN's figures seldom are quite correct. The original of the pygidium figured by ANGELIN on the same plate (fig. 1) as belonging to *L. laciniatus*, I have not either been able to find, but to judge from the figure, it is, as mentioned above (p. 299), referable to *L. affinis*. The original of the cranidium from the Leptæna Limestone which ANGELIN (Op. cit. Pl. XXXVIII, figs. 4—4 a) referred to *L. affinis* is also missing, but the figures indicate, as is already mentioned (p. 299), that it does not belong here but to *L. laciniatus*. The cranidium attributed to *L. (Platylichas) cicatricosus* by ANGELIN (Op. cit., p. 74, Pl. XXXVIII, fig. 6) on the other hand is apparently referable to *L. affinis,* as suggested by SCHMIDT (1907, p. 45).

A pygidium from Mösseberg in the State Museum of Natural History, according to an accompanying label collected by DALMAN, appears to be the one figured by LOVÉN (1845, Pl. I. fig. 7 b) as *L. laciniatus* β. It agrees well with the specimens from the Leptæna Limestone, except that the whole of the side lobes are flattened, which, however, probably is due to pressure, and as regards the ornamentation, the surface is not well enough preserved to show this distinctly.

The hypostoma which appears to belong to this species (Cf. above, p. 301) is represented by several specimens from Lissberg in the Museum of the University of Stockholm and in the Museum of the Geological Survey and by two small ones from Vestanå in ISBERG's collection in Lund. It has about the same general characters as that referred above (p. 301) to *L. laciniatus,* but it is longer in relation to the width and somewhat more convex, especially posteriorly; its anterior margin is arched more strongly forwards, the middle furrows which mark the central body are directed more backwards and the distance between their inner extremities is much greater; the lateral furrows are more curved and the lateral borders somewhat narrower.

Variations. — As mentioned in the description the pygidia of this species vary a little in the course of the prolongations of the axial furrows, though the degree of variation is much slighter than in *L. laciniatus*.

The fragmentary pygidium from Östbjörka figured below on Plate VIII, fig. 5 differs from the typical ones in some features. The flattened portions of the side lobes reach much farther backwards and, since the slope of the outer posterior portions thus becomes shorter, it becomes also more abrupt; the post axial piece does not slope at all posteriorly till near the margin, but here the surface bends steeply downwards and, since the surface is rather strongly raised in the middle to this point, the latter has about the same appearance as the apex of the axis. The prolongations of the axial furrows behind the axis diverge relatively slightly posteriorly to near their blind ends, where they curve more strongly outwards. Perhaps this specimen ought to be referred to a distinct variety. The material seems, however, to be too meagre to attach a distinct name to it, and in other respects the specimen agrees well, as far as it is preserved, with the typical pygidia.

Affinities. — This species seems, as mentioned above (p. 299), to be closely related to *L. laciniatus*. It differs from the latter: in the more convex glabella, whose surface commences to slope downwards anteriorly much closer to the occipital furrow; the anteriorly less abruptly expanded central glabellar lobe, and its broader, posteriorly more tapering neck, which everywhere is wider than, and raised above, the bi-composite lobes; the generally greater convexity of the cephalon; the more rounded shape of the pygidium; the relatively broader, and posteriorly more indistinctly defined pygidial axis; the different course of the prolongations of the axial furrows; the more approximately situated fulcrum on the pygidial (and thoracic) side lobes and their more strongly bent down outer portions; the curved outer margins and shorter free points of the two anterior pairs of pygidial pleurae; and by the somewhat different ornamentation of the surface.

Horizon and Localities. — Upper Leptæna Limestone; Lissberg, Boda, Osmundsberg, Östbjörka, Kallholn, Vestanå? (Dalarne). Brachiopod Shales; Mösseberg, Ålleberg (Västergötland, shale facies), Borenshult (Östergötland, limestone facies).

Lichas? sp. ind. Pl. VIII, fig. 22.

Remarks. — A fragmentary pygidium, measuring about 20 mm. in length, probably from Kullsberg (it is labelled Glistjern, Cf. above, p.

288) in the Museum of the Geological Survey represents apparently a new species. Its generic position is, however, somewhat uncertain. — The axis is moderately convex, short, rather less than one third the length of the entire pygidium, and seems to have occupied scarcely more than one fourth the width at anterior margin; it tapers posteriorly, is obtusely pointed behind and marked anteriorly by 3 axial furrows, of which the anterior ones are distinctly impressed and the third is very weak, almost obsolete in the middle. The axial furrows are narrow, but rather deep, and continue convergingly behind the axis, bounding the post axial piece, which anteriorly is gently convex (of the posterior portion only the imprint of the doublure is preserved). The side lobes have a flattened, posteriorly tapering area in front, adjacent to the axial furrows and outside this the surface becomes very slightly concave; they are marked by 3 pairs of pleural and 2 pairs of interpleural furrows, all rather deeply impressed, and of about equal strength, the two anterior pairs of pleural furrows, however, grow weaker posteriorly and die out at the bases of the free points (of the 3d pair only the anterior portions are preserved). The right anterior pleura is entirely lacking; of the left one the greatest part is preserved, though broken off from the main portion of the pygidium and somewhat dislocated — that it belongs to this specimen is evident. It has a (for a *Lichas*) rather long, broad-based free point, which, however, seems to have projected very slightly on the margin, since it is rather strongly curved and evidently followed the antero-lateral margin of the 2d pleura rather closely; the pleural furrow is rather strongly curved, as was evidently also the lateral margin of the pleura, whereas the anterior interpleural furrow is nearly straight and directed obliquely outwards and backwards. The 2d pleura has a shorter free point than the preceding one and the emargination between this and the 3d pleura is very narrow; the 2d pleural furrow begins in the axial furrow rather close to the anterior margin of the pleura, but becomes soon nearly median; the 2d interpleural furrow begins in the axial furrow a little in front of the end of the axis, is at first slightly sigmoidally curved, then nearly straight, and directed a little more backwards than the middle portion of the 2d pleural furrow. The 3d pleural furrow begins rather far behind the extremity of the axis and is at first sub-parallel to the 2d interpleural furrow, but bends soon slightly inwards. Of the posterior portion of the pygidium only the imprint of the doublure is preserved, and to judge from this the posterior margin seems to have been entire. The dorsal surface of the pygidium is, except in the furrows, closely covered with very small tubercles of different sizes. The doublure, which is wide, is marked on the upper surface by a series of moderately strong, impressed lines sub-parallel to the margin.

Affinities. — In the characters of the axial portion this pygidium much resembles that of *Platylichas planifrons* (Cf. above, p. 268 and below, Pl. VI, figs. 16, 18—19 22—23) and also to a certain degree in the concave side lobes. It appears, however, as already remarked above, as if the posterior margin back of the 2d pleural points was entire, which indicates that it is referable to *Lichas* s. str. and in the general outline of the entire pygidium and in the shape of the pleuræ it resembles several of the members of this genus rather closely. From the material now available only, it seems impossible to decide the generic position and affinities of the form.

Horizon and Locality. — (In all probability). Lower Leptæna Limestone; Kullsberg.

Genus **Amphilichas** RAYMOND.

Distinguishing Characters of the Species.

1. Central lobe of glabella pear-shaped, without antero-lateral extensions. Anterior lateral glabellar furrows meeting preglabellar furrow at nearly right angles. *Amph. periformis* n. sp.

Central lobe of glabella with pointed antero-lateral extensions. Anterior lateral glabellar furrows meeting preglabellar furrow at very acute angles. 2.

2. Glabellar furrows narrow, scarcely impressed except near their anterior extremities, not reaching occipital furrow. Glabellar lobes without independent convexity. *Amph. lineatus* ANG.

Glabellar furrows deeply impressed throughout, or only their hindmost portions weak, reaching occipital furrow. Central and tri-composite glabellar lobes, at least anteriorly, with independent convexity. 3.

3. Central lobe of glabella narrow, occupying where it is narrowest scarecely more than one fourth the entire width of the glabella; its frontal width rather less than two thirds the greatest width of the glabella. *Amph. parvulus* n. sp.

Central lobe of glabella very wide in front, its frontal width at least five sixths the greatest width of the glabella, where it is narrowest occupying at least three tenths the entire width the glabella. 4.

4. Anterior lateral glabellar furrows growing suddenly weak posteriorly. *Amph. atavus* n. sp.

Anterior lateral glabellar furrows strongly impressed throughout. 5.

5. Anterior margin of glabella arched strongly forwards. Distance along median line between anterior and posterior margins of glabella about equal to greatest width of latter. Central lobe of glabella narrowest between middle of eye lobes, here considerably narrower than tri-composite lobes, markedly increasing in width posteriorly. *Amph. dalecarlicus* ANG.

Anterior margin of glabella rather strongly and rather evently arched forwards. Distance along median line between anterior and posterior margins of glabella about equal to eight ninths the greatest width of latter. Central lobe of glabella at level of eye lobes wider than tri-composite lobes, tapering posteriorly or its hindmost portion nearly parallel-sided. *Amph. Wahlenbergi* n. sp.

Anterior margin of glabella forwards convex, with the strongest bend at sides and the middle-most portion broadly rounded. Distance along median line between anterior and posterior margins of glabella about equal to four fifths the greatest width of latter. Central lobe of glabella at level of eye lobes narrower than tri-composite lobes, slightly increasing in width posteriorly, or the hindmost portion nearly parallel-sided. *Amph. latifrons* n. sp.

Amphilichas dalecarlicus ANGELIN. Pl. VII, figs. 20—22, 23? 24—25, 26?. Pl. VIII, fig. 44; text-fig. 21.

1854. *Lichas Dalecarlicus*, ANGELIN, p. 74, Pl. XXXVIII, figs. 9—9 a, 9 b?
1854. *Platymetopus planifrons?*, ANGELIN, p. 73, Pl. XXXVIII, fig. 3 b (non figs. 3, 3 a).
1885. *Lichas dalecarlica*, SCHMIDT, p. 53, Pl. VI, figs. 11—13.
1901. *Lichas (Platymetopus) dalecarlicus*, GÜRICH, p. 524, Pl. XX, fig. 19.
1902. *Lichas dalecarlicus*, REED, p. 80. text-fig. 17.

Specific Characters. — Cephalon convex, sub-triangular in outline, narrowly rounded or very obtusely pointed in front.

Glabella sub-pentagonal in outline, slightly wider than long, convex longitudinally, with a distinct flattening of the curvature from a little in front of base to about the middle, bent down in front, the posterior slope to occipital furrow short, rather steep in the middle, becoming more abrupt laterally, the postero-lateral slope of the outermost portions generally being so steep that the corners appear rounded or truncated when the specimen is viewed in dorsal aspect; its posterior half very slightly convex transversally in the middle, the slope of the surface becoming stronger at sides, especially posteriorly; composed of a central lobe and a single pair of tri-composite lateral lobes. Central lobe strongly convex anteriorly, posteriorly without independent convexity, widest at front margin, where its width is about equal to that of entire glabella at base, narrowing posteriorly to opposite middle of eye lobes, where it occupies somewhat less than one third the width of entire glabella, then increasing slightly, but distinctly, in width again to occipital furrow. Tri-composite lobes elongate, about twice as long as wide, of nearly uniform width for the greater part of their length — widening slightly a little in front of middle — tapering rapidly in front to pointed extremities, extending about three fourths the length of glabella, their surfaces very gently convex transversally. Anterior lateral glabellar furrows strong throughout, continuous from front of tri-composite lateral lobes to occipital furrow, curving at first inwards, upwards and slightly forwards, but soon bending backwards and converging posteriorly to opposite middle of eye lobes, then diverging slightly to occipital furrow. 2d and 3d pairs of lateral glabellar furrows obsolete, the inner ends of the latter, however, evidently represented by small notches — observable in several specimens — on the inner sides of the tri-composite lobes situated immediately behind the narrowest portion of central glabellar lobe. Axial furrows about equal in strength to anterior lateral glabellar furrows and running nearly parallel to those from occipital furrow to anterior extremities of eye lobes, then curving gently inwards to meet them at antero-lateral angles of glabella and passing into anterior border furrow.

Fig. 21. *Amphilichas dalecarlicus* ANG. Imperfect cephalon × 1. Kallholn. Museum of the Geological Survey.

Occipital furrow strongly impressed, straight and horizontal behind central lobe of glabella; its side portions behind lateral glabellar lobes directed rather strongly downwards and slightly backwards, not quite straight, but arched very gently backwards, or, at least, bending more outwards near their lateral extremities. Occipital ring of moderate, nearly uniform width behind central glabellar lobe, narrowing behind lateral lobes, very strongly arched transversally and rather strongly convex longitudinally. Occipital lobes completely absent.

Anterior border of cranidium very narrow, with slightly rounded surface, bent steeply downwards in the middle in front, gradually bending more outwards postero-laterally. Anterior border furrow narrow, but distinctly impressed at sides, growing weaker internally, in some specimens obsolete in the middle.

Fixed cheeks narrow, band-like in front of eye lobes; their posterior portions behind latter of moderate width, sub-triangular, sloping steeply downwards postero-laterally with slightly convex surface to posterior border furrows, which are strongly impressed and directed somewhat forwards. Posterior borders thickened, narrow, widening laterally. Palpebral lobes sub-crescentiform, very slightly convex in both directions, but bending downwards near the extremities, anteriorly becoming confluent with anterior portions of fixed cheeks, posteriorly continued by narrow, gently curved, band-like portions, which are bent strongly downwards and in their turn continued by the rather high and convex lower eyelids on the free cheeks. Anterior and posterior portions of palpebral furrows meeting at slightly acute angles, the anterior ones scarcely impressed, the posterior ones weak in front but soon growing very strongly impressed and being continued on the free cheeks by strong lower eyelid furrows. Eyes high and prominent, strongly convex in both directions, with minute lenses. Free cheeks sloping abruptly downwards from eye lobes to lateral margins, marked by very narrow and shallow border furrows, which posteriorly grow somewhat more deeply impressed and bend inwards at the genal angles and are continued by the posterior border furrows on the fixed cheeks. The portions lying between these furrows and the eye lobes are rather narrow, their surfaces anteriorly rather flattened, growing gently convex posteriorly. The border portion (very badly preserved) consists of an upper tuberculated part and a lower untuberculated part marked by a few ridges. The former is flattened, very narrow anteriorly, but widens considerably posteriorly and is apparently produced backwards into a spine (not preserved). The lower part forms in front a rather wide rounded doublure — which, as usual, is continued forwards below the anterior border of the cranidium to the rostrum — but a little back of the antero-lateral extremities of the central glabellar lobe it widens suddenly and grows flat with sharp marginal edge, posteriorly it narrows again gradually. Anterior branches of facial sutures converging rather slightly anteriorly from eye lobes to a little back of antero-lateral extremities of central glabellar lobe, then bending more strongly inwards; posterior branches short, curving from eye lobes obliquely outwards and backwards.

Rostrum very narrow, bent steeply downwards with gently rounded surface; its lateral extremities very acutely pointed.

Hypostoma transversely sub-oval in outline with the posterior margin excavated by a broad rounded notch; its greatest width a little behind the middle. Central body gently to moderately convex, reaching anterior margin of hypostoma, about two thirds as long as wide in front, gradually narrowing posteriorly to about three fourths its anterior width, very broadly rounded in front, truncate behind, sides straight; marked posteriorly by pair of oblique, narrow and weak — on small specimens on the surface of the test almost obsolete — middle furrows, which end in small, shallow pits situated more than half the width of the body apart and rather close to its posterior margin. Lateral furrows of moderate strength. Posterior furrow strong, continued on each side a short distance beyond lateral furrow by shallower groove, which is directed very slightly backwards. Anterior edge of body concave, produced at sides into nearly flat, pointed anterior wings. Lateral borders convex in both directions outside body, increasing gradually in width to a little behind middle of body, then suddenly growing still wider and produced into a posterior pair of wings, which seem to have been directed obliquely forwards (not more than their bases are preserved on any of the specimens observed). Posterior border rather wide, slightly swollen behind body. Postero-lateral portions of border, flattened, but with the surfaces sloping gently towards the sides, produced posteriorly into pair of broadly rounded, flattened lobes. Surface ornamented with punctæ, and rather coarse, longitudinally directed, anastomosing ridges, the former alone occurring — on the specimens from the Leptæna Limestone observed by the writer — on the median portion of the body and on the posterior border behind the body, the latter on the sides of the body and on the lateral portions of the border.

Surface of cephalon, except in the furrows, on the rostrum, doublures and marginal portions of free cheeks, and on the lower eyelids, ornamented with tubercles of different sizes, some very large; the latter placed at rather great distances apart in somewhat irregular rows, subparallel to anterior margin. On both sides of the lateral glabellar furrows, inside the axial furrows, and along the anterior margin of the glabella the tubercles seem also, as a rule, to be arranged in a row. On most portions the tubercles are placed rather close together, but not crowded; they are highest and most closely set on the posterior portions of the cephalon, anteriorly they grow gradually lower and more sparsely distributed, but grow, in some specimens, somewhat higher again near the front end of the glabella. Excepting the lowest ones the tubercles are conical, but generally rather obtusely pointed, and mostly very oblique, the slope from the apex being much shorter on one side than on the other. On the whole the longer slope follows to a certain extent the general slope of the surface. At the same time there seems, however, to be a general stronger tendency for the apex to point backwards than to point forwards or towards the sides.

Dimensions:	I	II	III[1]
Length of cranidium (along median line)	35,0 mm.	25,5 mm.	15,5 mm.
» » glabella » » »	30,5 »	22,0 »	13,5 »
Distance between anterior and posterior margins of do. (along median line)	32,5 »	23,5 »	14,5 »
Maximum width of glabella	32,5 »	24,0 »	14,5 »
Width of glabella at base	27,0 »	20,0 »	12,0 »
» » front of central lobe	27,0 »	20,0 »	—
» » central lobe between eyes	9,0 »	6,0 »	4,2 mm.
» » » » at base	11,0 »	7,4 »	4,5 »
Length of tri-composite lobes	23,0 »	16,5 »	10,0 »
Width of do. between eyes	10,2 »	8,5 »	5,0 »
IV. Length of hypostoma (along median line)	21,0 »		
Maximum width of hypostoma	c. 36,0 »		
Length of central body	15,0 »		
Width of front of central body	23,0		

Remarks. — In addition to the small cranidium from Arfvet on which ANGELIN (Op. cit.) founded this species there are now available a good number of cranidia from other localities in Dalarne of which one — from Kallholn in the Museum of the Geological Survey — has portions of both the free cheeks and of the rostrum attached. Most of these cranidia are much larger than the type specimen but otherwise closely similar to it. This seems also to be the case with the small cranidia from the East Baltic Lyckholm Formation, which SCHMIDT (1885, p. 53, Pl. VI, fig. 11) referred to this species. Whether the cranidium from the

[1] This is the original type specimen figured by ANGELIN (1854, Pl. XXXVIII, figs. 9—9 a).

same formation which NIESZKOWSKI (1857, p. 576, Pl. I, figs. 18—19) referred to this species really belongs to it seems rather doubtful. SCHMIDT attributed it in 1885 (p. 49) to EICHWALD's species *Lichas lævis,* but later on (1907, p. 28), after he had come to the conclusion that the latter was identical with ANGELIN's *Lichas (Amphilichas) lineatus* (Cf. below, p. 326), he referred it to our species. He pointed out, however, that it differed from the typical cranidia by the strong deflection of its anterior portion. To judge from NIESZKOWSKI's description and figures the difference in the convexity is very strong, but in other characters it appears to agree rather closely.

SCHMIDT (1885, p. 53) was of the opinion that the two hypostomata, which ANGELIN (1854, p. 73, Pl. XXXVIII, figs. 3 a—b) with marks of interrogation attributed to *Platylichas planifrons* (*Platymetopus planifrons* ANGELIN) were referable to *Amph. dalecarlicus.* The specimens differ, however, distinctly and do not seem to belong to the same species. Probably the one shown in ANGELIN's fig. 3 b[1] belongs to *Amph. dalecarlicus.* Several other hypostomata of the same type are now known from the Leptæna Limestone, and the larger of these correspond in size to several of the cranidia of this species, but appear much too large to be referable to any of the other species, which have been found there. The hypostomata appear to agree well in characters with the one from the Lyckholm Formation, which SCHMIDT (1885, p. 53, Pl. VI, fig. 13) referred to this species, except — as was pointed out by the author just mentioned with regard to ANGELIN's specimen — that the anterior margin is more strongly arched, and that there are no longitudinal ridges, only punctæ, on the surface of the median portion of the central body. In the former feature they correspond better to the typical cranidia than does the specimen figured by SCHMIDT, but it appears possible that in the East Baltic form the anterior margin of the cranidium too may be more broadly rounded.

In addition to the cranidium, ANGELIN (1854, Pl. XXXVIII, fig. 9 b) figured, as belonging to this species, the axis and a portion of one of the side lobes of a small pygidium, which had been found at the same locality as the former. In this the surface is tuberculated in the same fashion as in the cranidium. The axis is bounded laterally by strongly impressed axial furrows, moderately convex with obtusely pointed somewhat protruding apex, about as long as wide in front, tapering posteriorly and indistinctly marked off from the more depressed, but not quite flat-

[1] The figure is not quite satisfactory. In the original the middle furrows on the central body are very weak and the posterior wing is steeply inclined — not horizontally extended as it appears in the figure — and its anterior extremity is not preserved. The lateral portion of the border is broken off on the one side, only the innermost part and the extremity of the postero-lateral lobe being preserved, on the other side the edge is slightly notched and crumpled in front of the postero-lateral lobe, but this seems to be an anomaly, since the latter is considerably shorter than its fellow.

tened, sub-triangular post axial piece, which is comparatively long — it appears to have occupied more than one fourth of the entire length of the axial portion; the slope from the apex to the post axial piece is shorter and steeper than the lateral slopes; anteriorly the axis is marked with one complete axial furrow, which is deeply impressed at sides and somewhat weaker in the middle; and a 2d much weaker and incomplete one, which is almost obsolete in the middle, grows stronger laterally, but does not quite reach the axial furrows. The side lobe is flattened; the 1st pleural furrow begins in the axial furrow close to the anterior margin and appears to have been very oblique; the 2d one originates within about half-way between the anterior and posterior margins of the pleura, is short and straight, parallel to the 2d interpleural furrow, and directed obliquely outwards and backwards.

It seems quite probable that ANGELIN was right in assuming that this pygidium belongs to our species, but on the other hand there are reasons for some doubt. The fact is that there is a fragment of a larger pygidium, from Östbjörka, in the State Museum of Natural History, which in the style of ornamentation of the surface also agrees with the cranidia and in point of size corresponds to the larger of these, and in the characters of the axial portion the two specimens differ somewhat.[1] In the one from Östbjörka the axis is rather more convex than in the other and has a more obtuse apex, the posterior slope from the latter to the post axial piece is longer and more gentle, equalling the lateral slopes in length and steepness, the anterior axial ring furrow curves more backwards laterally, and the post axial piece is flatter and shorter, occupying about one sixth of the entire length of the axial portion. The two anterior pairs of pleuræ are broken off in this specimen. Of the 3d pleura the posterior and middle portion is preserved on one side. This is flattened, except that the posterior end is very slightly bent upwards. Apparently the pleuræ had a rather unusual shape; the portion preserved is long and narrow with the longer axis directed obliquely inwards and backwards, widens slightly antero-laterally and has a slightly concave postero-lateral margin and a short, very obtusely pointed free end, which is placed rather close to the median line of the pygidium. The surface of the portions preserved is, except in the furrows and on the articulating half-ring, rather closely covered by tubercles of different sizes similar to those on the cephalon.

Affinities. — This species does not seem to be especially closely allied to any other described. The most important features which dis-

[1] In the figures of the two specimens given below (Pl. VII, figs. 23, 26) the difference appears greater than it really is. This is partly due to the fact that in the larger specimen the outermost portions of the axis are lacking anteriorly, and therefore the axis appears to be narrow in front and nearly parallel-sided. Partly it depends on the circumstance that in the figure (26) of this specimen the shading of the posterior part of the axial portion has not come out well in the printing.

tinguish it from the other species found in the Leptæna Limestone have already been pointed out above and need not be repeated here. Of the foreign species which might be compared *Amph. hibernicus* PORTL. (PORTLOCK, 1843, p. 274, Pl. IV, figs. 1 a—d, Pl. V, figs. 1—3; REED, 1906, p. 106, Pl. XV, figs. 1—3) has a relatively shorter and broader and more convex glabella, whose central lobe grows less narrow posteriorly and is everywhere considerably wider than the lateral lobes, and in *Amph. ardmillanensis* REED (REED, 1914, p. 29, Pl. V, fig. 1) the convexity of the glabella is much weaker, the central glabellar lobe is more projecting in front and its neck much narrower, at least in the middle.

Horizons and Localities. — Upper Leptæna Limestone; Kallholn, Arfvet, Östbjörka, Born, Boda (hypostomata only). Lyckholm Formation; Swarzen in Estland.

Amphilichas Wahlenbergi n. sp. Pl. VIII, figs. 27—35, 26? 41?

? 1901. *Platymetopus planifrons*, LINDSTRÖM, p. 67, Pl IV, figs. 50—51.

Specific Characters. — Glabella bounded laterally by strongly defined axial furrows, wider than long, sub-pentagonal in outline, rounded in front with the anterior margin rather strongly and evenly arched, strongly convex longitudinally, curved down anteriorly and overhanging front margin, the posterior slope to occipital furrow gentle; moderately convex from side to side posteriorly, growing more strongly arched anteriorly; composed of a central lobe and a single pair of tri-composite lateral lobes. Central lobe strongly convex anteriorly and in middle, growing more gently convex posteriorly, but generally with marked independent convexity throughout, widest in front with acutely pointed antero-lateral extremities, its width at front margin about equal to that of entire glabella at base, narrowing posteriorly to occipital furrow — or in some specimens its posterior portion from opposite middle of palpebral lobes nearly parallel-sided — generally occupying at base about two fifths the entire width of glabella. Tri-composite lobes with slight independent convexity, strongly bent down anteriorly with general curvature of glabella, elongate, somewhat less than twice as long as wide, pointed in front, truncated obliquely behind, of nearly uniform width for the greater part of their length, then rapidly narrowing to pointed anterior extremities, extending about three fourths the length of glabella with the postero-lateral extremities produced beyond base of central lobe. Anterior lateral glabellar furrows rather narrow, but strongly defined, about equal to axial furrows in strength, continuing backwards on either side of central lobe to occipital furrow. 2d and 3d pairs of lateral glabellar furrows obsolete.

Occipital furrow rather narrow, deeply impressed, straight in middle behind central glabellar lobe; its side portions directed rather strongly backwards. Occipital ring rather wide and nearly parallel-sided behind central lobe of glabella, rapidly narrowing laterally, rather strongly arched transversally, gently rounded longitudinally. Anterior border of cranidium narrow, flattened, bent obliquely outwards at sides and marked off by narrow, but well defined furrow, bending downwards internally and finally slightly backwards with general curvature of cranidium in the middle where it coalesces with the glabella.

Fixed cheeks with narrow, band-like anterior portions; the posterior portions behind palpebral lobes (the latter not preserved) of moderate width, sub-triangular, sloping rather steeply downwards with gently convex surface to posterior border furrows, which are very strongly impressed and directed somewhat forwards. Posterior borders thickened, narrow, widening laterally. Anterior branches of facial sutures converging rather slightly anteriorly adjacent to palpebral lobes, then bending rather strongly inwards; posterior branches directed obliquely outwards and backwards.

Free cheek (probably belonging to this species) sub-triangular, rather narrow. Eye large and high, strongly convex in both directions, supported by relatively high lower eyelid, which is marked off below by strong furrow. Lateral border furrow of moderate width, not deeply impressed, growing deeper posteriorly, sub-parallel to lower eyelid furrow. The portion lying between these furrows rather narrow, sloping steeply downwards with gently convex surface, which grows more flattened posteriorly. Lateral border flattened, obliquely bent downwards, very narrow anteriorly, suddenly widening at about middle of free cheek and produced into broad-based, tapering spine (only the basal portion preserved), which seems to have been directed nearly straight outwards. Doublure of free cheek produced into a nearly vertically inclined lower border-rim, which is rather wide and gently convex in front of the point where the border furrow meets the anterior branch of the facial suture, then growing narrower and more convex, but soon, and rather suddenly, growing wider again and then tapering gradually posteriorly and dying out at base of spine.

Surface of cranidium and free cheek, except in the furrows, on the anterior border and on the doublure of the free cheek, closely covered by tubercles of different sizes, highest on the posterior portions, growing lower anteriorly and in some specimens partly coalescing on foremost portion of central glabellar lobe. On most portions relatively large tubercles of sub-equal sizes are placed rather close together, and on several specimens 3 very large, but not very high, rounded or obtusely pointed ones are seen on the central lobe of the glabella, one being placed on the median line about half-way between the posterior and the anterior margins of the cranidium, the others, one on each side and some distance in front of the former. A somewhat smaller tubercle of the same type is often found on the median line of each of the tri-composite lobes at about its middle. These tubercles can be located in most specimens, but in some of them they scarcely differ in size from several of the other tubercles. Excepting those on the foremost portions of the cranidium and generally the very largest ones, the tubercles are, as a rule, rather sharply pointed and those on the posterior portions rather high; those on the down-curved portions are more or less oblique. Doublure of free cheek marked by a number of rather low ridges, sub-parallel to margin.

Dimensions:	I	II	III
Length of cranidium (along median line)	—	23,0 mm.	14,5 mm.
» » glabella » » »	21,0 mm.	19,0 »	11,0 »
Distance between anterior and posterior margins of do. (along median line)	23,5 »	21,0 »	11,5 »
Maximum width of glabella	26,5 »	23,5 »	13,0 »
Width of glabella at base	22,0 »	20,0 »	11,0 »
» » front of central lobe	22,0 »	20,0 »	11,0 »
» » central lobe between eyes	10,0 »	8,0 »	5,0 »
» » » » at base	9,0 »	7,9 »	4,5 »
Length of tri-composite lobes	16,0 »	14,5 »	9,0 »
Width of do. between eyes	8,0 »	7,0 »	4,0 »

Remarks. — The material on which this new species is founded consists of a great number of cranidia from Kallholn in the Upsala Museum, one from the same locality and another labelled Gulleråsen — which probably is from the hill Lissberg — in the Museum of the Geological Survey. Some more or less fragmentary free cheeks from Kallholn and Boda in the Upsala Museum agree in the style of ornamentation of the surface with the cranidia and appear to belong to this species.

A fragment of a thoracic segment from Kallholn in the Upsala Museum shows a similar ornamentation of the surface and belongs probably to the same species. The specimen is pressed and distorted and consists of a small portion of the axis and one pleura, of which the end is broken off. The axis seems to have been strongly arched and is bounded at the side by a deeply impressed axial furrow. The pleura is long and narrow — which indicates that also the genal spine was long — and appears to have been directed nearly straight outwards and to have been, as far out as it is preserved, nearly parallel-sided; probably it ended in a short point. (In the specimen the distal portion is bent abruptly downwards, slightly arched backwards and grows somewhat wider than the inner portion, but this condition appears to be caused by pressure.) It is marked by a weak pleural furrow, which appears to have extended about half its length.

There are further in the Upsala Museum some *Amphilichas* pygidia from Kallholn of two slightly different types, which probably belong to this and to the following species. One of the types -- represented by two rather badly preserved specimens, measuring along the median line 13,5 and 11,5 mm. respectively — agrees better in the style of ornamentation of the surface with the cranidia of the former than with those of the latter, and it therefore appears likely that it belongs to this species. Its description is as follows:

Entire pygidium nearly twice as broad as long. Axis moderately convex, anteriorly occupying rather more than one third the entire width of pygidium, somewhat wider in front than long, tapering posteriorly, rounded behind, but not very distinctly marked off from the post axial piece, with obtusely pointed somewhat protruding apex, from which the posterior slope is shorter and steeper than the lateral slopes; marked anteriorly by 2 axial ring furrows, of which the anterior one is rather strong and continuous across the axis, and the posterior one is weak in the middle and does not quite reach the axial furrows; behind this very faint traces of a 3d furrow are seen. Axial furrows narrow, but distinctly impressed, straight and rather gently converging posteriorly at sides of axis, curving inwards at its extremity, produced behind it and bounding the relatively long, depressed, triangular post axial piece, behind which they meet at the fork between the free terminations of the posterior pair of pleuræ. Side lobes flattened and horizontally extended anteriorly adjacent to axial furrows, then almost imperceptibly bent down, consisting of 3 pairs of pleuræ, separated by well marked interpleural furrows and with comparatively long free terminations. Anterior pair of pleuræ rather narrow, increasing in width to fulcrum, and beyond this tapering into backwards directed points, marked by short, narrow, oblique pleural furrows, extending less than half their length. 2d pair of pleuræ sub-equal to anterior pair, but directed more backwards and with considerably shorter pleural furrows, which converge distinctly distally with the 2d interpleural furrows. 3d pair of pleuræ (imperfectly preserved), without pleural furrows, broader than the anterior ones, sub-rhomboidal in outline with the longer axes directed obliquely inwards and backwards; the inner margins of the free terminations seem to have diverged rather slightly posteriorly just at first adjacent to the extremity of the post axial piece[1], but bend very soon strongly outwards, and the posterior ends appear to have been produced into small tips (which, however, are not preserved in either of the specimens). Dorsal surface of pygidium closely covered by sub-conical, pointed, slightly oblique tubercles of different sizes, a good number of them rather large, of sub-equal sizes, and relatively high. Doublure marked by rather closely placed, wavering, low ridges or terraced lines, sub-parallel to its inner margin.

In addition to those attributed above (p. 313) to *Amph. dalecarlicus*, several other hypostomata, of two somewhat different types and apparently belonging to two different species of *Amphilichas* have been found in the upper Leptæna Limestone. Neither of the forms seems to agree

[1] In the figure given below (Pl. VIII, fig. 26) the axial portion reaches somewhat too far backwards.

quite in characters with the hypostoma of *Amph. lineatus,* to judge from the descripton and figures given by SCHMIDT (1885, p. 51, Pl. VI, figs. 5, 9) of specimens from the East Baltic Lyckholm Formation, and it appears probable that one of them belongs to the species now under consideration and the other to the following one. One of them is relatively narrower and more strongly rounded in front than the other, and most likely this belongs to *Amph. Wahlenbergi.* Its description is as follows:

Entire hypostoma broadly sub-oval in outline, wider than long, with the posterior margin excavated by a deep, but not very broad, rounded notch. Central body very gently convex, reaching anterior margin of hypostoma, about two thirds as long as wide in front, gradually narrowing posteriorly to about three fourths its anterior width, strongly rounded in front, truncate behind, sides straight; marked posteriorly at sides by pair of deeply impressed furrows, which run from the lateral furrows nearly straight inwards a little more than half-way to median line of body, then turn obliquely backwards (or divide, a short, weak anterior branch is discernible in a few specimens), grow shallower and die out before reaching posterior furrow; just inside the posterior portions of these furrows a pair of small, low, longitudinally elongated maculæ have been observed in some specimens. Lateral furrows deep, not very wide, continued a short distance behind posterior furrow by shallower grooves directed nearly straight backwards. Posterior furrow about equalling lateral furrows in strength. Anterior edge of body slightly concave, produced at sides into pair of flattened, pointed anterior wings. Lateral borders strongly convex in both directions at sides of body, increasing gradually in width to a little behind lateral extremities of middle furrows, then suddenly growing still wider and produced into a posterior pair of inclined, pointed wings, which are directed obliquely forwards. Posterior border rather wide, gently convex transversally, slightly swollen behind body. Postero-lateral portions of border with more flattened surfaces, sloping gently towards the sides. Surface of hypostoma ornamented by punctæ on the median portions, and on the lateral portions — antero-lateral parts of body and lateral borders — marked by rather fine anastomosing ridges, sub-parallel to lateral margins.

The hypostomata of this type which have been observed, are of rather different sizes. In the largest one the length along the median line appears to have been about 18 mm., in another rather large one it is 12 mm., and in the smallest specimens it is 6 mm. — The hypostoma figured by LINDSTRÖM (1901, Pl. IV, fig. 50) as belonging to *Platymetopus planifrons* ANG. belongs to this type.

Horizon and Localities. — Upper Leptæna Limestone; Kallholn, Gulleråsen (probably from the hill Lissberg), Osmundsberg, Arfvet, Boda?

Amphilichas latifrons n. sp. Pl. VIII, figs. 36—38, 24—25?, 43?

?1854. *Platymetopus planifrons,* Angelin, Pl. XXXVIII, fig. 3 a.

Specific Characters. — Glabella bounded at sides by strongly defined axial furrows, considerably wider than long, sub-pentagonal in outline, rounded in front, with the anterior margin broadly rounded in the middle and with the strongest bend at sides, strongly convex longitudinally, curved down anteriorly and overhanging front margin; its posterior half slightly convex transversally in the middle, the slope of the surface becoming stronger at sides, especially posteriorly; composed of a central lobe and a single pair of tri-composite lobes. Central lobe with gentle independent convexity across its middle, generally growing flatter posteriorly, widest in front, with acutely pointed antero-lateral extensions, its width at front margin about equal to that of entire glabella at base, narrowing posteriorly to opposite middle of palpebral lobes, where it occupies somewhat less than one third the entire width of glabella, then increasing slightly in width again to occipital furrow, or — in some specimens — growing nearly parallel-sided. Tri-composite lobes with gentle independent convexity, steeply curved down anteriorly with general curvature of glabella, elongate, somewhat less than twice as long as wide, pointed in front, truncated obliquely behind, widest a little in front of their middle, slightly narrowing posteriorly, rapidly tapering in front to pointed extremities, extending about three fourths the length of glabella, with the postero-lateral extremities produced beyond base of central lobe. Anterior lateral glabellar furrows strongly defined, not very wide, about equal to axial furrows in strength. 2 d and 3 d pairs of lateral glabellar furrows obsolete, or in some specimens their inner ends represented by very faint notches indenting inner sides of tri-composite lobes; the posterior pair (observed in several specimens) situated nearly opposite middle of palpebral lobes, the anterior pair (only observed in a few specimens) somewhat nearer the former than anterior extremities of lobes.

Occipital furrow deeply impressed, not wide, straight in middle behind central glabellar lobe; its side portion directed rather strongly backwards and downwards. Occipital ring rather wide and nearly parallel-sided behind central lobe of glabella, rapidly narrowing laterally, strongly arched transversally, rather gently rounded longitudinally. Anterior border of cranidium narrow, flattened, bent obliquely outwards and distinctly marked off at sides, bending downwards internally, and finally slightly backwards with general curvature of cranidium in the middle where it coalesces with the glabella.

Fixed cheeks with narrow band-like anterior portions; posterior portions behind palpebral lobes of moderate width, sub-triangular, sloping steeply downwards laterally and posteriorly with gently convex surface. Palpebral lobes sub-crescentiform, very slightly convex in both directions, posteriorly continued by narrow band-like portions, which curve strongly downwards and apparently in their turn are continued by the lower eyelids on the free cheeks, anteriorly confluent with inner portions of fixed cheeks; the palpebral furrows beginning at about the middle of lobes. Posterior borders narrow, thickened, marked off by strong furrows. Anterior branches of facial sutures converging rather strongly anteriorly; posterior branches curving obliquely outwards and backwards.

Surface of cranidium, except in the furrows, on the anterior border, and in some specimens on the foremost portion of the glabella, closely covered by pointed or rounded, oblique tubercles of different sizes, all relatively low, highest on the posterior portions, growing gradually lower anteriorly. Four very large, but not very high, rounded or obtusely pointed tubercles seem generally to occur on the central lobe of the glabella, two placed nearly on the median line at a short distance from each other, the foremost one (generally not quite straight in front of the other) about half-way between posterior and anterior margins of cranidium, the other two, one on each side some distance in front of this. A few other relatively large tubercles of different sizes are scattered on different portions of the cranidium and surrounded by small and relatively small ones.

Dimensions:	I	II
Length of cranidium (along median line)	20,0 mm.	—
» » glabella » » »	16,0 »	13,0 mm.
Distance between anterior and posterior margins of do. (along median line)	20,0 »	15,0 »
Maximum width of glabella	24,0 »	19,0 »
Width of glabella at base	— »	15,0 »
» » front of central lobe	21,5 »	15,5 »
» » central lobe between eyes	6,5 »	5,4 »
» » » » at base	6,7 »	6,0 »
Length of tri-composite lobes	14,5 »	11,0 »
Width of do. between eyes	7,5 »	6,5 »

Remarks. — The material on which this new species is founded consists of about a dozen more or less fragmentary cranidia from Kallholn and one from Östbjörka in the Upsala Museum.

Three fragmentary pygidia, measuring along the median line respectively 5, 11 and 16 mm., from Kallholn in the same Museum, which agree in the style of ornamentation of the test with the cranidia, appear to belong to this species. They resemble on the whole closely the pygidia attributed above (p. 317) to *Amph. Wahlenbergi,* but differ in some features. The axis is more convex — especially in the smaller specimens — and the slope from the apex to the post axial piece about as long and rather gentler than the lateral slopes; the post axial piece is shorter and the axial furrows curve more inwards at the base of the axis. Except that the 2d pleural and interpleural furrows on each side do not converge distally, there are no apparent differences in the characters of the side lobes, but since in the specimens of both types these portions are either fragmentarily or badly preserved, a comparison in every detail is excluded. In the specimens now under consideration, the free portions of the 3d pair of pleuræ are produced posteriorly into small points, and their inner margins diverge at first very slightly posteriorly for a short distance — the length varies a little in the specimens — and then curve strongly outwards.[1]

One of the hypostomata which ANGELIN (1854, p. 73, Pl. XXXVIII, figs. 3 a—b) tentatively referred to *Platylichas planifrons (Platymetopus planifrons* ANGELIN) — viz. the one shown in his fig. 3 a — and several others of the same type, which have been found in the Upper Leptæna Limestone at difference localities, appear also to belong to this species. They resemble rather closely the hypostoma of *Amph. dalecarlicus* (p. 311) but differ in the following characters: the central body is broader in relation to its length, tapers more posteriorly and has the postero-lateral corners more obtuse; the portions of the borders lying at the sides of the body are less convex and not defined behind by distinct grooves; and finally the middle furrows are much better defined and run from the lateral furrows nearly straight inwards about half-way to the median line of the body, generally widening within, then they divide into two short weak branches, of which the anterior ones are the shorter and only discernible in a few specimens; inside the posterior branches, which are directed obliquely backwards, a pair of small, low, longitudinally elongated maculæ have been observed in some specimens. In ANGELIN's figure the shape of the central body is not correctly given and the middle furrows are placed too far from its hind margin and the posterior border is too narrow. In the original of the figure the length along the median line is 12 mm., the greatest width approximately 18 mm., the length of the body 8 mm., its frontal width 16 mm., and the sides of the body converge posteriorly at about 90°.

Horizon and Localities. — Upper Leptæna Limestone; Kallholn, Östbjörka (Osmundsberg, Dalby, Torsmo, at these three localities hypostomata only have been found).

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[1] In the figure of the smallest specimen (Pl. VIII, fig. 24) their posterior portions ought to have been directed more outwards and the points a trifle more remote; in the figure of the largest one (Pl. VIII, fig. 25) the margins ought not to have been in so close contact adjacent to the extremity of the post axial piece, but to have diverged very slightly posteriorly. In the latter figure the shading has come out badly in the printing, the difference between the convex axis and the depressed post axial piece not being properly pronounced, and the 2 d pleural furrow on the left side is directed to much backwards.

Amphilichas atavus n. sp., Pl. VII, figs. 37—38.

Specific Characters. — Glabella bordered by well defined axial furrows, sub-pentagonal in outline, rounded in front, wider than long, flattened on top posteriorly, the anterior slope strongly convex and protuberant, lateral slopes gently convex, its postero-lateral portions curving steeply downwards. Central lobe of glabella bent down anteriorly and overhanging front margin, expanded transversally in front to about three thirds its basal width; the antero-lateral expansions acutely pointed and overhanging lateral lobes for more than half their width; anterior outline broadly rounded; posterior half of central lobe with slight independent convexity, nearly parallel-sided, occupying at base about one third the entire width of glabella. Lateral lobes tri-composite, about twice as long as wide, pointed in front, obliquely truncated behind, widest in front of middle, gently tapering posteriorly and rapidly narrowing anteriorly to pointed anterior extremities, extending along posterior two thirds of central lobe and with the postero-lateral extremities produced beyond this, bent strongly downwards and overhanging in front, curved somewhat less steeply downwards postero-laterally, gently convex transversally and nearly reaching the same level as central lobe. Anterior lateral glabellar furrows narrow, but deeply impressed to a little in front of occipital furrow, where they suddenly become very weak. 2d and 3d pairs of lateral glabellar furrows obsolete. Occipital furrow narrow and deep, nearly straight and horizontal behind central lobe of glabella, directed rather strongly backwards and downwards behind lateral glabellar lobes. Occipital ring of moderate, nearly uniform width behind central lobe of glabella, narrowing laterally, strongly arched transversally with a flattening of the curvature in centre, gently rounded longitudinally, with small, ill-defined median tubercle near posterior margin. Anterior border narrow, flattened and marked off by distinct furrows at sides, growing narrower internally and finally disappearing, or coalescing with glabella.

Fixed cheeks (imperfectly preserved) with narrow, band-like anterior portions and broader sub-triangular posterior portions, which latter slope rather steeply downwards with gently convex surfaces towards the sides, and posteriorly to the deep posterior border furrows, which mark off thickened borders of moderate width.

Surface of cranidium, except in the furrows, closely covered by tubercles of different sizes; most of the tubercles are relatively small, but there are also some of medium sizes, and a few coarse ones occur on the central and lateral glabellar lobes a little in front of their middle.

Dimensions. — In the type specimen the distance along the median line between the anterior and posterior margins of the cranidium is not quite 4 mm. and the greatest width of the glabella somewhat less than 4,5 mm.

Remarks and Affinities. — The above description is drawn up from a single, small cranidium from Amtjärn in ISBERG's collection in Lund, which with the exception of the outer portions of the fixed cheeks is well preserved.

In most of its characters it bears a close resemblance to the cranidia referred above (p. 320) to the new species *Amph. latifrons.* It differs, however, in the following characters: the difference between the width of the glabella across its widest portion and that at the anterior margin and at the occipital furrow respectively is relatively smaller, and the greatest width of the glabella is farther forwards; the downward curve of the anterior portions of the central and lateral glabellar lobes commences, especially in the latter, nearer the anterior margins; the posterior portions of the lateral glabellar lobes are flattened within, and the downward slope towards the outside commences nearly half-way between the anterior lateral glabellar furrow and the axial furrow, instead of close to the former; and the anterior lateral glabellar furrows are parallel, or nearly parallel, for a considerably longer part of their course — thus the shape of the central glabellar lobe is different — and they are not of equal strength throughout, but very weak in their hindmost portions. — The weakness of the posterior portions of the lateral glabellar furrows appears to be of a primitive or juvenile character (Cf. REED, 1902, p. 68; RAYMOND, 1910 a, p. 73), and since the specimen is so much smaller than all the known typical cranidia of *Amph. latifrons,* it might perhaps have been regarded as representing an immature individual of this species — which conceivably might have differed from the adult also in the other features mentioned — if it had not been found at a much lower stratigraphical horizon. This being the case, however, it appears necessary to refer it to a distinct species.

Horizon and Locality. — Lower Leptæna Limestone; Amtjärn.

Amphilichas parvulus n. sp., Pl. VII, figs. 34—36.

Specific Characters. — Glabella strongly convex longitudinally, curved down and slightly overhanging in front, more gently convex transversally, much wider than long, widest in front of middle, slightly narrowing posteriorly; its anterior outline broadly rounded with the central lobe only slightly protruding in front of the tri-composite lateral lobes. Central glabellar lobe with independent convexity, curved down for anterior half, widest in front with small pointed antero-lateral extensions overhanging lateral lobes for rather less than half their width, narrowing posteriorly to a little in front of occipital furrow, where its width is somewhat more than one third that in front, and where it occupies scarcely more than one fourth the entire width of the glabella, then widening a little again at base. Tri-composite lobes sub-oval in outline, about two thirds as wide as long, very obtusely pointed in front, obliquely truncated behind, very strongly convex longitudinally, being curved down behind as well as in front, gently convex transversally. Anterior lateral glabellar furrows rather narrow, strongly impressed — except adjacent to occipital furrow — curving from their anterior points of origin strongly inwards just at first, thence rather slightly converging posteriorly to near base of glabella, then suddenly becoming weaker and turning gently outwards before reaching occipital furrow. 2d and 3d pairs of lateral glabellar furrows obsolete. Axial furrows about equal in strength to anterior lateral glabellar furrows and nearly parallel to median portions of latter for the greater part of their length, curving strongly inwards in front around anterior ends of lateral glabellar lobes to pass into anterior border furrow. Occipital furrow deep and narrow, nearly transverse behind central lobe of glabella, directed obliquely backwards behind lateral glabellar lobes. Occipital ring rather broad and of nearly uniform width in centre, rapidly decreasing in width laterally, strongly arched transversally, gently rounded longitudinally. Anterior border very narrow, widening a little laterally, gently rounded, marked off by narrow furrow, which is weak in middle, but, at least in casts, distinct throughout.

Fixed cheeks (incompletely preserved) with narrow, flattened, bandlike anterior portions, and wider sub-triangular posterior portions, whose surfaces are gently convex and slope steeply downwards postero-laterally. Anterior branches of facial sutures converging very strongly anteriorly; posterior branches directed obliquely outwards and backwards.

Surface of cranidium, except in the furrows, closely covered by tubercles of very different sizes, most of them being very small, but a few relatively very large ones occur also.

Dimensions. — In the largest cranidium of this species observed the distance along the median line between the anterior and the posterior margins is about 5 mm., and the greatest width of the glabella approximately 6 mm., in another one the distance between the margins is just over 3 mm. and the greatest width of the glabella nearly 4 mm.

Remarks. — This new species is founded on five cranidia from Kallholn — three in ISBERG's collection in Lund, one in the Upsala Museum, and one in the State Museum of Natural History. On the whole they are all rather well preserved, though the fixed cheeks are complete in none of them.

Affinities. — The species is well characterized by the narrowness, especially in front, of the central glabellar lobe in relation to the lateral lobes and by the relative weakness of the posterior, outwards directed, portions of the anterior lateral glabellar furrows. It does not seem to be especially closely related to any other, hitherto, known species of *Amphilichas,* and therefore, a more detailed comparison with any of these seems unnecessary.

Horizon and Locality. — Upper Leptæna Limestone; Kallholn.

Amphilichas lineatus ANGELIN, P. VIII, figs. 39—40.

1854. *Platymetopus lineatus,* ANGELIN, p. 75, Pl. XXXVIII, figs. 12—12 a (non fig. 13).
1884. *Lichas brevilobatus,* TÖRNQUIST, p. 34, Pl. I, figs. 32—33.
1885. *Lichas lævis,* SCHMIDT, p. 49 (pars), Pl. VI, figs 5—7, 9 (non fig. 10, 8?).

Specific Characters. — Glabella bordered laterally by narrow, strongly impressed axial furrows, sub-pentagonal in outline, broader than long, narrowly rounded in front, posteriorly flattened convex, but with the postero-lateral portions rather strongly bent downwards, curved strongly downwards anteriorly and overhanging front margin. Anterior lateral glabellar furrows not reaching occipital furrow, generally ending a little behind a line joining middle of palpebral lobes, narrow, rather deeply impressed in front, but soon growing very shallow — in some specimens their posterior portions only impressed in casts and discernible on the surface of the test as lines of different colour to the rest of the surface, or not marked at all — curving from their anterior points of origin at first inwards and slightly forwards, then convergingly backwards to near their posterior extremities where they turn nearly straight backwards. 2d and 3d pairs of lateral glabellar furrows obsolete. Lobes of glabella without independent convexity. Central glabellar lobe very wide in front — the width there exceeding that of entire glabella at base — with pointed antero-lateral extremities overhanging lateral lobes for the greatest part of their width, narrowing posteriorly to a little in front of a line joining the middle of the palperal lobes, where its width is about one fourth its width in front and rather less than one fourth the entire width of glabella, thence growing nearly parallel-sided, posteriorly entirely coalescing with lateral lobes. Lateral glabellar lobes tri-composite, nearly two thirds as long as wide, widest at about middle, tapering posteriorly and coalescing with central lobe, narrowing anteriorly, at first slightly then very rapidly, to pointed antero-lateral extremities, extending about four fifths the length of glabella. Occipital furrow deep and narrow, nearly straight in the middle, curving slightly backwards at sides. Occipital ring rather narrow, broadest and nearly parallel-sided in the middle, narrowing laterally, projecting at sides a little outside base of glabella, moderately arched transversally, rounded longitudinally. Anterior border very narrow, well marked off at sides, but with the surface in the middle confluent, or almost confluent, with that of glabella, the anterior border furrow being distinctly impressed laterally and growing weaker internally to became obsolete, or almost obsolete, in the middle.

Fixed cheeks with narrow, flattened, band-like anterior portions; posterior portions of moderate size, with gently convex surfaces sloping rather steeply downwards laterally and posteriorly to posterior border furrows. Palpebral lobes sub-crescentic, slightly bent downwards, very gently convex longitudinally. Palpebral furrows obsolete anteriorly, beginning behind middle of palpebral lobes as weak, slightly inwards directed grooves, and continued by well-marked furrows curving backwards and outwards to facial sutures and marking off narrow, upturned, band-like portions, which apparently support the eyes posteriorly and are continued by the lower eyelids on the fixed cheeks. Posterior borders of fixed cheeks narrow, thickened, curving slightly forwards laterally, marked off by deep, rather narrow furrows. Anterior branches of facial sutures converging very slightly forwards adjacent to palpebral lobes, curving more strongly inwards anteriorly; posterior branches curving from the palpebral lobes obliquely outwards and backwards and finally nearly straight backwards.

The surface of the cranidium is ornamented by low tubercles of different sizes or by minute punctæ. These are, however, very differently distributed on different specimens according, as it appears, to the age of the individuals and the thickness of the test, which is thin in small specimens, but the larger the specimen is the thicker the test seems to be. On the largest cranidia only punctæ, but no tubercles are discernible on the surface of the test — on the casts rather indistinctly defined tubercles are seen on the occipital ring and on the hindmost portions of the glabella and fixed cheeks; in medium-sized cranidia the occipital ring, the posterior portions of the fixed cheeks and the hindmost portion of the glabella — or only the occipital ring and the posterior borders of the fixed cheeks — are tuberculated, but not the other parts of the surface; in smaller specimens the tuberculation reaches farther forwards, but the tubercles decrease in height anteriorly; in the smallest one observed tubercles occur on the whole of the glabella, except just in the middle in front — and in the furrows, of course — where the surface instead is ornamented by punctæ. The tubercles seem, as a general rule, to be higher and more distinctly defined on the natural casts than on the surface of the test; they are, everywhere where they occur, placed rather close together. The punctæ are also placed rather close together in the vicinity of the tuberculated portions, but on other parts they are more sparingly distributed.

Dimensions. — The dimensions of a medium-sized cranidium are: distance along the median line between anterior and posterior margins 18 mm., greatest width of glabella 18 mm., frontal width of central lobe 17 mm. In a large fragmentary cranidium — the largest observed — the frontal width of the central glabellar lobe is about 30 mm. and in the smallest one which has come under my notice, it is about 6,1 mm.

Remarks and Affinities. — The material from which the above description is drawn up consists of a little over a dozen cranidia — in different collections — from the Upper Leptæna Limestone.

As already mentioned above, the smaller and the larger specimens show a marked difference in the ornamentation of the test. This seems to be, at least partly, due to the fact that the test becomes thicker with age and in connection with this the tubercles grow more and more obsolete and finally disappear entirely. Even in very large specimens tubercles are discernible on the posterior portions in the natural casts, although they have disappeared on the surface of the test. This shows that the hollows on the internal surface of the test disappear more slowly than the tubercles on the upper surface.

TÖRNQUIST's species *Lichas brevilobatus* (TÖRNQUIST, 1884, p. 34, Pl. I, figs. 32—33) is, as has already been remarked by SCHMIDT (1907, p. 26), evidently identical with *Amph. lineatus* ANG. The material on which he founded his species consists of two very fragmentary, large cranidia with thick, untuberculated test. TÖRNQUIST stated that the test was smooth, without any kind of ornamentation and that the anterior lateral glabellar furrows only divided the anterior half of the glabella, but this is not quite correct. On the best preserved portions of the test impressed punctæ are very distinctly seen — on some parts, where the test is lacking, tubercles are discernible on the cast — and the glabellar furrows extend far beyond the middle of the glabella, although their posterior portions are very weak in the specimen figured by TÖRNQUIST.

SCHMIDT (1907, p. 26) was of the opinion that EICHWALD's species *Lichas lævis* also was identical, but of this I cannot feel certain. In the specimens (casts) from the East Baltic Lyckholm Formation, which EICHWALD (1860, p. 1387, Pl. LIV, figs. 16 a—b) referred to his species, the anterior lateral glabellar furrows extend to the occipital furrow, and to judge both from his figures and from what he has remarked in the text[1] it seems as if these were rather distinctly impressed throughout. In 1885 (p. 49, Pl. VI, figs. 5—8) SCHMIDT described and figured a greater number of cranidia from the Lyckholm Formation, which he attributed to EICHWALD's species, but later on (1907) after having seen a cranidium of *Amph. lineatus* from the Leptæna Limestone he came to the conclusion that the two species were identical. Most of the specimens figured by SCHMIDT (figs. 5—7) seem, as far as can be judged from the figures, to agree closely with the typical cranidia from Dalarne, and it appears probable that they really belong to *Amph. lineatus*.

In his fig. 8, however, the anterior lateral glabellar furrows reach the occipital furrow on the side where the test is preserved as well as on the other where this is removed, the neck of the central glabellar lobe is wider than in the other figures and in the cranidia from the Leptæna Limestone, the anterior outline of the glabella is more evenly rounded and the tubercles on the surface appear to be differently distributed than in our specimens. In the description (p. 50) he stated, that the anterior lateral glabellar furrows are generally (N. B. not always) narrow, and on the surface of the test grow weaker posteriorly or disappear entirely, but

[1] In the description he did not state anything concerning the strength of the furrows, and he compared his species to *Amph. dalecarlicus* ANG. and pointed out the differences, but without mentioning anything, which indicates that the furrows grow weak posteriorly or show a tendency to become obsolete.

that, on natural casts, they are always distinctly discernible all the way to the occipital furrow. It might be worth mentioning that SCHMIDT did not figure any cranidium — with partly removed test — which illustrated this statement that the furrows sometimes extented farther backwards and reached the occipital furrow on the cast, but not on the surface of the test, and it appears likely that he had not observed this difference in one and the same specimen. In all the cranidia from the Leptæna Limestone which have come under my notice, in casts as well as in testiferous specimens, the glabellar furrows die out entirely, well in front of the occipital furrow. It is conceivable, of course, that variations in this respect may occur inside the species. I am more inclined to believe, however, that only some of the cranidia from the Lyckholm Formation, which SCHMIDT in 1907 regarded as referable to *Amph. lineatus* really belong to this species, and that it is not identical with *Amph. lævis,* to which species belong probably all the casts and the testiferous specimens in which the anterior lateral glabellar furrows extend to the occipital furrow.

Two of the cranidia figured by SCHMIDT, which really appear to belong to our species, have portions of the fixed cheeks attached and one of these has also the rostrum and the hypostoma. Of the latter SCHMIDT has also figured some detached specimens. Several hypostomata, which in most of their characters agree closely with those figured by SCHMIDT, have been found in the Leptæna Limestone. They differ, however, in some features, and it appears, therefore, more probable that they belong to one of the other species of *Amphilichas*, which occur in this formation, than that they are referable to *Amph. lineatus* (Cf. above pp. 319, 322). As is already remarked above (p. 256), the pygidium which SCHMIDT (1885, 1907) attributed to *Amph. lævis* or *lineatus* appear to belong to a species of *Homolichas*.

Horizon and Localities. — Upper Leptæna Limestone; Kallholn, Boda, Osmundsberg, Lissberg, Unskarsheden, Torsmo. Lyckholm Formation; Estland.

Amphilichas periformis n. sp. Pl. VII, figs. 32—33.

Specific Characters. — Glabella somewhat wider than long, widest a little behind middle, tapering slightly anteriorly and posteriorly, but with a slight expansion near the base, rather narrowly rounded in front, composed of a central lobe and a single pair of compound lateral lobes. Central lobe of glabella pyriform in shape, with the anterior margin very strongly arched forwards, widest in front, but without distinct anterolateral extensions, narrowing posteriorly to about four fifths the distance from its anterior end to occipital furrow, where its width is about one third that at the anterior margin and about one third that of entire glabella, then widening slightly to occipital furrow; its hindmost portion gently convex transversally and separated from anterior portion by slight depression across narrowest part of lobe; its anterior portion strongly convex in both directions, bent down and slightly overhanging in front, from the highest point, which is situated somewhat nearer the occipital furrow than the anterior margin, the surface slopes very steeply downwards laterally as well as anteriorly, but very gently posteriorly to the depression just mentioned. Compound lateral lobes about two thirds as long as central lobe, only reaching a little in front of middle of latter, but produced posteriorly a short distance beyond it, sub-crescentic in outline, more than twice as long as wide, widest a little behind middle, with pointed extremities, strongly convex longitudinally, and rather gently rounded transversally. Anterior pair of lateral glabellar furrows strongly impressed, reaching occipital furrow and in front meeting preglabellar furrow at nearly right angles. 2d and 3d pairs obsolete. Axial furrows well marked anteriorly and posteriorly, though shallower than anterior lateral glabellar furrows, weak in middle.

Occipital furrow deep and narrow, nearly transverse in middle, curving rather strongly backwards at sides. Occipital ring of moderate, nearly uniform width in middle, rapidly narrowing laterally, very strongly arched transversally, slightly rounded longitudinally at sides, more flattened in middle; its surface sloping rather steeply downwards from posterior edge to occipital furrow; its posterior margin transverse in middle, curving forwards at sides. Anterior border narrow, flattened, bent steeply downwards in the middle in front, increasing slightly in width and bending outwards towards the sides, marked off by narrow furrow, which is shallow in middle and grows deeper laterally.

Fixed cheeks with narrow, band-like anterior portions, sloping nearly vertically downwards anteriorly; posterior portions of moderate width, subtriangular, with gently convex surfaces sloping downwards laterally and posteriorly. Palpebral lobes (incompletely preserved) marked off by rather weak, sinuate furrows. Posterior borders thickened, narrow adjacent to axial furrows, widening laterally, marked off by strong furrows. Anterior branches of facial sutures slightly converging anteriorly; posterior branches running from eye lobes obliquely outwards and backwards.

Surface of cranium, except in the furrows, closely covered by tubercles of different sizes.

Remarks and Affinities. — This new species is founded on three small cranidia (measuring from 3 to 5 mm. in length) from Kallholn in ISBERG's collection in Lund. It differs from all other, hitherto, described species of *Amphilichas* by its pyriform, rather than clavate, central glabellar lobe, but on the whole it agrees in the general characters of the cranidium with other members of the genus.

Horizon and Locality. — Upper Leptæna Limestone; Kallholn.

Family **Isocolidæ** ANGELIN.

Genus **Isocolus** ANGELIN.

Isocolus Sjögreni ANGELIN. Pl. XI, fig. 29.

1854. *Isocolus Sjögreni* ANGELIN, p. 59. Pl, XXXIII, fig. 8.

Specific Characters. — Entire body elongated sub-ovate in outline, nearly twice as long as wide. Cephalon and thorax of about equal length; pygidium shorter, occupying about two ninths the entire length of body.

Cephalon strongly convex, semielliptical in outline, the length along the median line about five sixths the width at the level of occipital ring; surrounded anteriorly and laterally by very narrow border and with the genal angles produced into rather long, flattened, broad-based, tapering, pointed spines pressed against sides of thorax.

Glabella defined by well marked axial and preglabellar furrows, moderately convex in both directions, bent down in front, sub-oval in outline, slightly longer than wide, rounded in front, truncated behind; marked by two pairs of strong lateral furrows; the foremost of these situated at about middle of glabella, nearly straight and directed nearly straight inwards or slightly backwards, reaching about half-way up on glabella, generally widening and growing deeper within; posterior pair beginning in axial furrows somewhat nearer to occipital furrow than to preceding pair, running nearly parallel to latter and about as far inwards as these, widening and growing deeper within so as to form small rounded pits from which shallow, indistinctly defined, narrow grooves run back to occipital furrow. Occipital furrow deeply impressed, rather narrow, nearly straight in middle, bending obliquely backwards at sides behind basal lateral glabellar lobes. Occipital ring rather broad and of nearly uniform width in middle behind central lobe of glabella, narrowing laterally, moderately arched transversally, rounded longitudinally.

Cheeks sub-triangular in outline, narrowing anteriorly, steeply bent downwards with convex surfaces, slightly overhanging the margins, connected in front by narrow rounded preglabellar band. Eye lobes situated far forwards and close to glabella, not very prominent; inner portions of eye lobes formed by short, nearly transverse, comparatively broad eye ridges, which are marked off behind by deep furrows, in front by rather shallow ones, and appear to be truncated at their distal extremities so that no real palpebral lobes are formed. [The line of demarkation between the eye ridge and the eye proper is, howewer, not quite distinct in any of the specimens observed.] Eyes very small, situated near the lateral margins of the cheeks. Posterior borders of cheeks of moderate width, widening laterally, raised and rounded, marked off by strong furrows.

The anterior branches of the facial sutures (not distinctly observed) seem to converge rather strongly anteriorly; the posterior branches curve from the eye lobes backwards and slightly outwards and downwards to the posterior borders, where they seem to bend slightly inwards and upwards to cut the posterior margin of the cephalon just inside the base of the genal spines. Free cheeks narrow.

Thorax of 6 segments, slightly tapering posteriorly. Axis convex, rather wide, its width being nearly half that of entire thorax, gently tapering posteriorly. Axial rings with distinctly marked off, slightly depressed lateral nodes. Pleuræ straight and horizontally extended as far as rather remote fulcrum; their outer portions curved nearly vertically downwards and bent slightly backwards, tapering to obtuse points. Each pleura marked by a deep pleural furrow reaching nearly to extremity of pleura.

Pygidium small, semi-oval in outline, nearly twice as wide as long. Axis convex, anteriorly occupying about half the width of entire pygidium and extending about four fifths its length, tapering posteriorly to rounded extremity; consisting of two rather broad axial rings and a short terminal piece; 1st axial ring (in well preserved specimens) defined behind by distinctly impressed, though rather shallow furrow, and with distinct lateral nodes; on the 2d one the lateral nodes are very indistinctly defined, and the furrow which defines it behind is very weak (in most specimens observed not discernible). Axial furrows narrow, distinctly impressed, connected round extremity of axis. Side lobes with a small, flattened area in front, adjacent to axial furrows, which tapers posteriorly and becomes obsolete before reaching extremity of axis; outside and behind this flattened area the surface slopes rather gently to margin; with pair of half ribs on anterior edge, followed by two pairs of rather broad regular ribs, defined (in well preserved specimens) by distinct pleural furrows and marked by weak interpleural furrows, and between 2d pair of regular ribs a rather broad, unfurrowed post axial portion. Anterior pair of pleural furrows strong, reaching nearly to margin; 2d pair somewhat weaker and shorter; 3d pair considerably weaker and shorter than preceding ones.

The surface of the test appears to be smooth.

Dimensions. — The entire individuals observed have a length from about 3 mm. to about 4,5 mm. In one individual in which the entire length is just over 4 mm. the length of both the cephalon and of the thorax is about 1,6 mm., the length of the pygidium about 0,9 mm., and the greatest width approximately somewhat over 2 mm.

Remarks. — Of this species a good number of more or less complete individuals have been found at Kallholn and Osmundsberg together with detached portions of the carapace and imprints (most of these specimens belong to the Upsala Museum); it is also represented from Östbjörka and Arfvet by specimens in the State Museum of Natural History and from Boda by a cranidium in the Upsala Museum.

The specimens are not very well preserved. In the imprints the marginal portions of the cephalon are generally wanting and even in the nearly complete individuals — mostly natural casts — these portions are very difficult to discern owing to the bad state of preservation, the small size of the specimens and the strong convexity of the cephalon. In some specimens portions of the very narrow marginal cephalic border have, however, been observed, also the small eye, the posterior branch of the facial suture, and traces of the anterior one. This contradicts ANGELIN's (1854, p. 59) statement that the form lacks both cephalic border, eyes and facial sutures. It seems probable that in the specimen (or specimens) on which this author based his diagnosis, the narrow free cheeks were wanting or embedded in the matrix, or else very badly preserved.

Affinities. — The genus *Isocolus,* of which only this single species is known, does not seem to be closely related to any other, hitherto, described form, and ANGELIN appears to have been in the right, when he referred it to a distinct family. The only species which seems to be comparable to it, and which perhaps might be referred to the same family is *Cyphoniscus socialis* SALTER (SALTER, 1853, Pl. IX, and text), which occurs in the Kildare and Keisley Limestones, homotaxial with the Upper Leptæna Limestone. This is also a small form — though it appears to attain greater dimensions than our species — with few (7) thoracic segments; a very convex cephalon; sub-ovate, convex glabella; steeply downbent, convex fixed cheeks, which grow narrow anteriorly and are connected by a narrow, rounded preglabellar band; thoracic axial rings, which are not sharply defined by the axial furrows, but run out a little in the pleural furrows — as do the lateral nodes in our species; deeply grooved thoracic pleuræ; and a rounded pygidium with strongly convex axis, not reaching the posterior margin, and convex side lobes. The free cheeks are not known, but were evidently narrow, and seem on the whole to have been rather like those of our species, with small eyes, situated far forwards and only slightly indentating the course of the facial sutures. The glabella is, however, smooth without lateral furrows, there do not seem to be any marked eye ridges or palpebral lobes, no genal spines appear to be developed, the thorax has one more segment than in our form, on the thoracic pleuræ the fulcrum is more approximate, and their extremities are more bluntly rounded, and on the pygidium there seem to be no axial ring furrows and only one pair of furrows (the 1st pleural furrows) on the side lobes. SALTER (Op. cit pp. 1, 3) considered *Cyphoniscus* to be closely related to *Triarthrus* GREEN, and referred it consequently to the family Olenidæ (s. lat.) to which family it has also, later on, been referred by REED (1896, p. 410). The characters in which it differs from *Triarthrus* (and related species) seem, however, to be of so great importance, that it appears to me more than doubtful, whether it really can be placed in the same family. There seems then to be more ground far placing it with *Isocolus* in the family Isocolidæ.

Horizon and Localities. — Upper Leptæna Limestone; Kallholn, Osmundsberg, Östbjörka, Arfvet, Boda.

Family **Encrinuridæ** ANGELIN.

Genus **Encrinurus** EMMRICH.

Encrinurus striatus ANGELIN. Pl. XI, figs. 30—33.

1854. *Cryptonymus striatus,* ANGELIN, p. 89, Pl. XLI, fig. 13.
1884. *Encrinurus multisegmentatus,* TÖRNQUIST, p. 24, Pl. I, figs. 18—19.

Specific Characters. — Pygidium triangular in outline, somewhat broader than long, strongly convex. Axis moderately convex in front, growing lower posteriorly, long and narrow, occupying anteriorly less than one third the entire width of pygidium, gradually tapering posteriorly and ending in a narrow obtuse point between hindmost pair of pleuræ, divided into 26 narrow, rounded axial rings and a minute terminal piece, by distinct furrows, which are more strongly impressed at sides than in the middle, and grow gradually weaker posteriorly. Axial furrows narrow. Side lobes strongly curved downwards but with the tips of the ribs bent outwards; with a pair of very narrow half ribs on anterior edge and behind this 11 or 12 pairs of raised, rounded, narrow regular ribs, increasing somewhat in width laterally, defined by strong pleural furrows and terminating in short, outbent, obtuse free points. Anterior pair of ribs directed nearly straight outwards (and downwards) from axis but curving gently backwards near their ends; following pairs directed successively more and more strongly backwards, the last rib on each side nearly parallel with its fellow. Interpleural furrows obsolete.

On the natural casts no ornamentation of the surface is discernible either on the axis or on the side lobes, but in one specimen with badly preserved test there are traces of a few minute tubercles or granules along the centre of the pleural ribs.

Dimensions. — In the best preserved pygidium which has come under my notice, the length is 5,5 mm. and the anterior width 7 mm. A large, incompletely preserved pygidium — the largest one observed — seems to have had a length of about 11 mm. and a width anteriorly of about 14 mm.

Remarks. — This species was originally founded by ANGELIN (1854, p. 89, Pl. XLI, fig. 13) on a somewhat fragmentary pygidium from Osmundsberg. Later on TÖRNQUIST (1884, p. 24, Pl. I, figs. 18—19) described a fragment of a glabella and described and figured a better preserved pygidium from Unskarsheden which specimens he attributed to *Encr. multisegmentatus* PORTL. and pointed out that it seemed doubtful, whether ANGELIN's species was separable from this. That the specimens in question from the Leptæna Limestone belong to the same species[1] seems indubitable, ANGELIN had stated that there were 10 pleural ribs and about 17 axial ring furrows on the pygidium. In his type specimens, which I have had the opportunity of examining, the foremost portion is broken off and the end badly preserved. It seems as if ANGELIN had not observed the former fact and not counted the first pair of pleural ribs, of which the tip on one side is present. Counting this there are 11 distinctly developed pairs of regular ribs and obscure traces of a twelfth pair. On the axis 25 axial rings are traceable and it is evident that the foremost one is lacking in the specimen. In other characters it agrees closely with the pygidium figured by TÖRNQUIST.

In addition to these specimens there are now available two imperfectly preserved pygidia from Boda and another imperfect one from Kallholn in the Upsala Museum, one nearly complete pygidium, which shows 11 pleural ribs, from the latter locality in ISBERG's collection in Lund, and finally one from Lissberg in the Museum of the University of Stockholm. The latter occurs in a piece of red lime-shale and is the only one in which the test is preserved (though rather badly and not completely). There are on this, as is already mentioned, traces of a few minute tubercles along the centre of the pleural ribs, whereas on the other specimens, which are natural casts and occur in ordinary limestone, there is no ornamentation visible on the surface. In this specimen the side lobes bear 12 distinctly developed regular ribs, but the last pairs are very short and narrow. In TÖRNQUIST's specimen there are only 11. This difference, however, hardly seems to be of specific importance; it may perhaps only be due to the state of preservation, whether one pair more or less is discernible.

The only specimen of the other portions of the carapace found in the Leptæna Limestone is the fragmentary glabella already described by TÖRNQUIST (Op. cit.) which apparently belongs here. In this the foremost and the postero-lateral portions are broken off. Evidently there has been a frontal marginal row of large tubercles, but of these only the hindmost one on the right side is preserved in the specimen. The glabella is moderately convex, not especially inflated in front, pear-shaped in outline, gradually widening anteriorly and not contracted in the middle; on each side are 3 short lateral furrows, directed nearly straight upwards; the two anterior ones are rather strong and end in the axial furrow in rounded pits; the posterior one has perhaps been similar, but of this only the proximal portion is preserved. Of the lateral glabellar lobes the anterior and 2d ones at least, have each apparently been entirely covered by a large tubercle, all of which are broken off in the specimen. The tubercles on the central glabellar lobe are coarse and high, rather varying in size, but on the whole large and conical with a small rounded pit on the top; at

[1] For reasons that will be given below it seems to me best to regard this, for the present at least, as a distinct species and to keep ANGELIN's name *Encr. striatus*.

the base of the central lobe between the posterior lateral lobes there seems to have been only a single rather small tubercle; and between, and on a line with those on the 2d lateral lobes, are two large ones; on the middle portion of the central lobe there are also large, but more irregularly placed tubercles, with smaller ones between them, whereas the tubercles on its frontal portion are all comparatively small. The axial furrows do not seem to have been very deeply impressed. The occipital furrow is, at least in the middle, shallow and rather narrow.

Affinities. — As mentioned above, TÖRNQUIST (Op. cit.) referred the specimens of this form described by him to *Encr. multisegmentatus* PORTL. (PORTLOCK, 1843, pp. 291, 262, Pl. III, figs. 6, 11; REED, 1906, p. 122, Pl. XVI, figs. 9—11 a; 1914, p. 39, Pl. VII, figs. 1—3), and it does not seem improbable that ANGELIN's species really may be identical with this. It is not possible to decide this question definitely, however, without having more complete material from the Leptæna Limestone or any specimen of the Irish and British form for comparison, and since to judge from the figures and descriptions available of this latter there seem to be some differences, it appears safer to keep the Swedish form apart rather than to assume a possibly non-existent specific identity. PORTLOCK (Op. cit. p. 291) stated that in the type of his species (pygidium) the axial rings are »numerous, 28 being enumerated as far as the last side segments» (ribs) »and still continuing, though very minute, to the very apex»; and to judge from his figure 6 b the side lobes seem to be very slightly bent down at the sides of the axis anteriorly, and that this is the case in the pygidium from Girvan described and figured by REED (1906) is stated by this author, and to judge from the figure the boundaries between the inner portions and the steeply bent down outer portions are distinct, though there is no sharply marked fulcrum. In the pygidia from the Leptæna Limestone on the other hand the whole of the side lobes are much more evenly curved downwards. In the fragmentary glabella from Unskarsheden described above the two anterior pairs of lateral furrows are distinctly marked, but neither PORTLOCK nor REED has mentioned anything about the presence of such furrows in the cranidia described by them (by the former as *Ampyx? baccatus*). This might, however, conceivably depend on the circumstance that in specimens in which the tubercles on the side lobes are preserved, the furrows are less conspicuous, but in PORTLOCK's figure of the cranidium no large tubercles occur on these places; in the cranidia figured by REED lateral glabellar furrows seem, as a matter of fact, to be present, but in these specimens the glabella appears to be broader in relation to its length than the glabella from Unskarsheden.

Whether the form from the East Baltic Lyckholm Formation which SCHMIDT (1881, p. 227, Pl. XIV, figs. 14—15, Pl. XV, figs. 19—20) hesitatingly referred to *Encr. multisegmentatus* — and which occurs also in the North Baltic Östersjö Limestone (WIMAN, 1907 a, p. 132, Pl. VIII, fig. 34)

— really belongs to this species seems doubtful. At any rate it does not appear to be referable to the same species as the form which occurs in the Leptæna Limestone. The glabella appears to be relatively wider than that of the latter and to be without marked lateral furrows and the occipital ring seems to be stronger; the pygidial side lobes are less steeply curved down, the ribs are, on the whole, directed more strongly backwards, are broader, flattened and separated by very narrow furrows, and their tips are scarcely bent outwards and scarcely project on the margin.

Horizon and Localities. — Upper Leptæna Limestone (limestone and lime-shale facies); Osmundsberg, Unskarsheden, Boda, Kallholn, Lissberg.

Genus **Cybele** LOVÉN.

Cybele brevicauda ANGELIN. Pl. XI, fig. 38.

1854. *Cybele brevicauda,* ANGELIN, p. 89, Pl. XLI, fig. 14.
?1881. *Cybele brevicauda,* ANG.?, SCHMIDT, p. 219, Pl. XI, fig. 23, Pl. XIV, figs. 7—10, Pl. XV, figs. 15—17.
?1897. *Cybele brevicauda,* KIÆR, p. 13.

Remarks. — The specimen from Osmundsberg, on which ANGELIN founded this species, is only a fragment showing the hollow inner surface of a portion of a pygidium.

The pygidium seems to have had the usual sub-ovate shape. The axis is gently convex, long and narrow, gently tapering posteriorly and furnished with a great number of axial rings (probably there have been 16), of which only the anterior ones are complete, the others incomplete in the middle. The 1st axial ring appears to be smooth; the 2d bears a distinct median tubercle and traces of a smaller one on each side of this; on the following rings a tubercle is situated on each side, where the ring abuts against the smooth median portion of the axis — in the specimen some of these are very distinct, the others more faintly indicated. The side lobes are gently convex and consist of 4 pairs of curved pleuræ — the 4th pair the least curved — corresponding to the anterior axial rings. Each pleura is divided by, a longitudinal furrow into two unequally developed bands or ridges, the posterior one being much the stronger and bearing one or two tubercles.

Whether the specimens from the East Baltic Lyckholm and Wesenberg Formations, which SCHMIDT in 1881 described and figured as *Cybele brevicauda* ANG.? really belong to ANGELIN's species is as impossible to decide now as it was then, since no additional specimens, which seem referable to the species, have been found as yet in the Leptæna Limestone. As stated by SCHMIDT the specimen from Osmundsberg resembles, as far as it is preserved, the pygidia of this East Baltic form rather closely, but several species of the genus seem to have almost the same pygidial characters. It appears, however, quite probable that SCHMIDT's assumption as to the specific identity of the forms is correct, since, as especially emphasized by him, the Lyckholm Formation and the Leptæna Limestone at Osmundsberg (viz. the Upper Leptæna Limestone) in other cases show a close faunistical correspondence. Moreover, a form, which seems to be identical with the East Baltic one, has been recorded by KIÆR (1897, pp. 13, 52) from the Etage 5 a in Norway and a great number of species are common to this formation, the Upper Leptæna Limestone and the Lyckholm Formation. (Cf. KIÆR, op. cit., pp. 48—53.)

Horizons and Localities. — Upper Leptæna Limestone; Osmundsberg.

[?Lyckholm and Wesenberg Formations; East Baltic Area. ?Etage 5 a; Norway.]

Cybele cf. **revaliensis** SCHMIDT. Pl. XI, fig. 39.

Remarks. — A fragmentary and crushed pygidium, about 9 mm wide, from Osmundsberg in the Museum of the Geological Survey recalls that of *Cyb. revaliensis* SCHMIDT (SCHMIDT, 1881, p. 207, Pl. XIII, fig. 20, Pl. XIV, fig. 6, Pl. XV, figs. 6—7, Pl. XVI, fig. 40).

The pygidium is broadly sub-ovate in outline, narrowing posteriorly; the length seems to have been about equal to the greatest width. The axis is sub-conical, elongated, slender, and seems to have been rather acutely pointed behind; it does not reach the posterior margin of the pygidium, but was probably followed by a small, narrow post axial piece. There are 16 or 17 axial rings, of which only the anterior ones are complete, the others being depressed and indistinctly defined or interrupted in the middle. The side lobes consist of 4 pairs of pleuræ, which successively decrease in strength of curvature, the anterior pair being strongly curved. Each of the 3 anterior pleuræ on each side consists of a broad, raised and rounded posterior ridge and a narrower, more depressed anterior one, which tapers posteriorly and does not reach the end of the pleura. The anterior ridge of the 1st pleura is gently rounded and comparatively broad; that of the 2d pleura is considerably narrower and more depressed and that of the 3d one still narrower and lower. Of the 4th pleura only the posterior ridge appears to be developed. All the pleuræ have probably ended in short, slightly upturned, free points, forming together a backwards convex posterior outline to the pygidium. [In the specimen only the two outermost free points are preserved on one side.] The test of the pygidium is finely granulated, and small tubercles are situated singly or in pairs along the median portion of the axis and in a single row along each of the posterior pleural bands.

The specimen of rock, in which this pygidium occurs, is a greenish limestone interstratified by thin layers of greenish shales, and it is very similar in appearence to the lowest part of the Lower Leptæna Limestone found immediately above the Chasmops Limestone in the Amtjärn Quarry. It has been collected by v. SCHMALENSÉE in 1883, and on the accompanying label is quite properly noted that it is from the Lower Leptæna Limestone immediately above the Chasmops Limestone. In a paper published the following year, v. SCHMALENSÉE (1884, p. 286) has referred to this pygidium[1], regarding, however, the part of the limestone occurrence, in which it was found, as well as the underlying beds, as Chasmops Limestone. In fact, as will be shown below in the chapter on the stratigraphy, the lowest Leptæna Limestone seems to be homotaxial to the Macrourus Limestone, which in other districts of Sweden (Öland, Östergötland) and in some localities in Dalarne, e. g. Vikarbyn, forms the upper part of the Chasmops Limestone. According to v. SCHMALENSÉE (Op. cit.) and TÖRNQUIST (1884 a, p. 318; 1886, pp. 81—82) the beds in question occur on the southern or south-western slope of the hill Osmundsberg, and are succeeded by layers of Trinucleus Shales; and both authors seem to have been of the opinion that a fault exists between the latter and the Leptæna Limestone (Upper Leptæna Limestone), which forms the main part of the hill.

Horizon and Locality. — Lower Leptæna Limestone (lowest part); Osmundsberg (on the southern or sout-western slope of the hill).

Family **Cheiruridæ** SALTER.

RAYMOND in 1913 (1913 a, p. 724) proposed a sub-division of the family Cheiruridæ into the sub-families Cheirurinæ, Pliomerinæ and Deiphoninæ, referring to the latter the genera *Deiphon* BARR., *Sphærocoryphe* ANG. and *Staurocephalus* BARR. The validity of this sub-family seems doubtful to me. BARTON (1915) places *Sphærocoryphe* among the Cheirurinæ, on good grounds apparently. This genus and *Deiphon* appear, however, to be too closely allied (Cf. REED, 1898, p. 211) to be referred to separate sub-families and, therefore, it seems necessary to include the latter also in Cheirurinæ, if we recognize this as a sub-family of Cheiruridæ. *Staurocephalus,* on the other hand, does not seem to have close affinities with *Deiphon* and *Sphærocoryphe* or with any of the other Cheirurids, and ought then, perhaps, to be referred to a distinct sub-family, or possibly it should not be included in the family Cheiruridæ (Cf. REED, 1898, pp. 212—214). As regards the sub-family Pliomerinæ it appears questionable whether it ought not to be raised to the rank of family.

[1] That it really is this pygidium, which is meant, is shown quite clearly by a comparison between the notes on the labels and the statements in the paper concerning the occurrence and characters of the beds.

Genus **Cheirurus** BEYRICH (RAYMOND and BARTON).

In his paper A Revision of the Cheirurinæ 1915, BARTON, when enumerating the species belonging to *Cheirurus* s. str., gives only a single Swedish species, *Ch. conformis* ANG., and this with a query against its name. To the genus *Ceraurus* s. str. he refers, on the other hand, several species occurring in our country, and with the exception of the Lower Ordovician *Cer. exul* BEYR., all of these, viz. *Ch. speciosus* HIS., *Ch. gotlandicus* LINDSTR., *Ch. glaber* ANG., *Ch. punctatus* ANG.[1] and *Ch. subulatus* LINRS., as well as the British *Ch. keisleyensis* REED, seem, as far as I am able to judge, to be better placed in *Cheirurus.*

Before entering into a discussion of these species, attention may be called to a dissimilarity between the two genera, which seems to be of classificatory value, and which, although pointed out by BARRANDE (1852, p. 785) with regard to the genotypes *Cheirurus insignis* BEYR. (BEYRICH, 1843, p. 12, Pl., fig. 1) and *Ceraurus pleurexanthemus* GREEN (GREEN 1832, p. 84, Pl. I. fig. 10), appears to have been overlooked by later writers. In *Cer. pleurexanthemus* and, as far as I have been able to ascertain from specimens, descriptions, and figures available to me, in all other species which seem referable to the same genus, the glabella is surrounded in front by a narrower or wider anterior border, throughout distinctly marked off. In *Cheirurus*[2], on the other hand, the anterior border of the cranidium is distinctly marked off only at the sides, and adjacent to the fixed cheeks bent outwards; internally it bends more and more strongly downwards, and the bounding furrow grows gradually weaker and finally obsolete in the middle in front, where the »border» becomes incorporated in the glabella; sometimes, however, the boundary between the glabella proper and this incorporated border-portion is indicated on internal casts by a very weak groove.

Why BARTON has not referred the Silurian species *Ch. speciosus* (HISINGER 1840, p. 6, Pl. XXXIX, figs. 2 a—b; ANGELIN 1854, p. 78, Pl. XXXIX, fig. 14) and *Ch. gotlandicus* (LINDSTRÖM 1885, p. 45, Pl. XII, figs. 9—10) to *Cheirurus* is very difficult to understand, since the figures show the typical characters of the genus, except that in the figures of the former the basal lateral glabellar lobes differ slightly in shape, without, however, being like those of *Ceraurus.* As a matter of fact these portions are not correctly given in the figures; in HISINGER's

[1] Against this species in BARTON's list is a query.

[2] As far as I have been able to find out, only, one of the species referred to *Cheirurus* by RAYMOND and BARTON (R. and B. 1913; BARTON 1915), viz. WELLER's *Ceraurus Hydei* (WELLER 1907, p. 264, Pl. XXIV, fig. 22) has a well developed anterior border in front of the glabella, but this species shows also in other respects such typical *Ceraurus* characters — the two anterior pairs of lateral glabellar furrows are very short and straight and the pygidium is of the *Cer. pleurexanthemus* type — that it appears to me to be better placed in the latter genus, although, in some features, it bears a closer resemblance to *Cheirurus.*

original type specimen (ANGELIN seems to have figured the same specimen) they are more triangular and rather like those of the genotype.

That the species from the Leptæna Limestone, *Ch. glaber* and *Ch. punctatus* (Cf. below, p. 350 and p. 347) have been placed in *Ceraurus* is more easily accounted for, since it is difficult to ascertain their true characters from ANGELIN's diagnoses and figures; they differ also in some features rather more from the genotype than the Silurian species just mentioned; moreover as regards *Ch. glaber,* BARTON has naturally believed it to be identical with SCHMIDT's *Ch.* cf. *glaber* (SCHMIDT 1881, p, 151, Pl. VII, figs. 18 a—b), which, however, does not belong here and really appears to be a *Ceraurus.*

As regards the other two Upper Ordovician species, *Ch. subulatus* (LINNARSSON 1869, p. 60, Pl. I, figs. 4—5) and *Ch. keisleyensis* (REED 1896, p. 417, Pl. XX, figs. 7—9; 1914, p. 45) they are apparently referred to *Ceraurus* chiefly on account of the characters of the pygidia. These differ markedly from the pygidia of the typical species of *Cheirurus*, and although they differ at least as strongly from the *Ceraurus pleurexanthemus* type, they resemble, to a certain extent, those of some of the East Baltic species of *Ceraurus,* and, still more, that of *Cer. Ruedemanni* RAYM. (RAYMOND 1916 c, p. 121, Pl. XXX, fig. 9—12). They recall, however, also the pygidium of *Ch. gelasinosus* PORTL. (SALTER 1864 a, p. 71, Pl. V, figs. 6—8), which species is regarded by BARTON (Op. cit., p. 143) as a primitive form of *Cheirurus.* In the Upper Leptæna Limestone of Dalarne some pygidia have also been found, which recall those of *Ch. keisleyensis* and *Ch. subulatus,* but at least one of them (Pl. IX, fig. 10) differs decididedly less from the *Ch. insignis* type. The characters of the pygidium are, however, as being more variable, evidently of less importance than those of the cranidium for determining the generic position of a species, and the cranidia of the two species are essentially of the *Ch. insignis* type, or rather of the *Ch. bimucronatus* type (the occipital furrow is rather narrow in the middle). It is true that in both, as well as in *Ch. glaber* and *Ch. punctatus*, the basal lateral glabellar furrows are not straight, but bend more strongly backwards internally, which is not in strict accordance with BARTON's diagnosis of the genus *Cheirurus,* and they are also considerably shallower within. As far as I have been able to ascertain, this is the case in all species of *Cheirurus*, though the depth and direction of the inner portions of the furrows — and the shape of the basal lobes — vary in different species and even in different specimens of the same species (Cf. BARRANDE 1852, Pl. XLII, figs. 2, 5, Pl. XLI, figs. 1, 2, 5; SALTER 1853, text to Pl. II, p. 3; below, p. 344). It appears, however, as if they were generally somewhat shallower in the Ordovician species than in the Silurian ones, which seems only natural, since this must evidently be considered a more primitive stage.

Distinguishing Characters of the Species.

Length of cephalon along median line somewhat more than half, but less than three fifths, the width at level of occipital furrow. Glabella moderately convex with gentle, or rather gentle, anterior slope, tapering posteriorly to about three fourths its frontal width; the frontal lobe occupying nearly half its length. Anterior two pairs of lateral glabellar furrows rather narrow, gently curved and directed slightly backwards, generally extending more than three fourths the distance from axial furrows to median line of glabella. *Ch. Clasoni* TQT.

Length of cephalon along median line rather more than three fifths the width at level of occipital ring. Glabella rather strongly convex in front with steep anterior slope, tapering posteriorly to rather less than two thirds its frontal width; the frontal lobe occupying somewhat more than half its length. Anterior two pairs of lateral glabellar furrows narrow, directed nearly straight inwards, extending somewhat more than half-way from axial furrows to median line of glabella. *Ch. Törnquisti* n. sp.

Length of cephalon along median line slightly less than half the width at level of occipital ring. Glabella moderately convex with moderately steep anterior slope, tapering posteriorly to about five sixths its frontal width; the frontal lobe occupying less than two fifths its length. Anterior two pairs of lateral glabellar furrows broad, rounded in the bottom, generally directed slightly backwards at their inner extremities, at least 1st pair extending more than three fourths the distance from axial furrows to median line of glabella. *Ch. glaber* ANG.

Cheirurus Clasoni TÖRNQUIST. Pl. IX, figs. 1, 3, 6—9, 2?, 4—5? 20?; text-fig. 22.

1884. *Chirurus speciosus,* TÖRNQUIST, p. 12.
1905. *Chirurus Clasonii,* TÖRNQUIST, p. 455, text-figs. 1—2.

Specific Characters. — Cephalon sub-semielliptical in outline, the length along median line somewhat more than half the width at level of occipital ring; with rather slender, tapering genal spines directed backwards and slightly outwards.

Glabella bordered laterally by strongly impressed axial furrows, moderately convex with rather gentle anterior slope, longer than wide, broadly rounded in front, widest at anterior margin, tapering posteriorly to about three fourths its frontal width, and occupying at base about one third the entire width of cephalon. Frontal lobe occupying nearly one half the entire length of glabella. Anterior lateral glabellar lobes rather small, roughly rectangular in outline, with the longer axes directed outwards, generally somewhat narrower within than at axial furrows. 2d pair rather smaller than anterior pair, widest within and gently tapering to axial furrows. Basal pair comparatively large, sub-triangular. Anterior two pairs of lateral glabellar furrows strongly impressed, but rather narrow, sub-parallel and reaching about equally far inwards, gently curved and directed slightly backwards, generally extending more than three fourths the distance from axial furrows to median line of glabella. Basal pair of lateral furrows directed obliquely inwards and backwards and deeper than the others for the greater part of their length, but growing shallower and bending more strongly backwards a little before reaching occipital furrow; the distance between their inner extremities less than one third basal width of glabella. Occipital furrow widest, but rather shallow, and arched forwards in middle, narrower and deeply impressed at sides. Occipital ring broad in the middle, narrowing towards the sides, strongly arched transversally, its surface somewhat higher than that of glabella on the median line and sloping gently downwards from posterior edge to occipital furrow. Anterior border narrow, rounded, bent outwards and

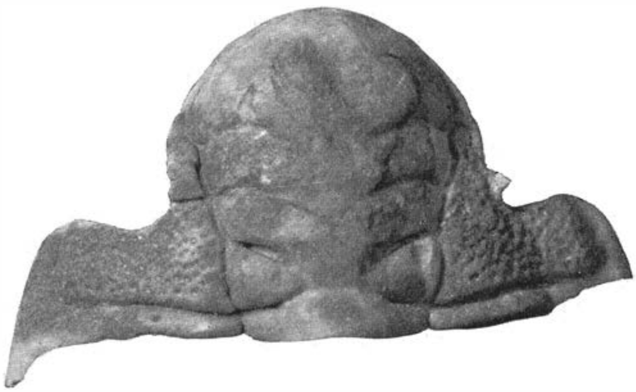

Fig. 22. *Cheirurus Clasoni* TQT. Cranidium. × 1.
Kallholn. Upsala Museum.

distinctly marked off at sides, bending downwards internally and becoming incorporated in the glabella in the middle.

Cheeks sloping rather gently downwards laterally and anteriorly, with strongly defined rounded marginal borders — the posterior borders in large specimens growing flattened and very wide laterally — which are produced at the genal angles into rather slender, tapering, rounded spines directed backwards and slightly outwards (their entire length not known). Surface of cheeks inside the bounding furrows gently convex. Eye lobes small, situated opposite 2d lateral glabellar furrows at marked distances from glabella. Palpebral lobes sub-crescentic, gently bent upwards, marked off on their insides by distinct furrows. Eyes small, rather high, strongly convex, supported by narrow, distinctly raised lower eyelids. Anterior branches of facial sutures converging slightly anteriorly to border, then bending inwards; posterior branches running from eye lobes outwards and slightly forwards, sub-parallel to posterior margins of cheeks, to lateral borders, then bending strongly backwards to cut lateral margins a little in front of bases of genal spines.

Surface of cheeks inside border furrows rather closely covered by relatively small, rounded pits. The interspaces between the pits, and the other portions of the cephalon, except the furrows, granulated; on large specimens the granulation is very fine, on smaller ones coarser.

Dimensions. — The cranidia of this species which have come under my notice, are of very varying sizes. The dimensions of a large, nearly complete cranidium are; length along median line 44 mm., width at level of occipital ring 81,5 mm., length of glabella along median line 37 mm., width of do. across frontal lobe 35 mm., width of do. across basal lateral lobes 27 mm. In the smallest cranidium observed the length along the median line is somewhat less than 8 mm.

Remarks. — This species is not previously described. TÖRNQUIST reported it originally (1884) from the Leptæna Limestone as *Ch. speciosus* HIS., but later he realized his mistake, and in a paper of 1905 he figured two cranidia from Unskarsheden under the name of *Ch. Clasoni* and pointed out some characters in which his new species differs from HISINGER's.

TÖRNQUIST's type specimens are very fragmentarily preserved, but in the abundant material now available there are several nearly complete cranidia, and in one of them — a very small specimen in ISBERG's collection at Lund — one of the free cheeks is attached in position. On the whole all the cranidia examined agree very closely in characters, except that in the smaller specimens, which are well enough preserved to show this character, the granulation on the surface is somewhat coarser than in the larger ones. Generally, but not always, the glabella in the small specimens seems also to be a little more gently convex than in the larger ones, and in some of the cranidia the glabella tapers somewhat more strongly posteriorly than in others. There are further some slight differences in the direction of the hindmost portions of the basal lateral glabellar furrows; these portions vary also rather much in strength, but probably this is chiefly due to the state of preservation.

A few fragments of thoracic segments, which appear to belong to this species, have been found at Kallholn (at which locality a great number of cranidia have been collected). In the largest of these the width of the axis is 23 mm., and thus it corresponds in point of size to the larger of the cranidia. The specimens show, as far as they are preserved, the typical characters of the genus. The axis of the thorax seems to have been narrow, occupying considerably less than one third the entire width of the thorax. The axial rings are rather strongly arched and bounded laterally by deep, narrow axial furrows. On the pleuræ the fulcrum is situated about one third the way out. The inner portion is straight and horizontally extended and divided by a strong, oblique furrow, which is accompanied by a ridging-up of the surface on each side of it;

along the anterior and posterior margins of this portion are narrow, depressed articulating bands, which continue for a short distance beyond the fulcrum, where they widen into small semioval articulating pieces. The furrow which separates the inner and outer portions of the pleura is distinctly, though not very strongly, impressed and runs from the fulcral point on the anterior margin obliquely backwards, converging towards the axial furrow at about 20° to 25°, to meet the pleural furrow a little in front of the posterior margin of the pleura. The extra-fulcral portion is rather strongly bent downwards; outside the furrow just mentioned, between the articulating pieces, it is slightly constricted and its surface raised into a rather low boss; laterally it curves more or less strongly backwards, tapering to a short point (the difference in the specimens being due apparently as to whether they are posterior or anterior segments). Where the test is preserved it shows a fine granulation.

A fragment of a pygidium from Osmundsberg in the Museum of the Geological Survey and another fragmentary pygidium from Kallholn in the Upsala Museum appear also to belong to this species. In the former the anterior width of the axis is 15 mm., in the latter 8 mm. The axis is strongly convex and tapers rapidly and decreases in height to the narrow, somewhat depressed terminal piece, which in both specimens is incompletely preserved. The articulating half-ring on the anterior segment is very conspicuous, more strongly arched than the rest of the axis, rounded longitudinally and marked off by a strong furrow, which is somewhat shallower in the middle. Behind it are 3 rounded rings; the furrows separating these are well marked, but shallower in the middle, where there are »rudimentary articulating half-rings», most distinctly developed in the 2d segment. The 2d and 3d axial rings are a little produced at the sides beyond the preceding transverse furrows, obtusely pointed, antero-laterally bounded by the innermost portions of the interpleural furrows, and only postero-laterally by the weak, interrupted axial furrows. The side lobes consist of 3 pairs of pleuræ, of which at least the anterior pairs — probably also the 3d — have free ends. The anterior pair is the largest in breadth and probably in length also, but whether its spines have reached beyond or as far backwards as those of the following pairs cannot be judged from the specimens available, in which none of the pleuræ are complete. The inner attached portion of each pleura of this pair increases in width distally and extends to the fulcrum, which is distant from the axis by less than half the width of the latter; on its anterior edge are traces of a narrow, depressed articulating band, which seems to have widened laterally. Beyond the fulcrum the pleura becomes free, bends back at an angle of about 50° to the straight anterior edge of the inner portion, and is produced into a tapering spine, which seems posteriorly to bend gradually more strongly backwards. A short, strong, oblique furrow traverses the inner portion of this pleura and is accompanied by a ridging-up of the surface on each side of it; the outer portion is unfurrowed and has, at least as far as it is preserved, a slightly rounded surface. The 1st interpleural furrow is narrow and deep, decreasing somewhat in depth towards its extremity, nearly straight, making an angle of about 50° with the median line of the pygidium, and extending nearly to the level of the 3d axial ring furrow. The 2d interpleural furrow is slightly shorter than the 1st one, which it equals in width and depth, and runs from the axial furrow backwards and slightly outwards for about half its length and then turns nearly straight backwards. Each pleura of the 2d segment is thus directed rather strongly backwards, and its attached portion, which is very narrow at the axial furrow, increases rapidly in width distally; the width across the base of the free portion is, however, only about two thirds the greatest width of the 1st pleura. The free portion consists of a rapidly tapering spine, which seems to have been rather short; its outer margin, which is almost straight, is nearly parallel to the median line of the pygidium. This pleura is unfurrowed and its surface is slightly ridged-up proximally and grows more flattened distally. Each pleura of the 3d pair has a short, narrow, unfurrowed anterior attached portion, which is directed nearly straight backwards and separated on the inside from the terminal piece by a deep narrow furrow, its surface is distinctly swollen in front, but posteriorly only gently rounded; the posterior portion of this pleura is not preserved. The surface of the pygidium, except in the furrows, is finely granulated.

A typical *Cheirurus* hypostoma, measuring about 12 mm. in length, from Kallholn in ISBERG's collection at Lund seems also to belong to this species. The central body is moderately convex, sub-ovate in outline, strongly tapering posteriorly, distinctly rounded behind, as well as in front, and marked at the sides, near the posterior end, by a pair of rather short, very oblique furrows. The anterior border and the anterior wings are broken off. The lateral and posterior borders form a narrow, continuous band, which is separated from the body by a deep furrow, gently rounded anteriorly, growing flatter posteriorly, widest just behind the anterior wings and at the sharply angulated postero-lateral corners; behind in the middle the border is produced into a short point, but this is so steeply inclined that when the hypostoma is seen in ventral aspect the posterior margin appears to be quite straight. The surface of the body and the borders is finely granulated.

Affinities. — The chief characters in which this species differs from *Ch. speciosus* HIS. and *Ch. Törnquisti* n. sp. (= *Ch. insignis* TÖRNQUIST non BEYRICH; cf. below p. 348) have already been pointed out by TÖRNQUIST (1905, p. 456; 1884, p. 13) and need not be repeated here. It does not seem to be especially closely related to either of these species. Its affinities seem rather to be with *Cheirurus keisleyensis* REED (REED 1896, p. 417, Pl. XX, figs. 7—9; 1914, p. 45). The cranidia which have been referred to, and which seem to belong to, the latter species (which was originally founded on the pygidium) are not very well preserved.

However, to judge from REED's figure and descriptions, as well as from specimens from Keisley and from the Girvan district, which I have had the opportunity to examine in different English Museums, they are very like those of our species, but differ in some features; the glabella appears to be somewhat more strongly convex and of a squarer shape; the lateral glabellar furrows seem to have a straighter and more horizontal course and to reach farther inwards, or at least to be more strongly impressed proximally; and the palpebral lobes seem to be situated somewhat farther forwards. To judge from REED's figure and description of the type specimen of *Ch. keisleyensis,* the pygidium differs from that which appears to belong to *Ch. Clasoni* in the following characters: the more gently convex axis; the more distant fulcrum; the somewhat broader anterior pair of pleuræ, whose free portions bend more strongly backwards beyond the fulcrum and, as it appears, attain a greater length; the curved anterior interpleural furrows, which posteriorly are directed very strongly backwards, and do not meet the outer margins of the free portions of the 2d pleuræ at distinct angles; and in the somewhat differently shaped, more backwards directed, and distally more rounded 2d pleuræ.

Horizon and Localities. — Upper Leptæna Limestone; Kallholn, Unskarsheden, Lissberg, Arfvet, Vestanå, Osmundsberg (at the latter locality pygidium only).

Cheirurus punctatus ANGELIN. Pl. IX, figs. 15—17; text-fig. 23.

1854. *Chirurus punctatus,* ANGELIN, p. 79, Pl. XXXIX, figs. 17—17 a.

Remarks. — In the old collection in the State Museum of Natural History the writer has found, together with the specimens of *Ch. glaber* ANG. used by ANGELIN, a small cranidium, which does not belong to this species, but appears to be ANGELIN's type specimen of *Ch. punctatus.* The specimen is fragmentary — the formost portion of the glabella is for instance lacking — and in a poor state of preservation and it is difficult to discern the characters clearly. In ANGELIN's figures some of the missing parts are evidently restored — if this really is his type specimen, of which I feel almost certain — and they are not quite reliable.[1]

Fig. 23. *Cheirurus punctatus* ANG. Imperfect cranidium. Probably the type specimen. × 2. State Mus. Nat. Hist.

The specimen shows, as far as it is preserved, a great resemblance to the cranidia of *Ch. Clasoni.* The glabella seems, however, to have been broader in relation to its length, the frontal glabellar lobe to have been comparatively shorter, and the outer portions of the basal lateral glabellar furrows are directed less strongly backwards. The inner, hindmost, portions of these furrows are very weak,

[1] In the figures given below on Pl. IX (figs. 16—17) the antero-lateral portions are restored on the left side.

which may be partly due to the state of preservation. The basal lateral glabellar lobes are sub-triangular rather then sub-quadrate, as they seem to be in ANGELIN's fig. 17 b, but not so truly triangular as in *Ch. Clasoni*. The surface of the glabella is granulated, and the granulation is about as coarse as in small specimens of the species just mentioned; on the other portions the surface is badly preserved and no granules are observable. The free cheek in front of the posterior border furrow is finely pitted.

It does not seem impossible that this specimen represents only a young individual of *Ch. Clasoni*, but anyhow it seems as if TÖRNQUIST's name, although younger, ought to be kept, since it is not possible to recognize the true characters of ANGELIN's species either from his figures and diagnosis or from this specimen.

Horizon and Locality. — ANGELIN stated that the species occurred in the Leptæna Limestone in Dalarne, but did not mention at which locality it had been found, and on the label accompanying this specimen (and the specimens of *Ch. glaber*) Dalarne is the only locality-name given. To judge from the appearance of the rock it seems to be from the Upper Leptæna Limestone, and it appears probable that it has been found either at Osmundsberg, Arfvet or Vestanå.

Cheirurus Törnquisti n. sp. Pl. IX, figs. 18—19.

1884. *Chirurus insignis*, TÖRNQUIST, p. 12, Pl. I, fig. 9.

Specific Characters. — Cephalon sub-semielliptical in outline, the length along the median line rather more than three fifths the width at level of occipital ring; with genal angles prolonged into spines (imperfectly preserved), which appear to have been slender and directed nearly straight backwards.

Glabella bordered laterally by deeply impressed, narrow axial furrows, rather strongly convex in front with steep anterior slope, growing more gently convex posteriorly, rounded in front, broadest at anterior margin, tapering posteriorly to rather less than two thirds its anterior width and occupying at occipital furrow somewhat more than one third the entire width of cephalon. Frontal lobe occupying rather more than half the length of glabella. Anterior pair of lateral glabellar lobes rather small, sub-rectangular. 2d pair of lateral lobes somewhat smaller than anterior pair, widest within, gently tapering to axial furrows. Basal pair of lateral lobes comparatively large, sub-triangular. Anterior two pairs of lateral glabellar furrows strongly impressed, narrow, directed nearly straight inwards, extending somewhat more than half-way from axial furrows to median line of glabella. Basal pair directed obliquely inwards and backwards, narrow, deeply impressed for the greater part of their length, but growing shallower a little before reaching occipital furrow; the distance between their inner extremities about one fourth the width of glabella at base. Occipital furrow shallow and strongly arched forwards in middle, deep at sides. Occipital ring broad in middle, narrowing laterally, rather strongly arched transversally, its surface higher than that of glabella on median line and sloping downwards anteriorly. Anterior border of cranidium narrow, rounded and distinctly marked off at sides, incorporated in glabella in the middle.

Fixed cheeks sloping rather strongly downwards anteriorly and laterally with convex surface. The palpebral lobes (imperfectly preserved) seem to have been situated rather far forward with their middle points in front of level of 2d lateral glabellar furrows. Posterior borders narrow and gently raised within, increasing in width and growing more flattened laterally, marked off by narrow, rather deep furrows, which at the genal angles become confluent with the lateral border furrows, being joined by a rather gentle curve. Posterior margins of cheeks directed nearly straight outwards and downwards. Anterior branches of facial sutures slightly converging anteriorly to border, then bending strongly inwards; posterior branches running from palpebral lobes nearly straight outwards and downwards to lateral borders, then bending obliquely backwards.

Test of entire cranidium, except in the furrows, very finely granulated; surface of fixed cheeks, excepting borders, furrows and palpebral lobes, marked by rounded pits of different sizes, though all rather small, placed rather close together.

Dimensions. — The dimensions of the type specimen (cranidium) are: length along median line 17 mm., width at level of occipital furrow about 26 mm., length of glabella 14 mm., width of do. across frontal lobe 14 mm., width of do. at base 9 mm.

Remarks. — The above description is based on a single somewhat incomplete cranidium from Boda in the Lund Museum. The specimen has earlier been figured by TÖRNQUIST (1884, Pl. I, fig. 9), who referred it to *Ch. insignis* BARR. (Cf. below).

Two fragmentary thoracic segments found by TÖRNQUIST at the same locality belong evidently to the same species (Cf. TÖRNQUIST, op. cit., p. 13). They show, as far as they are preserved, the typical characters of the genus, but differ in some features from the thoracic segments described above (p. 344) as probably belonging to *Ch. Clasoni*, the inner portions of the pleuræ being somewhat shorter (longitudinally) in relation to their own width, and the furrows which separate these from the outer portions being weaker.

Affinities. — As already mentioned above, TÖRNQUIST attributed this cranidium to *Ch. insignis* BEYR. (BEYRICH, 1845, p. 12, Pl., fig. 1; BARRANDE 1852, p. 782, Pl. XLI, figs. 1—13). It shows, however, some important differences from the cranidia of the Bohemian form, which seem to prove the necessity to refer it to a separate species. In *Ch. insignis* the lateral glabellar furrows and the posterior border furrows on the fixed cheeks are considerably broader than in the cranidium from Boda, the middle portion of the occipital furrow is much wider, the granulation of the cranidium very much coarser, and the pits on the cheeks larger. To judge from the figures available and from a cranidium — from the same locality as BEYRICH's type specimen, St. Ivan — in the Upsala Museum, it seems as if the glabella of the Bohemian form was somewhat less convex and of a somewhat different shape, being less expanded in front, but according to BARRANDE (Op. cit., p. 783) the specimens vary rather much in these characters.

The species, as represented by the cranidium, is easely distinguished from the other species found in the Leptæna Limestone and does not bear a close resemblance to any other described form.

Horizon and Locality. — Upper Leptæna Limestone (according to TÖRNQUIST in a lower bed than *Ch. Clasoni*); Boda.

Cheirurus glaber ANGELIN. Pl. IX, figs. 12–13.

1854. *Chirurus glaber,* ANGELIN, p. 79, Pl. XXXIX, figs. 16—16 a.
1896. *Cheirurus* cf. *glaber,* REED, p. 420
1901. *Chirurus glaber,* LINDSTRÖM, p. 50, Pl. III, fig. 11.

Specific Characters. — Cephalon (exclusive of genal spines) sub-semicircular in outline, the length along the median line being slightly less than half the width at level of occipital ring; with rather slender, tapering, pointed genal spines projecting obliquely backwards.

Glabella bordered laterally by strongly impressed axial furrows, moderately convex with rather gentle anterior slope, slightly longer than wide, broadly rounded in front, widest at anterior margin, tapering posteriorly to about five sixths its frontal width and occupying at posterior margin about one third the entire width of cephalon. Frontal lobe occupying less than two fifths the entire length of glabella. Anterior pair of lateral glabellar lobes small, sub-rectangular with the longer axes directed outwards. 2d pair rather smaller than anterior pair, widest within, growing very narrow laterally. Basal pair comparatively large, sub-triangular. Anterior pair of lateral glabellar furrows strong and deep, rounded in the bottom, generally slightly curved, and directed slightly backwards at their inner extremities, extending rather more than two thirds the distance from axial furrows to median line of glabella. 2d pair similar to anterior pair, but straighter and somewhat shorter, the distance between their inner extremities about equal to their length. Basal pair deeper than the others and running from axial furrows obliquely inwards and backwards a little more than half-way to median line of glabella, then bending more strongly backwards and continued as shallow grooves to occipital furrow [1]; the

[1] In the figure of the type specimen given below (Pl. IX, fig. 13) these grooves ought to have been somewhat more pronounced, and the anterior portions of the furrows directed slightly more backwards.

distance between their inner extremities more than one third the basal width of glabella. Occipital furrow of moderate width, shallow and arched forwards in middle behind central glabellar lobe; its side portions narrower and deeper. Occipital ring rather broad in middle, narrowing towards the sides, moderately arched transversally; its surface somewhat higher than that of glabella on median line and sloping gently downwards from posterior edge to occipital furrow; its posterior margin gently arched backwards. Anterior border of cranidium narrow, gently rounded and distinctly marked off at sides, becoming incorporated in glabella in the middle in front, where, however, on interior casts a weak groove indicates the boundary between the glabella proper and the portion formed by the border, which is somewhat wider here than at sides.

Cheeks sloping rather strongly downwards laterally and anteriorly with gently convex surface; their posterior margins directed slightly forwards to bases of genal spines. Eye lobes small, situated opposite 2d lateral glabellar furrows, at a marked distance from glabella. Palpebral lobes narrow, sub-crescentic, marked off by weak furrows. Eyes rather high, strongly convex, with small rounded lenses, and supported by distinctly raised lower eyelids. Lateral borders of moderate width, gently rounded, marked off by strong furrows. Posterior borders narrow and strongly raised proximally, growing somewhat wider and more flattened distally, marked off by strong furrows, which meet lateral border furrows at slightly acute angles at bases of genal spines. Genal spines somewhat less than two thirds the length of cephalon along median line, directed obliquely backwards; their anterior portions, at least, with gently rounded surface (only imprint of posterior portion preserved). Anterior branches of facial sutures converging slightly anteriorly to border, then bending strongly inwards; posterior branches running nearly parallel to posterior margins of cheeks to lateral borders, then bending strongly backwards to cut lateral margins at bases of genal spines.

The surface of the cephalon, which is badly preserved, seems to have been very finely granulated and on most portions marked by small, rounded pits scattered among the granules; on the fixed cheeks, in front of the posterior border furrows, the pits are placed more closely together, and the largest ones occur here.

Dimensions. — The dimensions of the type specimen, which is one of the largest found, are: length of cephalon along median line 15 mm., width at level of occipital ring 31,5 mm., length of glabella along median line 12,5 mm., width of do. across frontal lobe 12 mm., width of do. across basal lateral lobes 10 mm.

Remarks and Affinities. — The above description is drawn up from the type specimen and the other specimens used by ANGELIN (viz. one nearly complete cephalon and three cranidia), which are the only ones hitherto found in the Leptæna Limestone. They consist of internal casts, and in some cases portions of the intaglio showing the inner surface of the test are also preserved. ANGELIN described the surface of the glabella as smooth, but that is not the case (Cf. above), though the ornamentation is inconspicuous.

The cranidium from the Keisley Limestone in the Sedgwick Museum in Cambridge recorded by REED (1896, p. 420) as *Ch.* cf. *glaber* agrees closely in character with those from the Leptæna Limestone and belongs evidently to the same species. Its basal lateral glabellar lobes appear to be somewhat better defined within, but this character seems to vary a little in most species; moreover the difference may in this case depend on the different state of preservation.

Ch. cf. *glaber* SCHMIDT (SCHMIDT 1881, p. 151, Pl. VII, figs. 18 a—b) on the other hand, is a quite different species and seems to be a *Ceraurus;* it shows among other *Ceraurus* characters a well defined, rather broad anterior border to the cranidium and well developed eye ridges.

Ch. glaber is easely distinguished from *Ch. Clasoni* and *Ch. Törnquisti* by the shape of the glabella, the short frontal glabellar lobe and the characters of the lateral glabellar furrows, and it does not bear any close resemblance to any other described species.

Horizons and Localities. — ANGELIN did not state at which locality this species had been found, but only that it occurs in Dalarne in the Leptæna Limestone; neither is the locality-name noted on the label accompanying the specimens. To judge from the appearance of the rock, and also from the circumstance that it occurs in the Keisley Limestone, it seems to occur in the Upper Leptæna Limestone, and it appears probable that the specimens have been found either at Osmundsberg, Arfvet or Vestanå.

Outside Dalarne the species has been found in the Keisley Limestone at Keisley in England.

Cheirurus sp. ind. a. Pl. IX, fig. 10.

Remarks. — A fragmentary pygidium from Vestanå in the Museum of the Geological Survey recalls, as far as the same portions are preserved, the pygidium tentatively referred above (p. 345) to *Ch. Clasoni,* but it differs in some features and seems to belong to another species of *Cheirurus.*

The axis, which is very fragmentarily preserved, seems to have been gently convex and is triangular in outline, tapering rapidly posteriorly; it consists of 3 rounded axial rings and a gently convex, sub-triangular terminal piece. The axial furrows are weak and interrupted as in the pygidium just mentioned. The anterior and 2d pleuræ (whose posterior ends are not preserved) seem to be of the same type as in this, but differ in the following characters: in the anterior pleura the fulcrum is more remote and the free portion is directed more strongly backwards and is more rounded and slender; the 2d pleura is as a whole more slender and its outer portion more rounded. The 3d pleuræ are sub-parallel, more gently rounded than the preceding ones, very narrow anteriorly and widen posteriorly, embracing the sides of the terminal piece of the axis; beyond this they become free and are produced into spines, which are of about the same length as the anterior attached portions, but do not reach as far back as the spines of the 2 anterior pairs. The ornamentation of the test consists of closely set granules, somewhat coarser than those which occur on the surface of the other *Cheirurus* pygidia which have been found in the Leptæna Limestone.

This pygidium is of interest because, in most characters, it bears a rather close resemblance to those of *Ch. keisleyensis* and *Ch. subulatus*, but at the same time differs less from the *Ch. insignis* type. (Cf. above, p. 341.)

In the ornamentation of the test this pygidium resembles the cranidium of *Ch. punctatus* and the small cranidia of *Ch. Clasoni*. It differs too much from the pygidia which appear to belong to the latter, to be attributed to this species, but, provided that the two species are not identical (Cf. above, p. 348), it does not seem improbable that it may belong to the former.

Horizon and Locality. — Upper Leptæna Limestone; Vestanå.

Cheirurus sp. ind. b. Pl. IX, fig. 11.

Remarks. — A fragmentary pygidium, measuring 13 mm. along the median line (articulating half-ring excluded), from Boda in the Lund Museum, seems to represent a new species of *Cheirurus*, or perhaps it may belong to *Ch. Törnquisti* (p. 348).

The axis is sub-triangular in outline and rather gently convex, and the 3 axial rings less rounded, but otherwise similar to those of the pygidium tentatively referred above (p. 345) to *Ch. Clasoni*, and, as in this, the axial furrows are weak and interrupted. Behind the 3d axial ring is a rather long, narrow terminal piece, which anteriorly is rather gently convex, nearly parallel-sided, and bounded laterally by short, deep furrows; behind the extremities of the furrows it tapers slightly posteriorly, grows more flattened, and is indistinctly marked off, by very weak grooves, from the 3d pleuræ, between whose free ends it terminates in a very obtuse point. The side lobes consist of 3 pairs of pleuræ with free ends. The interpleural furrows are nearly straight, of moderate width and deeply impressed, but growing shallower and narrower adjacent to the margins; the 1st ones making angles of about 25° to the median line of the pygidium, and extending backwards a little beyond the level of the 3d axial ring furrow; the 2d ones extending somewhat farther backwards and sub-parallel. The

1st pleura is the largest; its greatest width seems to have been rather more than twice the greatest width of the 2d one. Its proximal portion is furnished with a narrow, depressed articulating band along the straight, horizontal anterior edge, and is marked by a short, deep, oblique furrow, which divides the surface into two rounded pleural bands; the distal, free portion of this pleura is not preserved. The 2d and 3d pleuræ are unfurrowed, and each consists of a relatively long attached portion and a short free point; their greatest width is across the bases of the free portions, the 3d pleura attaining about half the width of the 2d one. Their surfaces are gently rounded adjacent to the axis, but grow flattened posteriorly. The surface of the pygidium is, except in the furrows, finely granulated.

Horizon and Locality. — Upper Leptæna Limestone; Boda.

Cheirurus sp. ind. c. Pl. IX, fig. 14.

Remarks. — A hypostoma, measuring 11 mm. in length, from Östbjörka in the State Museum of Natural History resembles closely the one described above (p. 346) as probably belonging to *Ch. Clasoni,* but the central body has its sides a trifle more parallel and the posterior end broader and more obtuse. Otherwise there is no apparent difference between the two, and possibly they may be referable to the same species, but it seems more probable that they belong to different ones. In point of size this hypostoma would suit the cranidia of *Ch. Törnquisti* or *Ch. glaber,* but also the smaller ones of *Ch. Clasoni.*

Horizon and Locality. — Upper Leptæna Limestone; Östbjörka.

Genus **Ceraurus** Green (Raymond and Barton).

Ceraurus latifrons n. sp. Pl. IX, figs. 21—22.

Specific Characters. — Glabella bordered at sides by strong axial furrows and anteriorly by narrow, but throughout distinctly impressed preglabellar (or anterior border) furrow, moderately convex, somewhat longer than wide, widest across 2d pair of lateral lobes, slightly narrowing posteriorly and occupying at base nearly two fifths the entire width of cephalon, broadly rounded in front with a flattening of the curvature in the middle; marked by 3 pairs of short, equidistant lateral furrows; the 2 anterior pairs nearly transverse and extending less than one fourth the width of glabella; basal pair somewhat longer and directed slightly backwards, not reaching occipital furrow, but connected with this by very weak constrictions. Frontal lobe short, occupying only about one fourth the entire length of glabella. Anterior and 2d pair of lateral glabellar lobes bent down laterally with general curvature of glabella. Basal lobes with slight independent convexity, somewhat wider than preceding ones at axial furrows, narrowing proximally. Occipital furrow narrow and deep behind basal lateral glabellar lobes, wider and much shallower, but not arched forwards, in its median portion. Occipital ring rather narrow, scarcely wider in middle than at sides, strongly arched transversally, rounded longitudinally. The anterior border of the cranidium (imperfectly preserved) seems to have been very narrow in the middle, widening a little at sides; its surface not confluent with that of glabella in front, but throughout well marked off from this.

Fixed cheeks convex, sloping gently downwards anteriorly, slightly but distinctly raised above axial furrows, with a short, gentle inner slope and a long, steep outer slope. Palpebral lobes (not preserved) placed at a marked distance from glabella and with their middle points, as it seems, a little behind level of 2d lateral glabellar furrows, marked off within by rather broad, shallow furrows. Eye ridges well developed, rather broad, gently raised and rounded, running from axial furrows opposite antero-lateral extremities of frontal glabellar lobe obliquely backwards and outwards to palpebral lobes, marked off by distinctly impressed furrows. Borders of fixed cheeks rounded, marked off by strong, continuous furrows and prolonged into broad-based genal spines (not preserved); lateral borders broad; posterior borders narrow, widening slightly laterally. Posterior margins of cheeks running slightly forwards to bases of spines. Anterior branches of facial sutures rather strongly converging anteriorly; posterior branches running from palpebral lobes outwards, downwards, and slightly backwards to lateral borders, then bending more strongly backwards, to cut lateral margins near bases of genal spines.

Surface of cranidium, except in the furrows, covered with irregularly placed, rather small tubercles and granules of different sizes; on the portions of the cheeks lying behind and inside the eye-ridges and palpebral lobes and in front of the posterior borders, the tubercles are rather far apart and the interspaces marked by rounded pits of moderate sizes.

Dimensions. — In the best preserved and largest cranidium observed, the length along the median line is 12 mm. and the width at the level of the occipital furrow approximately 21 mm.; in the smallest one, the length along the median line seems to have been about 9 mm.

Remarks and Affinities. — Two somewhat fragmentary cranidia from Kullsberg, one in ISBERG's collection in Lund, the other in the Upsala Museum, appear to represent a new species referable to *Ceraurus*. There is also in the Upsala Museum a crushed and distorted, incomplete cranidium from the lowest part of the Lower Leptæna Limestone at Amtjärn Quarry, which seems to belong to this species.

On the whole these cranidia agree, as far as they are preserved, in their chief characters with those of the typical species of *Ceraurus* (Cf. BARTON, 1915, p. 135). The fixed cheeks are, however, very convex, with the outer portions bent downwards nearly vertically, and, as a consequence of this, the glabella is comparatively wide in relation to the entire width of the cranidium. The anterior border appears to have been very narrow in front, but it is, throughout, well marked off from the glabella.

This species does not appear to be especially closely related to any previously described species of *Ceraurus*, and therefore a more detailed comparison with any of them seems unnecessary.

Horizon and Localities. — Lower Leptæna Limestone; Kullsberg, Amtjärn Quarry.

Genus **Pseudosphærexochus** SCHMIDT.

Pseudosphærexochus granulatus ANGELIN. Pl. X, figs. 8—15, 17—18.

1854. *Sphærexochus granulatus* ANGELIN, p. 76, Pl. XXXIX, figs. 3—3 a.
1884. *Pseudosphærexochus conformis* TÖRNQUIST, p. 18, Pl. I, fig. 12.

Specific Characters. — Cephalon strongly convex, roughly semi-oval in outline, somewhat less than two thirds as long as wide.

Glabella large, occupying at base nearly half the width of entire cephalon, bounded all round by strong furrows, strongly and rather evenly convex, sloping steeply downwards and overhanging anteriorly, sub-oval in outline, with the base truncated, somewhat wider than long, its greatest width across second pair of lateral lobes nearly equal to distance along median line between anterior and posterior margins; its anterior margin rather narrowly rounded, but the anterior outline forming, when the glabella is viewed in dorsal aspect, a nearly true semicircle. 3 pairs of lateral glabellar furrows present; the two anterior pairs narrow and rather shallow, sub-parallel, nearly at right angles to axial furrows, extending rather less than half-way up sides of glabella — the second pair the longest of the two; first pair situated close to front end of glabella; second pair beginning in axial furrows about half-way between preceding and following pairs; basal pair of furrows longer and much stronger than the others, beginning in axial furrows somewhat nearer preceding pair than occipital furrow and curving obliquely inwards and backwards, not connected with occipital furrow; the distance between their inner extremities greater than the distance from these to axial furrows and about twice the distance to occipital furrow. Occipital ring of regular width, narrowing slightly towards the sides, strongly arched transversally, and with the surface flattened, or very gently rounded, longitudinally. Anterior border of cranidium of moderate width, with nearly straight anterior edge, projecting slightly in front of free cheeks.

Cheeks sloping steeply downwards with convex surface to lateral border furrows. Eye lobes rather small, situated opposite second lateral glabellar lobes, or extending a little behind these, rather close to glabella, but on a lower level, the portions of the cheeks inside them sloping rather steeply downwards laterally. Palpebral lobes sub-crescentic, relatively broad, bent strongly upwards, marked off by narrow, distinctly impressed furrows. [Eyes not preserved.] Posterior borders of cheeks raised and rounded and rather narrow adjacent to axial furrows, decreasing in width and still more so in height laterally, marked off by deep not very broad furrows, which curve forwards at genal angles to meet the shallower and broader lateral border furrows. Lateral borders of moderate width, narrowing slightly anteriorly. Genal spines slender, rounded, relatively long for this genus, their length being more than one fourth of the length of glabella, directed obliquely backwards, outwards, and upwards. Anterior branches of facial sutures running obliquely forwards and inwards in slightly outwards convex curves, sub-parallel to axial furrows; posterior branches curving obliquely outwards, backwards, and downwards to lateral borders, then bending strongly backwards to cut margins just outside bases of genal spines.

Pygidium of four segments. Axis sub-triangular, indistinctly defined posteriorly, rather strongly convex in front, growing less convex posteriorly; composed of two distinctly defined and strongly rounded axial rings, a third, a more gently rounded one, incompletely or indistinctly defined in the middle behind, and at the rear of this a small terminal piece, which is confluent with the posterior pair of pleuræ. Anterior two axial ring furrows strong, nearly transverse in middle, curving backwards at sides and terminating in deep, rounded pits; third furrow almost entirely obsolete in middle, forming at sides behind lateral portions of third axial ring deep, elongated, slightly oblique pits or impressions. Axial furrows narrow, but distinctly impressed outside anterior axial ring, much weaker outside second ring, becoming obsolete posteriorly. Side lobes flattened and horizontally extended in front proximally, the lateral and posterior portions curving obliquely upwards; composed of 4 pairs of pleuræ with short proximal attached portions — growing successively shorter posteriorly — and long distal free portions; the latter forming slender, rounded, sub-equal, nearly straight, radiating spines, those of the first pair bending back at an angle of 30° to 45° to the straight, transverse anterior edges of the side lobes; the extremities of the 8 spines placed at about equal distances apart. Inner portion of each pleura of the first pair with short punctate furrow — apparently formed by two elongated and almost confluent punctæ — and narrow, depressed articulating band on anterior edge widening at fulcrum into small sub-triangular articulating piece. Second pleura with faint traces of one or two punctæ on inner portion; following pleuræ without furrows or punctæ. First pair of interpleural furrows rather strong; second pair much weaker; third pair almost, or entirely, obsolete.

Surface of cephalon and pygidium, except in the furrows, ornamented with rather sparsely distributed small tubercles of different sizes and between the tubercles minute granules; portions of cheeks inside the bounding furrows having in addition small pittings.

Dimensions. — In ANGELIN's type specimen the distance along the median line between the anterior and posterior margins of the glabella is approximately 17 mm. and the greatest width of the latter 16,5 mm. In another, smaller, cranidium the distance along the median line between the margins is 13 mm., the width at the level of the occipital furrow 19 mm., the distance along the median line between the anterior and posterior margins of the glabella just over 11 mm., and the greatest width of the latter 11 mm. In a large fragmentary cranidium, the very largest observed, the distance between the anterior and posterior margins of the glabella seems to have been 27 to 28 mm.

Remarks. — This species is one of the most common trilobites in the Lower Leptæna Limestone. It was originally founded by ANGELIN (Op. cit.) on a fragmentary cranidium from Furudal, which is now in the State Museum of Natural History. Later on TÖRNQUIST (Op. cit.) under the name of *Ps. conformis* ANG. figured a more complete cephalon from the same locality and gave a brief description of its characters. He stated that ANGELIN's figured type specimen of *Ps. granulatus* could not be distinguished from *Ps. conformis*, but suggested that possibly ANGELIN's diagnosis of *Ps. granulatus* was founded on another specimen. His statement was evidently correct as far as it concerned the specific identity of the forms, namely that ANGELIN's type specimen of *Ps. granulatus* and the specimen figured by TÖRNQUIST as *Ps. conformis* belong to the same species, but this species seems to be the true *Ps. granulatus* and *Ps. confirmis* ANG. (ANGELIN, 1854, p. 76, Pl. XXXIX, figs. 2—2 a) — of which the type specimen unfortunately is lost — seems to be a distinct, though closely allied, species, which belongs to the fauna of the Upper Leptæna Limestone. ANGELIN had evidently a very sharp eye for detecting the differences between the species, and these dissimilarities are generally indicated, rather than correctly given, in his short diagnosis and almost always unsatisfactory figures. The difference between the two species is, according to his diagnosis, that *Ps. granulatus* has the central lobe of the glabella wider posteriorly than the basal lateral lobes — as is the case in the species now under consideration — whereas it is narrower in *Ps. conformis*. He stated that the former was tuberculated or granulated (»granulatus») and the latter finely tuberculated or granulated (»minute granulatus»); some further features in which this differs are indicated in his figures and shown in the form, which I believe referable to this species (Cf. below, p. 360).[1]

[1] SCHMIDT had some years earlier (1881, p. 176) than TÖRNQUIST discussed the two forms, and it seems as if he also was inclined to regard them as belonging to the same species, *Ps. granulatus* possibly as a variety of *Ps. conformis;* his statements are not quite clear. It appears to me probable that the specimens of »*Ps. conformis*» from the

Some more or less fragmentary pygidia from Kullsberg in the Upsala Museum belong apparently to *Ps. granulatus,* and there are also a fragment of a thoracic segment and a small, incomplete hypostoma from the same locality, which seem to belong to it.

The thoracic segment has the inner portion of the pleura strongly raised with a faint median row of punctæ and a narrow articulating band along the anterior edge; whether there is a posterior articulating band is not clearly discernible [the posterior »band» indicated on the figure (Pl. X, fig. 14) may be the lower edge of the test, which is not preserved on the other portions of the pleura]. The outer portion of the pleura is bent rather steeply downwards and very slightly backwards and forms a long conical point (incompletely preserved). The ornamentation seems to be similar to that on the cephalon and pygidium.

As far as can be ascertained from the fragmentary specimen, the characters of the hypostoma are as follows: — Entire hypostoma subparabolic in outline, somewhat wider than long. Central body moderately convex, somewhat longer than wide in front, slightly tapering posteriorly, very obtusely rounded in front, more narrowly rounded behind, marked close to posterior end by pair of weak, oblique furrows nearly meeting in the middle. Anterior border narrow, rounded, marked off by distinct, though not deep, narrow furrow. Anterior pair of wings strongly but not vertically inclined, short (longitudinally). Lateral and posterior borders continuous, rather narrow and strongly raised, growing somewhat wider in the middle behind the central body, and here produced into an obtuse point; marked off by strong continuous furrow. Surface of central body and borders ornamented with small tubercles and granules.

Affinities. — As mentioned above, *Ps. conformis* ANG. seems to have close affinities with *Ps. granulatus,* but not to be identical. *Ps. conformis* SCHMIDT (SCHMIDT, 1881, p. 174, Pl. X, figs. 5—7 c, Pl. XVI, figs. 28—29) which seems to be a distinct species (Cf. below, p. 362), appears to differ still more. Its glabella is considerably longer in relation to the width and, to judge from SCHMIDT's figures, much more gently convex, and the course of the basal pair of lateral glabellar furrows seems to be somewhat different. The form which SCHMIDT (Op. cit., p. 176, Pl. X, fig. 9, Pl. XVI, figs. 30 a—b) regarded as a variety of the latter, agrees, as pointed out by him, better with ours in the relative dimensions of the glabella and — as it appears from the figures — also in the

Leptæna Limestone, which according to his statement differed only by reason of their smaller size from the type specimen of *Ps. granulatus* (of which he had a plaster cast), were in reality small specimens of *Ps. granulatus,* which had been labelled *Ps. conformis* on account of the circumstance that they agreed in point of size with ANGELIN's figures of this species. SCHMIDT noted them as original specimens (»Originalexemplaren»), but in doing so he probably meant only to indicate that they were from the Leptæna Limestone in Dalarne and not from the East Baltic Area.

course of the basal lateral glabellar furrows, but in this form also the glabella is evidently relatively longer and much less convex.

Horizon and Localities. — Lower Leptæna Limestone. Furudal, Kullsberg, Sätra, Amtjärn Quarry (at the latter locality both in the thick-banded limestone and in the shales which interstratify the thin bands of limestone, underlying the former).

Pseudosphærexochus conformis ANGELIN. Pl. X, figs. 1—7, 19, 29.

1854. *Sphærexochus conformis* ANGELIN, p. 76, Pl. XXXIX, figs. 2—2 a.
1884. *Chirurus? tenuispinus* TÖRNQUIST, p. 15, Pl. I, fig. 11.
1896. *Cheirurus (Pseudosphærexochus) conformis* REED, p. 420.
1907 b. *Pseudosphæroxochus conformis*, WIMAN. p. 4.
1907 b. *Chirurus tenuispinus* WIMAN, p. 3.

Remarks. — As mentioned above, the species of *Pseudosphærexochus* which is common in the Lower Leptæna Limestone is *Ps. granulatus,* not *Ps. conformis* as is assumed by TÖRNQUIST (1884, p. 18). ANGELIN's type specimen of the latter is unfortunately lost (and ANGELIN did not state at which locality it had been found), but there is a species belonging to the fauna of the Upper Leptæna Limestone, which apparently must be regarded as the true *Ps. conformis* ANG., since its cranidium differs from that of *Ps. granulatus* as indicated in ANGELIN's diagnoses and figures (Cf. above, p. 358).

Of this species three almost complete cephala and several cranidia and detached free cheeks have been found at Kallholn by the present writer. In close association with these were found several more or less fragmentary pygidia, a few fragments of thoracic segments, and an incomplete hypostoma, which evidently belong to the same species. [These specimens are now in the Upsala Museum.] The species has also been found at Boda; TÖRNQUIST's (Op. cit.) species *Chirurus? tenuispinus,* founded on some pygidia from that locality, is evidently identical with this. The cranidia and the pygidia reported by WIMAN (Op. cit.) — as *Ps. conformis* and *Ch. tenuispinus* — from the West Baltic Leptæna Limestone, and the cranidia — but not the pygidium[1] — reported by REED (Op. cit.) from the Keisley Limestone in England, agree closely in characters with the specimens from Dalarne and appear to belong to the same species. The East Baltic form which SCHMIDT (SCHMIDT, 1881, p. 174, Pl. X, figs. 5—7 c, 9, Pl. XVI, figs. 28—30 b) attributed to *Ps. conformis* seems, on the other hand, to represent a distinct species (Cf. below, p. 362).

Ps. conformis is, as has been mentioned above, apparently closely allied to *Ps. granulatus.* It differs, however, in several characters, which, taken together, seem to justify a specific distinction, although most of

[1] This is a small specimen of the pygidium of *Holotrachelus punctillosus* TQT.

the characters considered separately may not seem to be of great importance. The glabella is somewhat more elongated, the distance between its anterior and posterior margins exceeding the greatest width by about one tenth, or a little more; its anterior margin is not so truly semicircular, but rather parabolic, and its convexity is somewhat stronger, but less even, especially so from side to side, the lateral slopes — and generally also the anterior slope — being considerably straighter, in some specimens so much so that the glabella becomes slightly keeled in the middle posteriorly; the neck of the central lobe between the basal lateral lobes has a slight independent convexity and the basal lobes have also a marked convexity of their own in both directions. The anterior two pairs of lateral glabellar furrows are weaker — narrower and especially shallower — and seem generally to be somewhat more curved; in the latter character, however, both forms vary rather much. The basal pair of lateral glabellar furrows are as usual stronger than the preceding ones, but they are narrower and rather shallower than in *Ps. granulatus* and have a somewhat different course; they leave the axial furrows at slightly more acute angles and run nearly straight until about half-way, or rather more, up the side of the glabella and then they bend abruptly strongly backwards; they do not reach the occipital furrow, but are generally connected with this by shallow grooves or narrow depressions, which can be rather distinctly impressed in casts; the distance between the inner extremities of the furrows proper is about equal to the distance from these to the axial furrows and rather more than twice the distance to the occipital furrow. Between the grooves just mentioned the central lobe of the glabella grows narrower, and although it everywhere occupies more than one third of the entire projected width of the glabella, it is posteriorly narrower than the basal lateral lobes, if the distance between the grooves and the axial furrows is regarded as their width. The axial and preglabellar furrows are narrower than in *Ps. granulatus* and are not so much impressed underneath the edge of the glabella; the former are also more strongly arched in the vertical plane.

The fixed cheeks are more convex longitudinally than in the species just mentioned, and the eye lobes are situated on a somewhat higher level since the portions of the fixed cheeks inside them are almost horizontally extended. The palpebral lobes are not complete in any of the specimens observed, but there is one detached free cheek which still shows the eye in a good state of preservation. This is about twice as long as it is high, strongly convex in both directions, with small rounded lenses, and supported by a relatively wide and strongly rounded lower eyelid.

The tubercles on the surface of the glabella, and on the other portions of the carapace, are on the whole smaller than in the foregoing species and situated somewhat more closely together.

The hypostoma is of the same type as that which apparently belongs to *Ps. granulatus.*

The thoracic segments have a wide, convex axis — in the specimens observed it occupies more than one third of the entire width of the axis — and this is marked off by narrow, sharply impressed axial furrows. The inner portion of the pleuræ is rather gently raised, flattened on top and with a faint median row of punctæ, it has a narrow, depressed articulating band along the anterior edge, which, as usual, terminates in a small somewhat wider articulating piece; it is horizontally extended, relatively broad and nearly parallel-sided to some distance inside the articulating piece, it then grows narrower, curves slightly backwards and generally somewhat more strongly downwards. Beyond the articulating piece the pleura is produced into a long, conical, pointed spine, which is bent strongly downwards within, bending more outwards adjacent to the extremity.

The pygidium differs from that of *Ps. granulatus* in having the free portions of the anterior three pairs of pleuræ gently curved instead of their being almost straight.

Dimensions. — The dimensions of the best preserved cephalon observed are: length along median line between anterior and posterior margins 15,2 mm., width at level of occipital furrow approximately 23 mm., distance between anterior and posterior margins of glabella along median line 14,3 mm., greatest width of do. 13 mm.

Affinities. — As mentioned above, the East Baltic form, which SCHMIDT (1881, p. 174, Pl. X, figs. 5—7 c, 9, Pl. XVI, figs. 28—30 b) attributed to *Ps. conformis*, does not seem to belong to this species, but resembles it rather closely in several characters. To judge from SCHMIDT's description and figures, the glabella is, however, much more gently and more evenly convex, and, in the typical form, considerably longer in relation to the width; the outer portions of the basal lateral glabellar furrows are directed less backwards; the axial furrows are wider; the cheeks are more elevated — according to the description, they slope steeply upwards from the axial furrows to the eye lobes — and the lateral border furrows are deeper. The genal spines are said to be short, flat, and triangular, but possibly only their bases are preserved in the specimens observed by SCHMIDT.

Horizons and Localities. — Upper Leptæna Limestone; Kallholn, Boda (Dalarne). West Baltic Leptæna Limestone; Öland (in boulders). Keisley Limestone; Keisley (England).

Pseudosphærexochus conformis ANGELIN var. **major** n. var. Pl. X, figs. 22—23 a.

Remarks. — There are a great number of more or less fragmentary cranidia from Kallholn in the Upsala Museum and some glabellæ from

Arfvet in the State Museum of Natural History, which seem to represent a variety of *Ps. conformis* or possibly a new species of *Pseudosphærexochus.* They differ from the cranidia of the typical form of *Ps. conformis* in the following characters: the glabella is slightly more elongated and somewhat higher and more conically elevated, having a faint tendency to a hump at about one third of the distance from the posterior to the anterior margin, and the slope from this level is straighter; the two anterior pairs of lateral glabellar furrows are somewhat more oblique, and appear generally to be weaker (this latter character may depend on the state of preservation); and the posterior wings of the fixed cheeks in front of the border furrows have the surface — which as usual slopes downwards laterally — flattened or slightly concave instead of convex from about the level of the palpebral furrows (their inmost portions are gently convex).

This form apparently attains greater dimensions than the typical form of *Ps. conformis,* but it cannot be regarded as representing the adult of this species, since there are some small specimens which agree closely in characters with the larger ones.

Dimensions. — In the largest specimen observed, the distance along the median line between the anterior and the posterior margins of the glabella is 37 mm., and in the smallest one 11 mm.; in the former the greatest width of the glabella is 32,5 mm. In two other cranidia of more ordinary sizes the dimensions of the glabella are: distance between anterior and posterior margins 1) 17,3 mm. 2) 26 mm., greatest width 1) 15 mm., 2) 22,5 mm.

Horizon and Localities. — Upper Leptæna Limestone; Kallholn, Arfvet.

Pseudosphærexochus tuberculatus n. sp. Pl. X, figs. 20, 24—25, 21 ?, 34?

Specific Characters. — Glabella bounded all round by distinctly impressed narrow furrows, rather gently convex in both directions, curved downwards in front, rounded in outline with the base truncated by occipital furrow, width somewhat greater than length (projected), widest across anterior parts of basal lateral lobes, tapering gradually anteriorly to rounded front end, occupying at base about half the width of entire cranidium. 3 pairs of narrow, sharply impressed, though not very deep, lateral glabellar furrows present; anterior two pairs sub-parallel, gently curved, with their inner portions directed obliquely backwards, short, the distance between their inner extremities greater than their length; first pair the shortest, situated near front end of glabella; second pair situated somewhat nearer the first than the basal pair; basal pair somewhat stronger and considerably longer than the others, beginning in axial furrows nearer second pair than occipital furrow, at first running sub-parallel to second pair, or being slightly more oblique and straighter than these, curving strongly backwards internally, not quite reaching occipital furrow but generally connected with this by faint longitudinal depressions; the distance between their inner extremities considerably shorter than the distance from these to axial furrows. Anterior two pairs of lateral glabellar lobes without independent convexity; basal pair with slight independent convexity, produced a little beyond base of central lobe.

Occipital ring of moderate, almost uniform width in centre, narrowing laterally, strongly arched transversally, gently rounded longitudinally. Anterior border (imperfectly preserved) with, apparently, the usual characters found in *Pseudosphærexochus*.

Fixed cheeks (imperfectly known) strongly convex, sloping steeply downwards laterally. Palpebral lobes (not preserved) apparently situated opposite second pair of lateral glabellar lobes. Posterior borders of cheeks raised and rounded, narrow adjacent to axial furrows, widening laterally, marked off by strong furrows, which curve forwards at genal angles to pass into lateral border furrows. [Genal angles not preserved.] Posterior branches of facial sutures curving obliquely outwards, backwards, and downwards to lateral margins, then bending more strongly backwards.

Surface of cranidium, except in the furrows, ornamented by large, rounded tubercles of somewhat different sizes, and, between these, covered by smaller tubercles and granules; portions of fixed cheeks in front of border furrows, apparently having small pits between the tubercles.

Dimensions. — In two well preserved glabellæ, the distance along the median line between the anterior and posterior margins is respectively 9 mm. and 10 mm. and is equal to the greatest width. In another, incompletely preserved, glabella the distance between the margins seems to have been 10 mm., and the greatest width 11 mm.

Remarks. — The material on which this new species is founded consists of five fragmentary cranidia from Kallholn, four cranidia in the Upsala Museum, which all lack the fixed cheeks, and a fifth, a very small one, in ISBERG's collection at Lund, which has portions of both the fixed cheeks preserved. The specimens vary a little in the course of the basal lateral furrows, but otherwise they agree closely in characters.

An incomplete cranidium (Pl. X, fig. 21) from the same locality, in ISBERG's collection, seems to represent a variety of this species. It is somewhat larger than the specimens just mentioned, the glabella measuring along the median line between the margins 13 mm. It differs in having the glabella more elevated with straighter lateral slopes, and with a long, comparatively steep and straighter anterior, and a short, gentle posterior slope. Two other fragments of cranidia from Kallholn, in the Upsala Museum, appear to belong to the same, or to a closely allied, form. They have considerably greater dimensions — the best preserved one having a width of approximately 20 mm. — and they differ somewhat as to the direction of the basal lateral glabellar furrows. In this latter character, however, the other specimens which seem to belong to this species vary also a little, as mentioned above; moreover, in one of the specimens (Pl.

X, fig. 34) now under consideration, these furrows have not quite the same course on both sides.

Affinities. — In some of its characters, the glabella of this species recalls that of *Ps. Roemeri* SCHMIDT (SCHMIDT, 1881, p. 178, Pl. X, figs, 8a—b, Pl. XI, figs. 22, 24), but the latter is longer, more depressed convex, and slopes more abruptly downwards anteriorly; its lateral furrows appear to have a somewhat different course, and the test seems to be more finely tuberculated.

Horizon and Locality. — Upper Leptæna Limestone; Kallholn.

Genus **Nieszkowskia** SCHMIDT.

Nieszkowskia cf. cephaloceras NIESZKOWSKI.

Description. — Glabella bounded all round by narrow, distinctly impressed furrows, very prominent, gradually passing up into a stout conical boss, which evidently supported a rounded spine (only the base of the latter preserved); the posterior slope from base of spine very steep, but not quite vertical, nearly straight, short — the posterior margin of the glabella being arched strongly upwards; the lateral and posterior slopes more gentle, but still very steep, the former nearly straight and more than twice as long as posterior slope; the anterior slope to preglabellar furrow about twice as long again, gently convex and slightly overhanging front margin, the convexity of the anterior portion from side to side stronger; lateral margins nearly straight, converging very slightly anteriorly, antro-lateral corners broadly rounded or sub-truncate, anterior margin nearly straight; width of glabella at base in proportion to distance along median line between anterior and posterior margins as 7 to 9,5. 3 pairs of narrow, distinctly impressed lateral glabellar furrows present; their lateral extremities situated at about equal distances apart; basal pair longer and somewhat stronger than the others, very oblique, the distance between their inner extremities slightly greater than their length and slightly more than twice the distance from these to occipital furrow; anterior two pairs of furrows less oblique, sub-parallel, short, extending rather less than half-way up sides of glabella; the more anterior pair situated close to front end of glabella. Basal lateral glabellar lobes sub-triangular, extending about as far along side of glabella as the two anterior ones together. Axial furrows sub-parallel, arched rather strongly forwards and upwards with long, steep anterior slope.

Occipital ring of moderate width, nearly parallel-sided, strongly arched transversally, gently rounded longitudinally. Anterior border of cranidium narrow, with nearly straight anterior edge apparently projecting slightly in front of free cheeks (the latter not preserved). Fixed cheeks (only a fragment preserved) with gently rounded posterior borders of moderate width (internally) and marked off by deeply impressed, narrow furrows.

Surface of cranidium, except in the furrows, rather closely covered with small to relatively large, pointed, low sub-conical tubercles — the larger ones occurring on the glabella only — the portions of the fixed cheeks lying in front of the posterior border furrows having in addition small pittings.

Remarks. — The above description is based on a single, fragmentary, small cranidium in the Upsala Museum — measuring between the anterior and posterior margins 19 mm. So far as it is preserved, it resembles closely the cranidium of *N. cephaloceras* NIESZK. as described and figured by SCHMIDT (1881, p. 186, Pl. IX, figs. 9—16. Pl. XI, fig. 27, Pl. XVI, figs. 36—37), except that the glabella is relatively somewhat broader at the base and more parallel-sided. This difference appears to be too slight to indicate a distinct species. The specimen is, however, rather too imperfect to warrant a precise determination. Moreover, I have not seen any cranidia of the East Baltic form, but only the figures available.

Horizon and Locality. — This specimen belongs to an old collection of Leptæna Limestone fossils, but there is no statement as to the locality at which it has been found. The character of the rock indicates that it is Lower Leptæna Limestone — moreover, it does not appear likely that *N. cephaloceras* or any closely allied species would occur in the Upper Leptæna Limestone — and it seems probable that it has been collected at Furudal.

Nieszkowskia? sp. ind. Pl. X, figs. 32—33.

Remarks. — A fragmentary cranidium from Kallholn in the Upsala Museum shows some peculiar features. The specimen is evidently abnormal, the two sides of the glabella being rather differently developed, and probably neither of them show quite the normal characters. It seems to represent a new species belonging to the family Cheiruridæ. Its generic position is uncertain, but its affinities seem to be with *Nieszkowskia* rather than with any other described genus.

Description. — The glabella is rather strongly convex with a tendency to a hump between the second lateral lobes. From this level it curves steeply downwards anteriorly with gently convex surface; the short posterior slope is much gentler, and slightly concave to a little in front of the occipital furrow — the hindmost portion of the central glabellar lobe having a slight convexity of its own — and the lateral slopes are moderately steep and nearly straight. The distance along the median line between the anterior and posterior margins of the glabella (just over 19 mm.) is somewhat less than its greatest width (20,5 mm.), which is across the anterior ends of the second lateral lobes. The left margin is nearly straight (in the horizontal plane) and parallel to the median line from the base to a little in front of the second lateral furrow, it then curves rather strongly inwards. On the right side the margin is gently outwards convex with a flattening of the curvature in the middle. The anterior margin is very slightly arched forwards.

There are 3 pairs of narrow, rather deeply impressed lateral glabellar furrows. The anterior furrows are situated very far forward, on the front side of the glabella, and are nearly straight, converging rather slightly posteriorly, and of moderate length; the length of each is about equal to two thirds of the distance between their inner extremities. The second pair of lateral furrows are directed slightly backwards and slightly sigmoidally curved, their outer portions being arched very slightly backwards, and their inner portions forwards; the right one, which appears to be more normally developed, extends a little more than half-way up the side of the glabella; the left one is considerably shorter. The basal pair of lateral furrows reach the occipital furrow; their courses are somewhat different; the right one begins in the axial furrow at a slightly greater distance from the occipital furrow than the other, and runs in a slight sigmoidal curve obliquely backwards at an angle of about 35° to the axial furrow until a little in front of the occipital furrow, it then curves slightly outwards to merge into this; the furrow on the left side makes a less acute angle with the axial furrow — this difference is chiefly due to the different course of the axial furrow on either side — like its fellow, it has the outer portion very slightly sigmoidally curved, but it bends back sooner, and its posterior portion is directed nearly straight backwards. The anterior and basal lateral lobes on each side have about the same length at the axial furrow (they are slightly longer on the left side than on the right), the second lobes being considerably shorter externally, especially that on the left side. This latter is evidently abnormally developed; the outermost portion is depressed, forming a small, elongated, flattened area between the axial furrow and the inner portion of the lobe, from which it is marked off by a distinct groove. The basal lateral lobes are of rather different shapes; the left one is the largest and appears to be the more normally developed. They are both considerably narrower than the base of the central lobe.

All the furrows which surround the glabella are narrow. The axial furrows are moderately deep and rather strongly arched in the vertical plane. The preglabellar furrow is shallow especially in the middle. The occipital furrow is rather shallow and nearly transverse behind the central lobe of the glabella; its lateral portions are deeper and arched gently backwards. The occipital ring is of moderate width, scarcely narrower at the sides than in the middle, strongly arched transversally, and gently rounded longitudinally. [Both the occipital ring and furrow are somewhat unsymmetrical.]

The inner portions of the fixed cheeks (incompletely preserved) are rather strongly convex longitudinally and slope gently downwards laterally. The palpebral lobes, which are not traceable on the specimen, appear to have been situated at a relatively great distance from the glabella.

The surface of the cranidium is ornamented with rounded tubercles of different sizes — varying from rather large to quite small — which are rather sparsely distributed on the middle, and especially on the posterior, portions of the central glabellar lobe and on the other parts placed more closely together, and between the tubercles the test is very finely granulated; the inner portions of the fixed cheeks have in addition small pittings.

Horizon and Locality. — Upper Leptæna Limestone; Kallholn.

Genus **Pompeckia** n. gen.

Cephalon convex, sub-semielliptical in outline. Glabella large, convex, broadly rounded; anterior two pairs of lateral glabellar furrows faint; basal pair considerably stronger, at first running parallel to occipital furrow, but curving backwards internally, not reaching occipital furrow, though sometimes connected with it by weak grooves. Anterior border of cranidium very narrow. Cheeks much reduced in size, bent steeply downwards; eyes about on median horizontal line and near glabella; borders of fixed cheeks produced into inconspicuous points or small spines situated well inside hindmost portions of facial sutures, which are directed nearly straight backwards. Thoracic segments (numbers not known) with moderately convex axis; pleuræ without ordinary pleural furrows, but each with a more or less distinctly marked furrow running from axial furrow some distance in front of posterior margin of pleura obliquely forwards towards fulcrum and on the extra-fulcral portion a pair of intra-marginal furrows. Pygidium large; axis, composed of 3 axial rings and a terminal piece indistinctly defined from the free post axial portion; side lobes with 3 pairs of free-ending pleuræ; free portions of pleuræ and post axial portion with intra-marginal furrows.

Genotype: *Pompeckia Wegelini* ANG.

Remarks. — This new genus is proposed to include ANGELIN's species *Sphærexochus Wegelini* (ANGELIN, 1854, p. 76, Pl. XXXIX, figs. 1—1 a) and a new, evidently closely related, smaller species, which will be described below under the name of *Pompeckia minor,* to which the pygidium tentatively attributed by ANGELIN (Op. cit., p. 75, Pl. XXXVIII, fig. 13) to *Amphilichas (Platymetopus) lineatus* seems to belong. No complete individual is known of either of the species, but already before any specimens of the smaller species had been found, the writer had arrived at the conclusion that the pygidium of the large type was referable to ANGELIN's species since it, as well as the cranidium, evidently represented a new genus belonging to the family Cheiruridæ and since several specimens of both had been collected at the same locality, Kallholn, and no other pygidia which could be associated with the cranidia, or vice versa, had been found in the Leptæna Limestone. Later on a great number of cranidia — two of them having each one free cheek and the rostrum attached — several pygidia, and fragments of thoracic segments, and a few detached free cheeks of the smaller form were found closely associated in a small piece of rock from Kallholn, and I think it can be assumed beyond reasonable doubt that in each case the different portions in question really belong to one and the same species. Associated with the other portions of *P. minor* were several hypostomata which appear to belong to this species. Probably a larger hypostoma of the same type from Kallholn, in ISBERG's collection at Lund, belongs to *P. Wegelini.*

The pygidium described and figured by POMPECKI (1890, p. 35, Pl. II. fig. 14) as *Cheirurus?* sp. belongs also to this genus and seems to represent a third species (Cf. below, p. 373). Professor POMPECKI [Op. cit.), in whose honour the genus is named, has already pointed out that this pygidium closely resembles the one which ANGELIN attributed to *Amphilichas (Platymetopus) lineatus,* and expressed the opinion that the two represented a distinct sub-genus of *Cheirurus* s. lat.

The species, *P. Wegelini,* proposed above as the type of this new genus was originally founded by ANGELIN (Op. cit.) on a very fragmentary cranidium and, as already mentioned, referred by him to *Schærexochus.* SCHMIDT (1881, p. 171) referred it to *Pseudosphærexochus,* apparently on account of the character of the basal lateral glabellar furrows, and in this genus (or sub-genus) it has also afterwards been placed by other writers (TÖRNQUIST, 1884, p. 19; BARTON, 1915, p. 120). *Pompeckia* has many points of resemblance with both these genera, and shows, especially in the development of the cephalon, in several respects intermediate characters. On the whole it is most like *Sphærexochus;* but in the characters of the thoracic and pygidial pleuræ it differs strikingly both from this genus and from *Pseudosphærexochus* and shows some more likeness to *Cheirurus* and allied genera. The oblique furrow on the inner portion of the pleuræ of *Pompeckia* seems to correspond to the furrow or groove which in these genera separates the inner and outer portions, but it has migrated farther inwards and grown more oblique, so as to reach the axial furrow, and the ordinary pleural furrow has disappeared. The furrow or groove in question is also rather oblique at least in some of the members of the *Cheirurus* group, and does not quite reach the posterior margin of the pleura (Cf. above, p. 345, and below, Pl. IX, figs. 8, 20).

Distinguishing Characters of the Species.

Glabella very gibbous. Pygidial pleuræ free for about half their length; the free portions broad, placed rather closely together, especially those of the two anterior pairs; third pair of pleuræ not reaching as far backwards as post axial piece *P. Wegelini* ANG.

Glabella moderately convex. Pygidial pleuræ free for considerably more than half their length; the free portions rather narrow, radiating, gradually tapering to pointed extremities; third pair of pleuræ reaching farther backwards than post axial piece *P. minor* n. sp.

Pompeckia Wegelini ANGELIN. Pl. IX, figs. 23—25, 27—31, 26?

1854. *Sphærexochus Wegelini*, ANGELIN, p. 76, Pl. XXXIX, figs. 1—1 a.

Specific Characters. — Glabella large, very gibbous, overhanging in front, sub-circular in outline with base truncated by occipital furrow. 3 pairs of lateral glabellar furrows present. Anterior two pairs very shallow, in some specimens scarcely impressed. First pair placed rather far forwards, comparatively wide and directed nearly straight upwards adjacent to axial furrows, then growing very narrow and running obliquely upwards and forwards about half-way up sides of glabella. Second pair starting from axial furrows somewhat nearer preceding than following pair, generally slightly stronger than the former, somewhat longer than these and directed less forwards, and, at least in some specimens, curving slightly backwards near their inner extremities, where they have grown very weak. Basal pair strong, but not very wide, originating in axial furrows about half-way between preceding pair and occipital furrow, or rather nearer to the former, running nearly straight upwards and inwards for the greater part of their length, but curving backwards near their inner extremities, ending well in front of occipital furrow and not connected with this by any grooves; the distance between their inner extremities about equal to or somewhat shorter than the distance from these to axial furrows. Axial furrows of moderate width, rather strongly impressed outside basal lateral lobes, growing shallower anteriorly, curving downwards anteriorly and terminating in small rounded pits. Preglabellar furrow shallow, relatively wide at sides, becoming linear in centre. Anterior border of cranidium very narrow, thread-like, growing slightly wider at sides. Occipital furrow of moderate width and rather shallow and nearly transverse behind central lobe of glabella; its side portions narrower and deeper, arched very slightly backwards. Occipital ring of moderate, nearly uniform width in the middle, narrowing laterally, strongly arched transversally, gently rounded longitudinally.

Fixed cheeks small; portions in front of palpebral lobes narrow, band-like, sloping both anteriorly and laterally; posterior portions subtriangular, sloping steeply downwards laterally. Palpebral lobes (incompletely preserved) placed near the glabella, comparatively long, with their posterior ends a little behind outer extremities of basal lateral glabellar furrows and their anterior ends a little behind outer extremities of second lateral glabellar furrows, marked off by strong furrows. Borders of fixed cheeks rather narrow adjacent to axial furrows, growing broad laterally with flattened surface, marked off by strong furrows; inner portions — the true posterior borders — directed outwards and downwards; outermost portions — the »lateral borders» — bending obliquely forwards, generally very slightly, but sometimes more strongly; at the junction of the two portions the borders are produced into small tips or points, evidently representing the genal spines. Anterior branches of facial sutures sub-parallel to axial furrows; posterior branches running from eye lobes obliquely backwards to borders, then bending nearly straight backwards.

Thoracic segments (only a single incomplete segment preserved) with rather strongly convex axis, defined by distinctly impressed, narrow furrows. Pleuræ sloping gently downwards to approximate fulcrum; beyond this bent more strongly downwards (in the specimen observed very strongly) and slightly backwards; inner portion of pleura marked by short, rather strong furrow, running from axial furrow a little in front of inner posterior corner of pleura[1] obliquely outwards and forwards towards fulcrum, separating small, gently raised and rounded, sub-triangular inner-anterior portion from flattened postero-lateral area. Extra-fulcral portion gradually tapering to obtuse point, marked anteriorly and posteriorly by intra-marginal furrows. (In the specimen observed, in which the surface is badly preserved, the anterior intra-marginal furrow is relatively wide and deep adjacent to the fulcrum, but grows rather suddenly extremely weak at less than half the distance to the extremity of the pleura; the posterior furrow is very weak even proximally, but it is traceable to near the extremity.)

Pygidium roughly sub-triangular in general outline, about three fifths as long as broad. Axis moderately to rather gently convex anteriorly, its width in front slightly more than one third the greatest width of entire pygidium, narrowing and decreasing in height posteriorly, obtusely rounded behind and indistinctly marked off from the free-ending post axial piece; composed of 3 broad (longitudinally), gently rounded axial rings and a rather large terminal piece, which is gently convex in both directions. Anterior axial ring, as usual, with articulating half-ring. »Rudiment of articulating half-ring» on second ring always very distinct, forming a small crescent-shaped area, depressed beneath surface of preceding ring, indenting it posteriorly in middle and marked off from main portion of second ring by shallow furrow, which is nearly transverse or slightly arched backwards. »Rudiment of articulating half-ring» on third axial ring generally also distinct, but narrower (longitudinally) than that on the second, and most often less distinctly marked off in front and rather more distinctly separated from main portion of ring. Portions of axial ring furrows outside these »rudiments» deep. Furrow behind third axial ring in some specimens very weak, especially in the middle, in others distinctly or even deeply impressed throughout — though always strongest at sides — and

[1] In the thoracic segment figured below (Pl. IX, fig. 30) both the axial ring and the pleura are fractured posteriorly adjacent to the axial furrow, and hence the figure gives the wrong impression that the oblique furrow reaches the posterior margin of the pleura.

then often widening a little or arching forwards in the middle. Axial furrows running from anterior margin of pygidium nearly straight backwards or slightly diverging posteriorly to a little behind middle of anterior segment, then converging posteriorly to third axial ring furrow, but not running straight, or in continuous curves, being bent outwards outside middle of second ring, and often also outside middle of third ring where they generally are very weak, in some specimens scarcely impressed, whereas they usually are distinctly impressed, though rather narrow, outside the two anterior rings. Between the terminal piece of the axis and the third pair of pleuræ the axial furrows grow deeper and stronger, and run nearly straight backwards; they do not meet in the middle behind the axis, but are continued inwards and backwards respectively outwards and backwards by the narrow intra-marginal furrows on the post axial piece and on the inner sides of third pair of pleuræ.

Side lobes of pygidium with 3 pairs of broad pleuræ, free for about half their length and ending in short, falcate, backwards directed points; followed by a broad, obtusely pointed post axial piece, which is free for about two thirds its length and extends slightly behind third pair of pleuræ. Anterior pair of pleuræ increasing slightly in width and sloping gently downwards to approximate fulcrum, then bending more strongly downwards and gently backwards, but with the points generally bent slightly upwards, though always situated on a lower level than adjacent portions of following pleuræ; their free portions close to those of second pleuræ and somewhat narrower than the latter. Posterior portions of side lobes gently concave, the inner portions of the two posterior pairs of pleuræ sloping downwards, their outer portions and the post axial piece curving upwards. Free portions of third pair of pleuræ about as wide as those of second pair, slightly diverging from latter and from post axial piece. Each pleura of the anterior pair with small, slightly swollen, subtriangular area in front adjacent to axial furrow marked off by rather shallow, but distinct, furrow, which starts within a short distance behind middle of pleura and runs obliquely forwards and outwards to cut front margin some distance inside fulcrum. Second pleuræ generally slightly swollen in front adjacent to axial furrows, the swollen area, howewer, always smaller and more indistinctly defined than in the anterior pair of pleuræ. Free portions of pleuræ and post axial piece marked by distinctly impressed, though not deep, intra-marginal furrows, which converge slightly towards extremity of pleura, respectively post axial piece, but without meeting, and die out a little inside margin. Interpleural furrows well-marked, reaching to a little inside angles between free portions of pleuræ, widening slightly at their extremities, and then seemingly dividing, the branches continuing as posterior respectively anterior intra-marginal furrows on preceding and following pleuræ. Inner portions and middle parts of outer portions of pleuræ generally with gently raised and rounded surface; marginal border portions flattened.

The surface of the test, which is badly preserved, seems to have been very finely granulated.

Dimensions. — The dimensions of a rather small cranidium are: distance along median line between the anterior and posterior margins 25 mm., width at base 30 mm., distance along median line between anterior and posterior margins of glabella 22,5 mm., greatest width of glabella 24,5 mm. (in this specimen the glabella is relatively broad). In two larger glabellæ the distance between the anterior and posterior margins is 31 mm., respectively 30,5 mm., and the greatest width 32 mm., respectively 30,5 mm., and in a very large, somewhat incomplete glabella the greatest width is 41 mm. In a large pygidium the length along the median line (articulating half-ring excluded) is 36 mm. and the greatest width 60 mm.

Remarks. — As has already been mentioned above (p. 368), a great number of cranidia of this species — which was originally founded by ANGELIN (Op. cit.) on a fragment of a cranidium — have been found at Kallholn and also several pygidia and a fragmentary thoracic segment, which evidently belong to the same species. Further, a small hypostoma from the same locality in ISBERG's collection at Lund seems to belong here. Its description is as follows:

Entire hypostoma about three fourths as long as wide, greatest width a little in front of middle, gently tapering anteriorly and posteriorly, broadly rounded in front; posterior edge excavated in middle by rather narrow, shallow notch, its side portions broadly rounded. Central body moderately convex, broadly sub-trapezoidal in outline with the anterior margin arched forwards, marked posteriorly by pair of weak, slightly oblique furrows, which die out before meeting each other. Anterior border narrow, thread-like, widening slightly laterally, marked off by narrow furrow, which is shallow in middle, but grows deeper at sides. Anterior pair of wings (incompletely preserved) short, placed far forward, steeply inclined, excavated by rather deep furrows. Lateral borders of moderate width, narrowing adjacent to anterior wings, raised and thickened outside body and separated from it by strong furrows. Posterior border rather broader than lateral borders, gently convex in middle and separated from body by broad, rather shallow furrow; postero-lateral portions of border flattened.

Affinities. — The pygidium described and figured by POMPECKI (1890, p. 35, Pl. II, fig. 14) as *Cheirurus?* sp. resembles closely that of *P. Wegelini*. It differs, however, in certain characters and appears to represent a distinct species. According to the description, the axial rings are highly arched and the surfaces of the pleuræ strongly convex, and each pleura is ornamented by a longitudinal row of elongated tubercles. To judge from the figure the free portions of the pleuræ and the post axial piece are relatively longer and diverge more from each other than in our species, and they have a rather different shape, tapering gradually to the acutely pointed extremities. In the figure the flattened marginal borders are also narrower, and the furrows which mark them off appear to meet or almost meet near the extremities of the pleuræ.

Horizon and Locality. — Upper Leptæna Limestone: Kallholn. [ANGELIN's type-specimen is probably from another locality, but there is no statement as to where it has been found.]

Pompeckia minor n. sp. Pl. IX, figs. 32—38, Pl. X, figs. 26—28.

1854. *Platymetopus lineatus?*, ANGELIN, Pl. XXXVIII, fig. 13.

Specific Characters. — Cephalon sub-semioval in outline, more than two thirds as long as wide, convex with the cheeks bent steeply downwards.

Glabella large, moderately convex, curved down and sligthly overhanging in front, sub-circular in outline with base truncated by occipital furrow. Anterior pair of lateral glabellar furrows linear, scarcely impressed, situated rather near front end of glabella, straight, directed slightly forwards, nearly at right angles to axial furrows; the distance between their inner extremities about equal to their length. Second pair beginning in axial furrows nearer anterior than basal pair, similar to the former, but rather longer and directed less forwards and generally bending slightly backwards near their inner extremities. Basal pair distinctly impressed and wider than the others, but not very strong, beginning at sides nearer preceding pair than occipital furrow, running at first almost straight inwards and upwards, curving backwards internally, not reaching occipital furrow, but in casts generally connected with this by rather distinct grooves; the distance between their inner extremities generally about equal to the distance from these to axial furrows and more than twice the distance to occipital furrow. Basal lateral glabellar lobes with slight independent convexity. Axial furrows narrow, moderately deep outside basal part of glabella, growing somewhat shallower anteriorly. Occipital furrow of moderate strength, almost straight behind central lobe of glabella, its lateral portions arched gently backwards. Occipital ring of moderate, almost uniform width in middle, narrowing laterally, rather strongly arched transversally, gently rounded longitudinally. Anterior border very narrow, flattened, bent obliquely downwards, or just in the middle bent almost straight downwards, marked off by narrow furrow, which is shallow in the middle and grows somewhat deeper and wider laterally.

Cheeks reduced in size, rounded-sub-triangular in outline, curving steeply downwards with gently convex surface from axial furrows to lateral border furrows. Eye lobes (incompletely preserved) of moderate size, situated opposite second lateral glabellar lobes and close to glabella, marked off below by distinctly impressed, rounded furrows. Fixed cheeks in front of eyes very narrow, band-like; the portions behind the eyes broader, marked posteriorly by strong border furrows, which widen laterally and have a nearly straight course from axial furrows to facial sutures, or curve very slightly forwards adjacent to the latter. Borders of fixed cheeks, slightly raised with flattened surface, narrow adjacent to axial furrows, widening laterally and produced into small triangular points or short, tapering, rounded spines situated well inside the facial sutures. Free cheeks produced posteriorly to such an extent that the facial sutures seem to cut the posterior margin of the cephalon. Lateral borders wide, narrowing slightly in front, very gently rounded, sloping less strongly downwards than inner portions of cheeks, marked off by strong furrows. Anterior branches of facial sutures sub-parallel to axial furrows; posterior branches curving from eye lobes obliquely backwards to borders, then bending nearly straight backwards.

Rostrum narrow, band-like, with acutely pointed lateral extremities and gently rounded surface.

Hypostoma (probably belonging to this species) rather more than two thirds as long as wide, tapering posteriorly with almost straight sides; anterior margin very gently arched forwards; posterior edge excavated in middle by narrow, shallow notch; postero-lateral portions of margin broadly rounded. Central body rather strongly convex, sub-trapezoidal in outline, marked near posterior end by pair of short, faint, oblique furrows. Anterior border thread-like, marked off by narrow furrow. Anterior pair of wings (imperfectly preserved) short, situated very far forward. Lateral borders of moderate width, raised and gently rounded outside body and separated from it by strong furrows. Posterior border wide, gently convex in middle; postero-lateral portions of border flattened.

Thoracic segments with strongly convex axis, bounded laterally by narrow furrows. Pleuræ sloping gently downwards to approximate fulcrum, beyond this bending more strongly downwards and curving slightly backwards, gradually tapering to obtusely pointed extremities. Inner portion of each pleura marked by short, rather weak, oblique furrow, beginning in axial furrow well in front of posterior margin of pleura and ending in front a little inside fulcrum, separating small, gently raised and rounded sub-triangular inner-anterior area from flattened postero-lateral area; extra-fulcral portion at least three times as long as inner portion, marked by rather strong intra-marginal furrows which do not quite reach the extremity of the pleura.

Pygidium irregularly sub-pentagonal in general outline, about twice as wide as long. Axis strongly convex in front, decreasing in height posteriorly, sub-triangular in outline, obtusely rounded behind and indistinctly marked off from the free-ending post axial piece; its width in front less than one third of the greatest width of entire pygidium; composed of 3 strongly rounded axial rings and a rather short terminal piece, which is gently convex in both directions. Second, and generally also the third, axial ring with narrow »rudimentary articulating half ring». Axial furrows narrow and shallow, though distinctly impressed throughout, not meeting behind axis, but continued by the intra-marginal furrows on the inner sides of the third pair of pleuræ and on the post axial piece. Side lobes composed of 3 pairs of rather narrow pleuræ with short, inner, attached portions and longer, outer free portions, which form gradually tapering, pointed, gently curved, radiating spines; followed by a sub-triangular post axial piece, which is free for the greater part of its length and does not reach quite as far backwards as the third pair of pleuræ. Anterior pair of pleuræ rather gently bent downwards to approximate fulcrum, then sloping more strongly downwards to near extremities, where the slope grows more gentle. Following pleuræ and post axial piece with proximal portions sloping downwards and distal portions curving upwards. Free portions of pleuræ and post axial piece with narrow, flattened, or very gently rounded, marginal borders, marked off by rather narrow furrows; their middle parts and the proximal portions with gently raised surfaces. Anterior pair of pleuræ — but not the following pairs — with short oblique furrow on inner portion, marking off a small, sub-triangular nodule in front adjacent to axial furrow.

Surface of test of all portions finely granulated, except in the furrows.

Dimensions. — The dimensions of a large cranidium — the type specimen, Pl. IX, figs. 33—34 — are: distance along median line between anterior and posterior margins 11 mm., width at base 13,5 mm., distance along median line between margins of glabella 10,3 mm., greatest width of glabella 11 mm. Most of the cranidia observed are much smaller, but there are also several of intermediate sizes and a few which have nearly the same size as the specimen measured. In the pygidia observed the length along the median line varies from about 2,5 mm. to about 6,7 mm.

Remarks. — The material on which this new species is founded consists of a great number of cranidia — two of them having each a free cheek and the rostrum attached — several more or less fragmentary pygida and thoracic segments, and a few detached free cheeks from Kallholn in the Upsala Museum, nearly all the specimens originally found closely associated in a small piece of limestone. In this were found also several small hypostomata which appear to belong to the same species. The pygidium — from Östbjörka — which ANGELIN (1854, Pl. XXXVIII, fig. 13) tentatively referred to *Amphilichas (Platymetopus) lineatus* ANG. seems also to belong to this species. It agrees on the whole very closely with the pygidia from Kallholn, except that the post axial piece is relatively broader and rather more obtusely pointed.[1]

The cranidia appear to vary rather much in the development of the genal spines. In larger specimens the latter seem to be represented by

[1] In reality it is more pointed than what is shown in the figure given below (Pl. IX, fig. 37), but it is so strongly curved upwards that the extremity appears very obtuse when the specimen is viewed in dorsal aspect. Moreover, in the pygidia from Kallholn the width of the post axial piece varies a little.

small triangular points or small tips only, but in several small cranidia real, though short, spines have been observed.

Horizon and Localities. — Upper Leptæna Limestone; Kallholn, Östbjörka.

Genus **Sphærexochus** BEYRICH.

This genus is generally described as lacking pits on the cheeks and as having the thoracic pleuræ smooth, without traces of furrows or pits. In the species which occur in the Leptæna Limestone, however, the central portions of the cheeks are pitted, although the pits are small and shallow and placed rather far apart, and these forms do not seem to be exceptions in this respect. There are several cranidia in the Upsala Museum of the typical Bohemian form of the genotype, *Sph. mirus* BEYR., which have the portions of the fixed cheeks lying in front of the border furrows quite distinctly pitted. These cranidia have not the test preserved on the cheeks, but there is also in the Upsala Museum a testiferous individual of the English Wenlock form generally referred to this species which both on the fixed and the free cheeks has a few well-marked pits. In this specimen the inner portion of the anterior thoracic pleura is marked near the axial furrow by a rather deep, horizontally elongated pit and outside this is a row of a few weaker, rounded pits. The second pleura bears also a row of pits on its inner portion, but the pits are on the whole weaker than those on the first pleura. On the third pleura are a few still weaker pits, and on the following ones there are faint traces of pits or short, very narrow, slightly impressed lines. A specimen of *Sph. calvus* McCOY from Osmundsberg in the State Museum of Natural History, which has two thoracic segments attached to the cephalon, also shows traces of similar pits or grooves on the inner portions of the pleuræ (Cf. below, p. 380).

It has further been supposed that *Sphærexochus* differed from other Cheiruridæ in having the free cheeks connected in front by a narrow band instead of having a separate rostrum. This was originally stated by SALTER (1853, Pl. III) to be the case in the English Wenlock form referred by him to *Sph. mirus*, but there are reasons to believe that he was mistaken — very likely the sutures at the sides of the rostrum, the connective sutures, were indistinct in the specimen on which he founded his statement. At any rate the free cheeks are not connected in all species of *Sphærexochus*, and it does not appear probable that the members of the genus would differ in this respect. That *Sph. calvus* has a separate rostrum is shown in the specimen from Osmundsberg just mentioned, and in the free cheek figured below (Pl. XI, fig. 4), belonging to the new species *Sph. tuberculatus*, the course of the connective suture is seen.

Distinguishing Characters of the Species.

Surface of test very finely granulated. Pygidial pleuræ with very short free ends, the posterior margin between the extremities of the third pair forming only a slight re-entrant curve *Sph. calvus* M^c^Coy.

Surface of test very finely granulated. Pygidial pleuræ with relatively long free ends, the posterior margin between the extremities of the third pair forming a deep re-entrant curve *Sph. Hisingeri* n. sp.

Surface of test ornamented with rather low, sub-conical tubercles of different sizes (all rather small) and between these finely granulated. Pygidial pleuræ with relatively long free ends, the posterior margin between the extremities of the third pair forming a deep re-entrant curve *Sph. tuberculatus* n. sp.

Sphærexochus calvus McCoy. Pl. XI, figs. 5—15.

1846. *Sphærexochus calvus,* McCoy, p. 44, Pl. IV, fig. 10.
1853. *Sphærexochus mirus,* Salter, Pl. III. figs. 14—15.
1854. *Sphærexochus angustifrons,* Angelin, Pl. XXXVIII, fig. 16 a, fig. 16? (non. fig. 17), Pl. XXII, fig. 8?
1864 a. *Sphærexochus mirus,* Salter, Pl. VI, figs. 26 a—b.
1881. *Sphærexochus angustifrons,* Schmidt, p. 189, Pl. IX, figs. 17 a—b, Pl. XVI, fig. 38.
1884. *Sphærexochus mirus,* Törnquist, pp. 20—21 (pars).
1896. *Sphærexochus mirus,* Reed, p. 423.
1896. *Sphærexochus latirugatus,* Reed, p. 423, Pl. XX, fig. 12.

Specific Characters. — Cephalon sub-semielliptical in outline. Glabella large, occupying nearly the whole width of cephalon, sub-hemispherical with base truncated by occipital furrow, strongly protruberant anteriorly beyond frontal margin. Anterior two pairs of lateral glabellar furrows scarcely impressed except close to axial furrows. First pair situated near front end of glabella, almost straight and nearly at right angles to median line of body, short, the distance between their inner extremities being nearly twice the length of each. Second pair longer, beginning in axial furrows about half-way between first and basal pairs and running at first nearly parallel to the former, generally curving slightly backwards internally; the distance between their inner extremities slightly greater than the length of each. Basal pair of lateral glabellar furrows deep, of moderate width, running from axial furrows at first sub-parallel to preceding pairs, then curving round to meet occipital furrow, generally growing shallower before reaching latter. Basal pair of lateral glabellar lobes generally with gentle independent convexity, longer than the others, slightly projecting posteriorly beyond base of central glabellar lobe, transversally sub-elliptical to sub-rhomboidal or sub-trapezoidal in outline with the corners rounded except the antero-lateral ones, which are rather acutely pointed; their transverse diameter generally about equal to the width of central glabellar lobe at occipital furrow or slightly less. Axial furrows deep, of moderate width — wider in casts — curving strongly downwards anteriorly. Occipital furrow of moderate depth and width and almost straight behind central lobe of glabella; its lateral portions narrower and deeper and arched gently backwards. Occipital ring rather narrow, almost parallel-sided for the greater part of its length, narrowing adjacent to axial furrows, strongly arched transversally, gently rounded longitudinally. Preglabellar furrow nearly equalling axial furrows in depth and width at sides, growing narrower and rather shallower internally, not connected with lateral border furrows on free cheeks. Anterior border very narrow, rounded, and continued as raised ridges along the anterior branches of the facial sutures past the lateral border furrows on the free cheeks.

Cheeks small, bent almost vertically downwards, sub-quadrilateral in outline with length greater than width, rather acutely pointed in front; the portions within the bounding furrows with slightly raised surface. Eye lobes (imperfectly preserved) small, sub-circular in outline, situated opposite distal extremities of basal lateral glabellar furrows and close to axial furrows. Palpebral lobes crescentic, relatively broad, convex in both directions. Palpebral furrows strong posteriorly, growing weaker anteriorly. Lower eyelid furrows broad and shallow. Portions of fixed cheeks lying in front of eye lobes very narrow, growing still narrower anteriorly and not marked off from anterior border of cranidium. Their posterior portions broader, sub-triangular, marked posteriorly by deep, wide border furrows, which are nearly straight and directed slightly backwards for the greater part of their length, but generally curve slightly forwards distally, where they are shallower than within, and die out — or become very weak — before reaching facial sutures. Borders of fixed cheeks rather narrow and rounded proximally, growing wider and flatter distally; their posterior margins rounded or (in internal casts) obtusely angulated some distance within facial sutures and, at least in some specimens, produced at the angles into short, triangular points evidently representing the genal spines. Free cheeks sub-rhomboidal in outline, with broad and deep lateral border furrows, which do not quite reach either the anterior or the posterior branches of the facial sutures. Borders of free cheeks relatively wide; their posterior portions flattened with straight distal margins; their anterior portions raised, with the distal halves, which have rounded margins, bent rather strongly inwards (Pl. XI, fig. 6). Beyond the anterior extremities of the border furrows the free cheeks grow very narrow and are continued on the ventral side obliquely inwards as narrow band-like portions separated from the rostrum by the connective sutures. Between these band-like portions and the lateral borders the margin forms on each side a hollow curve. Anterior branches of facial sutures sub-parallel to sides of glabella; posterior branches curving from eye lobes obliquely outwards, backwards, and downwards, bending more straight backwards posteriorly.

Rostrum transversally elongated, sub-trapezoidal in outline, marked by two rather broad, shallow grooves, of which the upper one, which is slightly shorter than the other, does not reach the lateral margins.

Anterior two thoracic segments (posterior segments not known) with highly arched axial rings bounded at sides by moderately strong axial furrows. Inner portions of pleuræ — to approximate fulcrum — straight and horizontal and marked by faint median furrows or elongated pits which do not quite reach the axial furrows; outer portions bent steeply downwards and tapering into conical points.

Pygidium about twice as wide as long. Axis sub-triangular, convex, more elevated than side lobes, but decreasing in height posteriorly; its anterior width from about one third to two fifths that of entire pygidium; composed of two prominent, rounded axial rings defined by strong furrows, and a long sub-triangular terminal piece, whose anterior portion — which coalesces at sides with the third pair of pleuræ — evidently represents a third, incompletely defined axial ring. Behind this the sides of the axis is indented by a pair of very short, but rather deep furrows, or elongated impressions, the representatives of the distal portions of the third axial ring furrow, which terminate laterally in deep pits. Axial furrows narrow and shallow outside anterior two axial rings, becoming obsolete outside third ring (or anterior portion of terminal piece) to the pits just mentioned, and behind these, along sides of terminal piece proper, forming rather shallow grooves, which generally are narrow anteriorly, but soon grow wide, and die out or become very shallow a little inside the posterior margin of the pygidium. Side lobes rudely triangular in outline with the margins scalloped owing to the projection of the ends of the pleuræ; composed of 3 pairs of gently rounded, unfurrowed pleuræ. Anterior pair of pleuræ slightly increasing in width and sloping very slightly downwards to approximate fulcrum, beyond this growing nearly parallel-sided, or very slightly increasing in width distally, and bending rather strongly downwards and backwards, ending in short blunt points projecting on margins. Second pair of pleuræ nearly straight, increasing in width distally, directed more backwards, but bent rather less strongly downwards, and attaining a greater width than distal portions of anterior pair; their ends forming rounded projections on margins. Third pair of pleuræ directed backwards, increasing in width posteriorly and growing wider than the others, with slightly concave inner sides, which converge posteriorly, nearly straight outer sides, and broadly rounded ends, and with their surfaces sloping gently downwards laterally; posterior margin of pygidium between their extremities forming a slight re-entrant curve. Interpleural furrows shallow and generally wide, growing wider distally; their width, however — and consequently the width of the pleuræ also — varying rather much in different specimens. [In internal casts the pleuræ — especially the two anterior pairs — generally project more on the margins than in testiferous specimens, and in some specimens the interpleural furrows are very wide and the pleuræ narrow and rather ridge-like, the two posterior pairs expanding distally.]

Surface of test finely granulated, except in the furrows; portions of cheeks inside bounding furrows in addition marked with small, shallow and rather sparsely distributed, rounded pits.

Dimensions. — The dimensions of a rather small cephalon are: distance along median line between anterior and posterior margins 11 mm., greatest width 13 mm., distance along median line between anterior and posterior margins of glabella 10 mm., greatest width of do. 11,2 mm. In one of the largest cranidia observed the distance between the anterior and posterior margins of the glabella is 26 mm. and its greatest width 27 mm. In a large pygidium the length along the median line (articulating half-ring excluded) is 11 mm. and the greatest width 21 mm.; in another pygidium of more ordinary size the length is 5 mm. and the width 9,5 mm.

Remarks and Affinities. — The species *Sphærexochus calvus* was founded by M^c^Coy in 1846 (p. 44, Pl. IV, fig. 10) on cranidia from the Kildare Limestone at the Chair of Kildare in Ireland, where several pygidia which evidently belong to this species have also been found.

M^c^Coy was of the opinion that the cranidium from Furudal in Dalarne figured by Hisinger (1840, Pl. XXXVII, fig. 1) as *Calymene clavifrons* Dalm. was referable to the same species, but this does not seem to be the case. Hisinger's specimen came from a lower stratigraphical horizon, the Lower Leptæna Limestone[1], and a great number of other cranidia evidently belonging to the same species — which I propose to call *Sph. Hisingeri* — have been found in the same formation both at Furudal and at Kullsberg. There do not seem to be any distinct features by which to separate these cranidia from those of *Sph. calvus*. The pygidia, however, which occur in the same part of the Lower Leptæna Limestone and apparently are referable to the same species as the cranidia differ markedly from the pygidia of the geologically younger form (Cf. below, p. 384).

In the Upper Leptæna Limestone in Dalarne, on the other hand, there occur numerous pygidia as well as cranidia which agree closely in characters with those from Kildare and I see no reasons to hesitate in referring these to M^c^Coy's species. It appears most probable that among the material on which Angelin (1854, p. 36) founded his species *Sph. angustifrons* were cranidia of both the younger and the older form. At any rate it is almost unthinkable that he had not seen cranidia of the younger form, since these are among the most abundant fossils in the Upper Leptæna Limestone; on the other hand, he referred Hisinger's

[1] It is obvious from Hisinger's (1831, pp. 8, 12) earlier statements that the cranidia from Furudal erroneously referred by him to Dalman's species had been found in Leptæna Limestone, and it is the Lower Leptæna Limestone that occurs in that locality.

specimen[1] to his species. It is impossible to decide to which of the two forms the cranidium primarily figured by ANGELIN (Op. cit., Pl. XXII, figs. 8—8 a) as *Sph. angustifrons* belongs, since the specimen is lost and there is no statement as to whether it had been found in the Upper or in the Lower Leptæna Limestone. The same is the case as regards the cephalon figured by him further on in the same work (Pl. XXXVIII, fig. 16). The pygidium, however, which he (Op. cit., Pl. XXXVIII, fig. 16 a) unreservedly referred to his species belongs to the younger form, *Sph. calvus*.[2] A pygidium of the other type, from the Lower Leptæna Limestone, was also figured by ANGELIN (Op. cit., Pl. XXXVIII, fig. 17) but as *Sph. angustifrons?* var. (Op. cit., p. 75). These being the circumstances it appears as if the species which occurs in the Upper Leptæna Limestone must be regarded as ANGELIN's *Sph. angustifrons*, and, since it evidently is identical with *Sph. calvus* M^cCOY, the former, younger name must be dropped.

The cranidia from the East Baltic Lyckholm Formation described and figured by SCHMIDT (1881, p. 189, Pl. IX, figs. 17 a—b, Pl. XVI, fig. 38) as *Sph. angustifrons* ANG. belong apparently to the younger form, *Sph. calvus*, and the small specimens from the Red Trinucleus Shale at Vikarbyn in Dalarne mentioned by TÖRNQUIST (1884, p. 20—21) seem also to belong to it.

REED's species *Sph. latirugatus* (REED, 1896, p. 423, Pl. XX, fig. 12), founded on pygidia from the Keisley Limestone at Keisley in England, appears to be identical with *Sph. calvus*. The pygidium from Keisley recorded by REED (Op. cit., p. 423) as *Sph. mirus* BEYR. seems also to belong to this species, as well as the *Sphærexochus* cranidia which have been found at the same locality. REED (Op. cit., pp. 423—424) considered it probable that some of these »so-called» *Sph. mirus* cranidia belonged to his species *Sph. latirugatus*. He also stated that he had seen several pygidia from Kildare which he considered referable to this species, and he has later on (1914, p. 48) himself suggested that *Sph. latirugatus* might be identical with *Sph. angustifrons* ANG. (Cf. above).

The cranidia from Keisley examined by the writer agree perfectly with those from Kildare and from Dalarne. The writer has also had the opportunity of examining in the Sedgwick Museum in Cambridge both the pygidium mentioned above, which REED referred to *Sph. mirus* and two pygidia (among them his type specimen) referred by him to *Sph. latirugatus*. The former shows a much closer resemblance, to the typical

[1] In ANGELIN's work (p. 37) *Calymene sclerops* is evidently a miswriting for *Calymene clavifrons*. The reference to the page and the plate is correct.

[2] ANGELIN's figure is quite misleading, and, without seeing the original, it would be impossible to recognize that it belonged to this species, which accounts for TÖRNQUIST's (1884, p. 20) statement concerning it. The specimen is, however, fortunately in the State Museum of Natural History, and it shows the characters of the species. The rock in which it occurs is undubitably Upper Leptæna Limestone, but there is no statement as to where it has been found.

pygidia of *Sph. calvus* than to those of *Sph. mirus* (Cf. below). It has relatively narrow interpleural furrows and differs in this respect from the pygidia referred to *Sph. latirugatus,* which, as stated by REED, have narrow ridge-like pleuræ — the second and third pairs increasing in width distally — separated by wide, shallow, concave depressions. These pygidia are to a great extent devoid of their test, and I have seen several specimens from Dalarne which on the internal cast show similar characters. As has been mentioned above, in the description of the species, the pygidia which seem referable to *Sph. calvus* vary much in the relative width of the pleuræ and interpleural furrows. In testiferous specimens the boundary-lines between the furrows and the rounded pleuræ are very sharp and the former seem always to be narrower than the latter. Sometimes the difference is, however, rather slight, in other cases stronger, and in some specimens considerable, although the furrows seem never to be really narrow. Among the internal casts the variation is much greater. In these the boundaries between the furrows and the pleuræ are often very indistinct (especially at the rear of the former), and in some specimens the surface of the broad pleuræ slopes very gradually downwards to the bottom of the relatively narrow furrows. In other specimens again with wide furrows on the surface of the test the pleuræ may, when the test is removed, appear as narrow ridges separated by wide, shallow, concave impressions as is the case in the specimens which REED referred to *Sph. latirugatus*.

SALTER (1853, Pl. III; 1864 a, p. 76) united M^cCOY's species with the Silurian species *Sph. mirus* BEYR. (BEYRICH, 1845, p. 21; 1846, Pl. I, figs. 8 a—c; BARRANDE, 1852, p. 808, Pl. XLII, figs. 16—23), but he admitted that the cranidia and pygidia from the Kildare Limestone differed in some characters from the British Silurian form, which he referred to BEYRICH's species.[1] TÖRNQUIST (1884, p. 20) likewise united ANGELIN's *Sph. angustifrons* — as well as *Sph. scabridus* ANG. — with *Sph. mirus*. There appears to me, however, to be no reason to hesitate in keeping the Ordovician species apart, since it shows several distinctive characters. M^cCOY (Op. cit.) when founding his species stated that it differed from *Sph. mirus* in the small distance between the basal lateral glabellar lobes. The same point was marked out by ANGELIN (Op. cit.) as distinguishing *Sph. angustifrons* from *Sph. scabridus*, and SCHMIDT (Op. cit.) has also emphasized this difference between the Ordovician species and *Sph. mirus*. As the authors who united the species have pointed out, the width of this space varies in both forms, but it always seems to be much narrower in *Sph. calvus,* where the lobes are transversally elongated and have a rather irregular shape, whereas they are almost circular in *Sph. mirus*. In the latter the glabella appears generally to be relatively shorter and wider, with the anterior outline more broadly rounded and with the

[1] It appears questionable to me whether the British form really belongs to this species. It appears to differ in several characters from the typical Bohemian form.

strong downward slope of the surface commencing nearer the occipital furrow. This is especially the case in the British form, and in this the basal lateral glabellar lobes are also more steeply inclined than in *Sph. calvus*. The pygidia differ more, however. In *Sph. mirus* — both in the typical Bohemian and in the British form — the hindmost portion of the axis is much more elevated than in *Sph. calvus* and the distal portions of all the pleuræ are bent steeply downwards. In the British form the pygidium is also, as stated by SALTER (Op. cit.), shorter and wider.

Horizons and Localities. — Upper Leptæna Limestone; Kallholn, Osmundsberg, Klittberg, Unskarsheden, Torsmo, Lissberg, Boda (at the two latter localities in lime-shales as well as in hard, thick-banded limestone). Red Trinucleus Shales: Vikarbyn in Dalarne. Kildare Limestone; Chair of Kildare in Ireland. Keisley Limestone; Keisley in England. Lyckholm Formation; Dago in Esthonia.

Sphærexochus Hisingeri n. sp. Pl. XI, fig. 16—19.

1840. *Calymene clavifrons*, HISINGER, Pl. XXXVII, fig. 1.
1854. *Sphærexochus angustifrons?* var., ANGELIN, p. 75, pl. XXXVIII, fig. 17.
1884. *Spærexochus mirus*, TÖRNQUIST, pp. 20—21 (pars).

Remarks. — That the cranidium from Furudal which HISINGER (Op. cit.) figured as *Calymene clavifrons* DALM., does not belong to DALMAN's species but to a species of *Sphærexochus* was already shown by BEYRICH (1845, p. 22), and, as mentioned above (p. 381), McCOY referred it to *Sph. calvus* McCOY and ANGELIN to his species *Sph. angustifrons*. As already pointed out (pp. 381, 382), it had been found in the Lower Leptæna Limestone, and whereas the species of *Sphærexochus* which occurs in the Upper Leptæna Limestone, and which must be regarded as ANGELIN's *Sph. angustifrons*, evidently is identical with *Sph. calvus*, the older form appears to represent a distinct species. This may appropriately be named *Sph. Hisingeri*.

There have later been found in the Lower Leptæna Limestone both at Furudal and at Kullsberg a great number of cranidia and a few pygidia which evidently belong to this species. The pygidium figured by ANGELIN in 1854 (Pl. XXXVIII, fig. 17) as *Sphærexochus mirus?* var., which is in the State Museum of Natural History, is of the same type as those found later at the localities just mentioned. Other fossils (pygidia of *Illænus fallax* HOLM), which occur in the same piece of rock, as well as the appearance of the latter, show that it is from the Lower Leptæna Limestone. There is, however, no statement as to the locality where it has been found, only that it is from Dalarne, but it appears most probable that it has been collected at Furudal.

There is no distinctive difference between the cranidia of this species and those of *Sph. calvus*. The only dissimilarity would be that in the former the average width of the base of the central lobe of the glabella seems to be somewhat smaller. I have measured a great number of cranidia of both species, and to judge from these *Sph. calvus* has the basal width of the central lobe about equal to or slightly greater than the transverse diameter of the basal lateral lobes of the glabella, whereas in *Sph. Hisingeri* it never exceeds this but may be slightly smaller.

The pygidium, however, differs distinctly from that of *Sph. calvus*, all the pleuræ having — both in testiferous specimens and in internal casts — relatively long free ends[1] separated by deep and rather wide emarginations; further the extra-fulcral portions of the anterior pair of pleuræ are directed less backwards and the terminal piece of the axis ends in a more acute point. All the pygidia of this form examined by the writer have wide interpleural furrows.

Dimensions. — In the largest cranidium observed the distance along the median line between the margins of the glabella is 20,5 mm. and the greatest width of the latter 21,5 mm. In a smaller glabella the distance between the anterior and posterior margins is 11 mm. and the greatest width 12 mm. In the pygidia observed the length along the median line (the articulating half-ring excluded) varies from about 7 mm. to 9 mm.

Horizon and Localities. — Lower Leptæna Limestone; Furudal, Kullsberg, Amtjärn.

Sphærexochus tuberculatus n. sp. Pl. XI, figs. 1—4.

Remarks. — In the lowest part of the Lower Leptæna Limestone (thin-banded limestone interstratified by shales) at the Amtjärn Quarry and at Sätra, there occurs a form which must be considered very closely allied to *Sph. Hisingeri*. It is represented in the Upsala Museum by numerous cranidia and pygidia and several detached free cheeks from the former locality and by one cranidium from the latter.

As far as can be judged from the portions preserved, this form agrees exactly with *Sph. Hisingeri* in all characters except in the ornamentation of the surface. In this respect, however, it differs so much, not only from *Sph. Hisingeri*, but also from all other hitherto described species of *Sphærexochus*, that it seems necessary to refer it to a distinct species. — The surface is ornamented with rather low, sub-conical tubercles of different sizes (all rather small) and between the tubercles it is finely granulated. The tubercles are placed rather close together on the posterior and middle portions of the glabella, and here the larger ones occur; towards the sides and frontal portion of the cephalon they grow gradually smaller and more sparsely distributed. On the occipital ring there is a fairly

[1] In the larger of the pygidia figured below (Pl. XI, fig. 18) the second pleura on the right side is not complete.

large median tubercle and a few scattered, smaller ones. On the pygidium the tubercles seem as a rule to be more evenly distributed than on the cephalon, and to be, on the whole, rather smaller and placed somewhat farther apart than on the posterior and middle portion of the glabella. — As in other species of the genus (Cf. above, p. 377) the central portions of the cheeks are marked by small, scattered pits, which, however, are rather indistinct in most of the specimens observed.

Dimensions. — In the type specimen (cranidium) the distance along the median line between the anterior and posterior margins of the glabella is 13 mm. and its greatest width 14,5 mm.; in a large fragmentary glabella, the largest observed, the distance along the median line between the margins seems to have been about 20 mm. In a pygidium of ordinary size the length along the median line (articulating half-ring excluded) is 12 mm. and the greatest width 25 mm.

Horizon and Localities. — Lowest part of Lower Leptæna Limestone; Amtjärn Quarry, Sätra.

Genus **Hemisphærocoryphe** Reed.

Cephalon transversally sub-semielliptical in outline, strongly convex, with genal angles produced into spines. Glabella, barring the basal lateral lobes, swollen into a large, sub-hemisphærical or sub-ovate mass, which in the middle posteriorly slopes directly down into the occipital furrow. Anterior two pairs of lateral glabellar furrows represented by weak, narrow grooves or shallow, rounded impressions, not reaching axial furrows; basal lateral glabellar furrows strong, oblique, reaching occipital furrow and entirely isolating a pair of small, nodular basal lateral lobes. Cheeks convex, sub-triangular, with eye lobes nearly in the centre. Anterior and posterior branches of facial sutures making obtuse angles; posterior branches cutting margins just in front of genal spines. Glabella finely tuberculated; cheeks inside bounding furrows pitted, sometimes with small tubercles between the pits. Thorax and pygidium unknown.

Genotype: *Hemisphærocoryphe pseudohemicranium* Nieszkowski.

Remarks. — Schmidt (1881, pp. 123, 165) considered Nieszkowski's species *Sphærexochus pseudohemicranium* (Nieszkowski, 1859, p. 376, Pl. II, figs. 7—8) to form a connecting link between the typical members of *Cyrtometopus* and *Sphærocoryphe*, placing it hesitatingly in the former genus. Törnquist (1884, p. 17) believed it to be identical with Angelin's *Sphærocoryphe granulata* (Cf. below) and referred it to *Sphærocoryphe*. Later on Reed (1896 a, pp. 121—122) followed out Schmidt's suggestion, and proposed it as the type of a new sub-genus of *Cheirurus* s. lat., *Hemisphærocoryphe*. The pygidium ascribed by Schmidt (Op. cit., p. 164, Pl. VIII, fig. 16) to this species is quite different from both the *Cyrtometopus*- and the *Sphærocryphe*-type of pygidia, but it seems very unlikely that it really belongs here. To judge from the description and figure it does not appear to belong to a member of the family Cheiruridæ at all, but rather to a Lichad. However, even if only the characters of the cephalon are taken into consideration, the species does not seem to be referable to either *Cyrtometopus* or *Sphærocoryphe* — although it shows affinities with both — and it seems justifiable to regard *Hemisphærocoryphe* as a distinct genus (when we regard the other proposed sub-genera of *Cheirurus* s. lat. as having generic rank).

ANGELIN's *Sphærocoryphe granulata* appears to be rather closely allied to *Hemisph. pseudohemicranium* and referable to the same genus. As mentioned above, TÖRNQUIST believed the two species to be identical, but this does not seem to be the case. At any rate the type form of *Hemisph. pseudohemicranium* (SCHMIDT, 1881, Pl. VIII, figs. 13—14, Pl. XVI, fig. 18—19) appears to be a distinct species. Possibly the form described and figured by SCHMIDT (Op. cit., p. 164, Pl. VIII, figs. 9, 10, 15, Pl. XI, fig. 29, Pl. XVI, figs. 20—21) as *Cyrtometopus pseudohemicranium* NIESZK. var. *dolichocephala* is identical with ANGELIN's species.

Whether SCHMIDT's species *Cyrtometopus Rosenthali* (SCHMIDT 1881, p. 236, text-figs. 15 a—c; 1907, p. 10) is referable to *Hemisphærocoryphe* is impossible to decide from the description and figures available. SCHMIDT regarded it as closely allied to NIESZKOWSKI's species, but, as he himself pointed out, it agrees in some characters better than this does with the typical species of *Cyrtometopus*.

In addition to the genotype, REED (Op. cit.) included in *Hemisphærocoryphe* also another species which SCHMIDT with some hesitation had referred to *Cyrtometopus*, namely *Cyrt.? aries* EICHW. (SCHMIDT 1881, p. 160, Pl. VII, figs. 19—21, Pl. XVI, figs. 16—17). It seems doubtful to me whether this species can be placed together with *Hemisph. pseudohemicranium*. It is true that both forms show a rather strong likeness to *Sphærocoryphe*, but in different respects (Cf. SCHMIDT, Op. cit. pp. 161, 163, 165). BARTON (1915, p. 127) refers also *Cyrt.? aries*, as well as SCHMIDT's species *Cyrt.? Rosenthali*, to *Hemisphærocoryphe*. The figure given by him as the cranidium of the genotype, *Hemisph. pseudohemicranium*, does not represent this species, but is an outline drawing after one of SCHMIDT's figures of *Cyrt.? aries*.[1] His diagnosis of the genus is apparently to a great extent founded on this species and does not quite fit any of the species which he refers to it, as they are described and figured by SCHMIDT. The diagnosis given above is based on SCHMIDT's description of the genotype and on the characters of *Hemisph. granulata* ANG., whereas the characters of *Cyrt.? aries* EICHW. are not taken into consideration.

[1] To avoid further confusion it may be pointed out in this connection, that the figures given by BARTON (Op. cit. p. 108, text-figs. 4 b—c) as representing the cephalon of the genotype of *Cyrtometopus*, *Cyrt. clavifrons* DALM., are drawn after two of SCHMIDT's (1881, Pl. VIII, figs. 1—2) figures of *Cyrt. affinis* ANG., and the one given by him (Op. cit., p. 125, text-fig. 16) as the genotype of *Sphærocoryphe*, *Sph. dentata* ANG., is drawn after one of SCHMIDT's (Op. cit., Pl. VIII, fig. 7) figures of *Sph. cranium* KUT.

Hemisphærocoryphe granulata ANG. Pl. X, figs. 35—39.

1854. *Sphærocoryphe granulata,* ANGELIN, p. 76, Pl. XXXIX, fig. 4.
1869. *Staurocephalus (Spærocoryphe) granulatus,* LINNARSSON, p. 61.
1884. *Sphærocoryphe granulata,* TÖRNQUIST. p. 17.

Specific Characters. — Cephalon convex, transversally sub-semi-elliptical in outline, with the genal angles produced into stout, rounded, tapering, strongly diverging spines (imperfectly preserved).

Glabella, barring the basal lateral lobes, swollen into a large, broadly sub-ovate mass, narrowing anteriorly, with the longer axis directed obliquely forwards and downwards, not very strongly contracted below, occupying about half the width of cephalon. Anterior two pairs of lateral glabellar furrows represented by small, sub-ovate impressions, which are rather shallow on the surface of the test, generally deeper on internal casts; first pair situated far forward, just above the terminal pits of the axial furrows; second pair larger, more elongated, and, generally, somewhat deeper than the first, situated at about middle of glabella close to axial furrows. Basal pair of lateral glabellar furrows very oblique, deep and wide at axial furrows, growing shallower within before reaching occipital furrow. Basal lateral glabellar lobes small, distinctly raised, narrowly sub-triangular in outline, with the longest sides along lateral glabellar furrows, strongly bent downwards and situated much below the middle point of the strongly arched occipital furrow, which separates them. Axial furrows not very deeply impressed, narrow outside basal lateral lobes, much wider outside anterior portion of glabella, terminating in front in deep, rounded pits. Occipital furrow of moderate width, rather shallow in middle, growing very deep and curving slightly forwards at sides behind basal lateral glabellar lobes. Occipital ring narrow in middle, widening slightly laterally, very strongly arched transversally, gently rounded longitudinally. Anterior border of cranidium narrow, gently rounded, separated from glabella by rather strong furrow, and continued on fixed cheeks along anterior branches of facial sutures by narrow, raised ridges.

Cheeks sub-triangular, rather strongly convex, but scarcely elevated, curving steeply downwards laterally and anteriorly; their posterior margins curving forwards laterally to bases of genal spines. Eye lobes (imperfectly preserved) rather small, prominent, rounded, situated opposite second pair of lateral glabellar impressions and about half-way between axial furrows and bases of genal spines. Lower eyelids relatively broad, strongly curved. Posterior borders rounded, rather narrow, widening slightly laterally; their inner portions with narrow, depressed articulating bands along posterior edges. Posterior border furrows rather strong (very wide on internal casts), dying out at bases of genal spines. Free cheeks relatively large, though smaller than the fixed ones, sub-triangular, the anterior and posterior branches of the facial sutures making slightly obtuse angles, the posterior branches cutting the margins just in front of bases of genal spines. Borders of free cheeks rather wide, gently rounded; border furrows weak, not connected with axial or preglabellar furrows and not quite reaching posterior branches of facial sutures.

Surface of glabella, except in the furrows, covered by small, rounded tubercles. Portions of cheeks inside bounding furrows pitted, with small, ill-defined tubercles between the pits. Occipital ring, borders, and genal spines granulated.

Dimensions. — The dimensions of a large, fragmentary cranidium are: distance along median line between anterior and posterior margins 15 mm., width between bases of genal spines 26 mm., distance between anterior and posterior ends of swollen portion of glabella 15 mm., greatest width of do. 12,7 mm.

Remarks and Affinities. — A great number of more or less fragmentary cranidia of this species have been found in the Lower Leptæna Limestone at different localities. One of the specimens, in ISBERG's collection, has one of the free cheeks attached in position. The thorax and the pygidium are not known. Possibly two fragmentary hypostomata — the larger one having a length of about 5 mm. — from Kullsberg in the Upsala Museum belong to this species; as far as can be ascertained from these specimens, the characters are as follows:

Entire hypostoma rounded sub-triangular in outline, about as long as wide, tapering posteriorly, broadly rounded in front, sub-truncate at base. Central body sub-ovate, rather strongly convex, unfurrowed. Anterior border (imperfectly preserved) narrow, marked off by rather narrow furrow. Anterior pair of wings very short (longitudinally), rather steeply, though not vertically, inclined. Lateral furrows strong, continuous with the somewhat shallower posterior furrow. Lateral borders narrow, raised and thickened, especially in front. Posterior border rather wider, gently recurved. Surface of body (and borders?) granulated.

Cranidia of this species have also been found in the upper part of the Chasmops Limestone, the Macrourus Limestone, at Fjecka in Dalarne, and, according to LINNARSSON (1869, p. 61), in the Chasmops Limestone at Mösseberg and Ålleberg in Västergötland.

As mentioned above (p. 386), TÖRNQUIST (1884, p. 18) has expressed the opinion that the species described by SCHMIDT in 1881 (p. 163) as *Cheirurus (Cyrtometopus) pseudohemicranium* NEISZK. was identical with our species. To the former SCHMIDT referred in addition to the type form (SCHMIDT, op. cit., Pl. VIII, figs. 13—14, Pl. XVI, figs. 18—19) another form, var. *dolicocephala* SCHMIDT (Op. cit., Pl. VIII, figs. 9—10, 15, Pl. XI, fig. 29, Pl. XVI, figs. 20—21). Concerning this latter form, he remarked, however, that it perhaps was specifically distinguishable, and, as far as can be judged from his description and figures, this appears to be the case. It is this form which shows the greatest likeness to *Hemisph. granulata,* but whether it is identical is impossible to decide without seeing any of the specimens. To judge from the description and figures it appears to differ in having the base of the sub-globular portion of the glabella more produced posteriorly so as to project more distinctly between the basal lateral glabellar lobes. The difference seems to be rather slight, however, and at any rate the forms appear to be closely allied.

The fragmentary glabella from the Keisley Limestone at Keisley in England which REED (1896, p. 423) hesitatingly referred to our species, does not seem to belong here, but possibly to *Sphærocoryphe punctata* (Cf., below, p. 393).

The cranidia from the East Baltic Lyckholm Formation described and figured by SCHMIDT (1881, p. 169, Pl. VIII, figs. 17—19) as *Cheirurus (Sphærocoryphe)* cf. *granulatus* ANG. differ strongly from the cranidia of the true *Hemisph. granulata*, and represent apparently a new species of *Sphærocoryphe*.

Horizons and Localities. — Lower Leptæna Limestone: Kullsberg, Furudal, Sätra, Östbjörka, Sinksjön, Änderåsen, Amtjärn. Chasmops Limestone (Macrourus Limestone); Fjecka in Dalarne. Chasmops Limestone; Ålleberg and Mösseberg in Västergötland.

Genus **Sphærocoryphe** ANGELIN.

Sphærocoryphe punctata ANGELIN. Pl. X, figs. 43—49.

1854. *Deiphon punctatus*, ANGELIN, p. 77, Pl. XXXIX, fig. 6.
?1896. *Sphærocoryphe granulata?*, REED, p. 423.

Specific Characters. — Cephalon, barring the protuberant glabella, gently convex, transversally sub-semielliptical to broadly sub-triangular in outline, with the genal angles produced into spines.

Glabella in front of basal lateral furrows swollen into a large, sub-globular mass, protruding beyond anterior margin of cephalon and partly overhanging the cheeks. Portion of glabella lying behind the globular portion occupying about one third the width of entire cephalon between bases of genal spines, short, depressed, with small, sub-triangular, nodular basal lateral lobes. Anterior two pairs of lateral glabellar furrows entirely obsolete. Basal pair of furrows broad, but not deep, connected across middle of glabella, growing wider internally so as to reach occipital furrow, or, perhaps more correctly expressed, growing confluent internally with the short, smooth, groove-like neck of the central glabellar lobe. Axial furrows narrow and shallow outside basal lateral glabellar lobes, in front of latter wide and very deep. Occipital furrow of moderate width, shallow in middle and almost confluent with depressed neck of central glabellar lobe, growing deep at sides, slightly sinuately curved, its middle portion being arched forwards, the lateral portions backwards. Occipital ring of moderate width, narrowing slightly laterally, strongly arched transversally. Anterior border of cranidium rather narrow, bent obliquely downwards with gently rounded surface, continued on fixed cheeks along anterior branches of facial sutures by narrow, raised ridges. Anterior border furrow of moderate strength (wider and shallower on internal casts than on the surface of the test).

Cheeks sub-triangular, convex, but much lower than globular portion of glabella; their posterior margins curving gently forwards laterally to bases of genal spines. Eye lobes small, high, conical, situated far forward in front of middle of globular portion of glabella. Palpebral lobes very prominent, bent strongly upwards. Eyes strongly convex in both directions, with numerous, rather small, rounded lenses, and supported by relatively high lower eyelids. Posterior borders of cheeks narrow, widening slightly laterally, marked off by deep, rather narrow furrows; their inner portions with narrow, depressed articulating bands along posterior edges. Genal angles furnished with long, rather stout, rounded, and strongly curved spines. Lateral borders rather wide, narrowing anteriorly, rounded, bent downwards; each with a relatively stout, tapering, pointed, down-bent marginal spine near base of genal spine and with traces of another, smaller marginal point just behind posterior branch of facial suture. Lateral border furrows narrow and rather wide on fixed cheeks, but dying out before reaching posterior branches of facial sutures and not quite meeting posterior border furrows — on internal casts sometimes connected with latter by weak depressions. Border furrows on free cheeks rather weak, not connected with axial or preglabellar furrows. Free cheeks very small, bent steeply downwards, sub-triangular, placed on front side of cephalon, almost entirely occupied by the eyes and the borders. Anterior branches of facial sutures directed obliquely inwards, forwards, and downwards, making slightly acute angles with the posterior branches, which run slightly forwards from the eye lobes, but generally curve more outwards before reaching the margins.

Pygidium (excluding spines) sub-triangular in outline, broader than long, with pleuræ of two anterior segments produced into spines. First segment seemingly a thoracic segment which, at least along the inner portions of the pleuræ, has become fused with the front of the pygidium proper (whether the axial ring is free or fused with the »articulating» half-ring of the following segment is not clearly shown in the specimens). Its axial ring rather strongly arched and slightly compressed from the sides, rounded longitudinally, narrow and arched forwards in middle, widening laterally into small, transversally sub-oval nodules, bounded at sides by well-marked, rather narrow axial furrows. Pleuræ of this segment with short, straight, gently convex inner portions, marked by faint median furrows and separated from outer portions by very weak constrictions; outer portions produced into long, depressed semicylindrical, tapering, pointed spines, which are bent gently downwards, and distally curved rather gently backwards. Axis of posterior portion of pygidium (pygidium proper) sub-conical, ill-defined, except anteriorly; composed of 3 rounded axial rings and a short, gently convex terminal piece, separated by well-marked furrows ending at sides in rather deep pits. Anterior axial ring of this portion similar to that of preceding segment with broad, prominent »articulating» half-ring and rather distinct lateral nodules, bounded at sides by distinct, but rather weak, axial furrows. Following axial rings less prominent, with more indistinct lateral swellings, and very indistinctly defined at sides, the axial furrows growing obsolete, or almost obsolete, posteriorly. Side lobes of this portion with one anterior pair of large pleuræ with broad bases and forming long, stout, rounded, divergent spines (imperfectly preserved), which are directed obliquely upwards. Posterior portions of side lobes confluent with bases of spines, unfurrowed, very narrow, rounded, produced postero-laterally into pair of short, triangular points, which are bent straight downwards and invisible when the pygidium is viewed in dorsal aspect.

Test of glabella, except in the furrows, covered with small rounded tubercles. Portions of cheeks inside bounding furrows with similar tubercles and between them small pittings. Test of other portions observed more finely tuberculated or granulated. [On internal casts the tubercles and granules are generally not observable.]

Dimensions. — The dimensions of a medium-sized cranidium are: length along median line between anterior and posterior margins just over 5 mm., width between bases of genal spines approximately 12 mm., longitudinal diameter of globular portion of glabella 6 mm., transversal diameter of do. slightly less, about 5,9 mm., and about equal to the height. Most of the specimens observed are much smaller; in the smallest ones the diameter of the sub-globular portion of the glabella is a little over 2 mm. only. There are, however, also a few much larger ones. In a very large, fragmentary cranidium, the largest observed, the length between the margins is 9 mm. and the width between the bases of the genal spines approximately 20 mm. In most specimens the relation between length and width of the sub-globular portion of the glabella is about the same, but often this portion is comparatively somewhat lower than in the medium-sized cranidium mentioned above, especially in the larger specimens. In one of these its width is 9 mm. and the height a little over 7 mm. In the larger of the pygidia observed, the length of the entire pygidium (including the anterior segment, but not its articulating half-ring) is just over 3 mm., and the width across the bases (in front) of the huge second pair of spines 4,5 mm.

Remarks. — The small sub-globular portion of a glabella which ANGELIN (1854, p. 77, Pl. XXXIX, fig. 6) described and figured as *Deiphon punctatus* n. sp. apparently does not belong to the genus *Deiphon* but to *Sphærocoryphe*. In the old collection in the State Museum of Natural History there are two such globular portions labelled *Deiphon punctatus* ANG. Dalarne, and one of them agrees perfectly with ANGELIN's figure, and is probably the type specimen. In addition to these and numerous other similar fragmentary glabellæ from different localities in Dalarne there are now available several more complete cranidia — from Kallholn and Boda, in the Upsala Museum — which show the typical characters of *Sphærocoryphe*. In one fragmentary specimen showing the hollow, inner surface, one of the free cheeks is attached in position, and of the cheek portion the internal cast and the eye are also preserved. There are also two small pygidia from Kallholn in the Upsala Museum which appear to belong to this species.

TÖRNQUIST (1884, p. 22) has assumed that ANGELIN's type specimen belonged to the same species as the fragmentary cranidia from Gulleråsen (Lissberg) which he (Op. cit., p. 22, Pl. I, figs. 13—14) attributed to *Deiphon Forbesi* BARR., but this is evidently not the case. The latter belong to the genus *Deiphon*, but, as suggested by WIMAN (1907 b, p. 4), apparently to a distinct species, which will be described below (p. 394) as *Deiph. Angelini*. The fragmentary cranidium from the West Baltic Leptæna Limestone recorded by WIMAN (Op. cit.) as *Deiph. punctatus* A. appears to belong to the same species of *Deiphon*.

Sph. punctata seems to occur also in the Kildare Limestone at the Chair of Kildare in Ireland. In the Museum of the Geological Survey of Ireland the writer has seen a small imperfect cranidium from this locality (labelled *Encrinurus sexcostatus*), which shows the globular portion of the glabella and the greater part of one of the fixed cheeks, and which, as far as it is preserved, agrees closely in characters with the cranidia from the Leptæna Limestone. A fragmentary glabella (labelled *Staurocephalus*) from the same locality in the Museum of Practical Geology in London appears also to belong to our species.

Possibly the small fragmentary glabella from the Keisley Limestone at Keisley in England which REED in 1896 (p. 423) hesitatingly referred to *Sphærocoryphe (Hemisphærocoryphe) granulata*, is also referable to *Sph. punctata*. The specimen, which I have had the opportunity to examine, is too fragmentary and too badly preserved to permit a definite determination. There does not, however, at any rate appear to be any reasons to regard it as belonging to *Hemisph. granulata* — which species occurs on a lower stratigraphical horizon (Cf. above, p. 390) — but it seems rather probable to me that it may belong to a species of *Staurocephalus* BARR.

Affinities. — The cranidia from the East Baltic Lyckholm and Borkholm Formations described and figured by SCHMIDT (1881, p. 169, Pl. VIII, figs. 17—19) as *Cheirurus (Sphærocryphe)* cf. *granulatus* ANG. differ very strongly from those of the true *Hemisphærocoryphe granulata* (Cf. above, p. 390). They bear a rather close resemblance to the cranidia of *Sph. punctata*, and seem to represent an allied species. They differ from these in the shape of the bulbous portion of the glabella, which is pressed more forwards and is less strongly constricted below. Further the two anterior pairs of lateral glabellar furrows appear to be represented on internal casts by rounded impressions; the strong spine in front of the genal spine seems to be situated closer to the facial suture and to have a somewhat different direction and there does not seem to be any traces of a second spine or point.

Horizons and Localities. — Upper Leptæna Limestone; Kallholn, Boda, Osmundsberg, Klittberg. Kildare Limestone; Chair of Kildare, Ireland. ?Keisley Limestone; ?Keisley, England.

Genus **Deiphon** Barrande.

Deiphon Angelini Pl. X, figs. 40—42.

?1854. *Deiphon lævis,* Angelin, p. 77, Pl. XXXIX, fig. 5.
1884. *Deiphon Forbesi,* Törnquist p. 22, Pl. I, figs. 13—14.
1907 b. *Deiphon punctatus,* Wiman, p. 4.

Specific Characters. — Glabella in front of basal lateral furrows swollen into a large, convex mass, sub-oval to sub-quadrilateral in outline, widest at about half-way between posterior and anterior margins; the width here somewhat less than the longitudinal diameter; its anterior margin slightly arched forwards, lateral margins slightly arched outwards, posterior margin almost straight, antero-lateral and postero-lateral corners rounded; strongly convex from back to front and overhanging front margin; more gently convex from side to side, but with steep lateral slopes. Anterior two pairs of lateral glabellar furrows entirely obsolete. Neck of glabella very short, depressed, with small, sub-triangular, nodular basal lateral lobes; its middle portion smooth and groove-like, forming a direct continuation of the basal lateral glabellar furrows, which are rather wide, but not deep. Axial furrows narrow and shallow outside occipital ring and basal lateral glabellar lobes, in front of latter of moderate width and outside base of swollen portion of glabella very deep, almost straight, diverging anteriorly, then growing shallower again and curving at first slightly upwards and then steeply downwards and slightly inwards to merge into the well-marked, almost straight preglabellar (or anterior border) furrow. Occipital furrow narrow, nearly transverse and very shallow in middle and almost confluent with depressed neck of central glabellar lobe, growing deep and curving forwards at sides. Occipital ring narrow, scarcely wider in middle than at sides, strongly arched transversally, gently rounded longitudinally. Anterior border of cranidium narrow, flattened, bent downwards, with almost straight anterior margin.

Cheeks (imperfectly preserved) with, apparently, the usual characters found in *Deiphon.*

Test of cranidium, except in the furrows and grooves, covered with small tubercles and granules of different sizes (often not discernible on internal casts).

Dimensions. — In the largest specimen observed by the writer the longitudinal diameter of the swollen portion of the glabella is just under 6 mm., and its greatest width not quite 5,5 mm.

Remarks and Affinities. — The material on which the above description is based consists of several more or less fragmentary cranidia from Lissberg (Gulleråsen) in the Museum of the Geological Survey and one imperfect glabella — reported by WIMAN (1907 b, p. 4) as *Deiph. punctatus* A. — from the West Baltic Leptæna Limestone, in the State Museum of Natural History.

Most of the specimens from Lissberg have already been studied by TÖRNQUIST, who (1884, p. 22, Pl. I, figs. 13—14) attributed them to the Silurian species *Deiph. Forbesi* BARR. (BARRANDE, 1852, pp. 814, 931, Pl. XXXIX, figs. 50—55; 1872, p. 115, Pl. II, figs. 19—20). There are, however, as already suggested by WIMAN (Op. cit.) strong reasons to believe that this Ordovician form represents a distinct species. As far as I know, no other Silurian species of trilobites occur in the Leptæna Limestone. Several have earlier been recorded from this formation, but a better knowledge of the forms has then proved the necessity to remove the Ordovician examples from their previous specific associations. The same is the case, at least to a great extent, as regards Silurian species of trilobites recorded from other Ordovician formations.

As shown above (p. 392), the fragmentary glabella figured by ANGELIN (1854, Pl. XXXIX, fig. 6) as *Deiph. punctatus* does not, as was assumed by TÖRNQUIST and WIMAN, belong to the same species or genus as the specimens now in question, but to *Sphærocryphe*. As regards ANGELIN's species *Deiph. læwis* (ANGELIN, op. cit., p. 77, Pl. XXXIX, fig. 5) which, according to its author, also occurs in the Leptæna Limestone, our knowledge is very scanty. ANGELIN figured only a fragmentary glabella and gave a short, vague diagnosis, and unfortunately the type specimen seems to be lost. It seems quite probable to me that the specimen figured by him was a somewhat incorrectly drawn interior cast — not showing any ornamentation on the surface — of a glabella of the form now in question, but since this is uncertain it appears best to drop ANGELIN's name, which, moreover, is misleading. It appears probable, however, that ANGELIN had seen specimens of the form of *Deiphon* which occurs in the Leptæna Limestone and that he had those in mind when he founded his species — even if neither of his figured specimens belongs to this genus — and, since it appears practical, in order to avoid confusion, to give the Ordovician form, at least provisionally, a specific name, I propose to call it *Deiph. Angelini*.

Unfortunately I am not able to decide definitely in which characters *Deiph. Angelini* differs from *Deiph. Forbesi*. The former is as yet only imperfectly known and I have not had the opportunity to see any specimens of the Bohemian form. BARRANDE's description of this is rather vague and it is impossible to know how far his figures are reliable. There appears, however, to be a difference in the development of the basal lateral glabellar lobes. In the cranidia from the Leptæna Limestone (in which these portions are preserved) the lobes are quite distinctly discernible, though small, and outside them the axial furrows are shallow and narrow. There is nothing in BARRANDE's description indicating that such lobes occur in the Bohemian form or that the axial furrows grow shallow and narrow anywhere in their course. Regarding the latter, it is stated, on the contrary, that they are very distinct and rather deep and that one can easily trace their course from the extremities of the occipital ring and forwards. Nor are the lobes in question drawn in BARRANDE's figures. At the junctions of the occipital and axial furrows there are, however, in some of the figures indications of deep pits which seem to correspond to the deep lateral portions of the occipital furrow, behind the lobes, in our species. It appears very likely that the lobes in question really are developed in the Bohemian species and were overlooked by BARRANDE, but it seems most probable to me that they are still smaller and more depressed than in the Ordovician species. In the Silurian, Gothlandian form which ANGELIN (1854, p. 66, Pl. XXXIV, fig. 7) called *Deiph. globifrons* this is the case. LINDSTRÖM (1885, p. 51) — and SCHMIDT (1907, p. 13) also — believed ANGELIN's species to be identical with *Deiph. Forbesi,* and this appears very probable to me. At any rate there appear to be more reasons to suppose that the Bohemian species would occur in the Silurian of Gothland than in the Leptæna Limestone. In addition to the dissimilarities in the development of the basal lateral glabellar lobes, the cranidia of the Gothlandian form differ, as pointed out by TÖRNQUIST, from those found in the Leptæna Limestone in having the main portion of the glabella more swollen.[1]

Horizon and Localities. — Upper Leptæna Limestone; Lissberg in Gulleråsen. West Baltic Leptæna Limestone; Öland (in boulders).

Family **Phacopidæ** CORDA.

Sub-family **Pterygometopinæ** REED.

Genus **Pterygometopus** SCHMIDT.

Pterygometopus Schmidti. Pl. XI, figs. 27—28.

Specific Characters. — Cephalon semielliptical in outline, about five eights as long as wide, median portion rather flattened, cheeks steeply bent down outside eye lobes with obtusely pointed or narrowly rounded genal angles.

Glabella very weakly convex, except at base where it is rather strongly arched transversally, about twice as long as wide at base, widening anteriorly and expanded in front to more than twice its basal width,

[1] In the specimens examined by the writer this portion is, however, not quite so strongly convex as in ANGELIN's figure, which probably is exaggerated in this respect.

occupying at base about one fourth the entire width of cephalon, anterior margin arched rather strongly forwards, sides gently concave outwards. Frontal lobe of glabella large, more than half the length of entire glabella, transversally sub-rhomboidal in outline, overhanging lateral lobes and indistinctly defined at sides from lateral borders of free cheeks. Anterior lateral glabellar lobes sub-triangular, narrowing proximally, not circumscribed, but with very slight independent convexity (transversally), more than one fourth the length of glabella along axial furrows, and about as long as the following lobes together. Second and basal lateral glabellar lobes oblong, transverse (their width not much greater than their length); second lobes slightly longer within than at axial furrows; basal lobes with outer portions swollen, sub-nodular, and slightly contracted inside these portions. Anterior lateral glabellar furrows slightly sigmoidally curved, originating in axial furrows at about three fifths the length of glabella from base and curving obliquely inwards and backwards, making an angle of about 70° with median line of glabella and an angle of about 45° with the portions of the axial furrows lying behind them; distance between their inner extremities about equal to their length. Second lateral glabellar furrows arising in axial furrows somewhat nearer occipital furrow than anterior lateral furrows, directed obliquely inwards and forwards at an angle of about 65° to median line of glabella, extending rather farther inwards than anterior pair. Basal lateral glabellar furrows about as long as preceding pair, but directed somewhat less strongly forwards, situated about half-way between them and occipital furrow. Axial furrows of moderate strength, curved inwards, concave outwards, very strongly diverging in front of anterior lateral glabellar furrows to pass into lateral border furrows on free cheeks.

Occipital furrow strongly impressed, rather narrow, arched forwards in middle. Occipital ring rather wide in middle, narrower and slightly swollen at sides, strongly arched transversally, gently rounded longitudinally (in middle), higher than glabella on median line. Anterior border furrow narrow and shallow, becoming almost obsolete before reaching axial furrows, marking off a very narrow border or rim between front of glabella and facial suture.

Fixed cheeks with inner portions convex, sloping up to eye lobes; posterior wings very narrow (longitudinally) behind eye lobes, widening laterally and bent steeply downwards. Free cheeks small, sub-triangular, sloping nearly vertically downwards from eye lobes. Eye lobes (broken off in the specimen) parallel to median line of glabella, arched outwards, rather less than half the length of glabella, anteriorly reaching axial furrows at anterior lateral glabellar furrows and with posterior ends opposite basal lateral glabellar furrows. Posterior borders of cheeks narrow and rounded proximally, widening considerably and growing flattened distally, marked off by narrow, sharply impressed furrows. Lateral borders of moderate width, thickened in front adjacent to facial sutures into triangular portions forming continuations of antero-lateral expansions of central lobe — or, if we prefer such a terminology, constituting the outermost parts of the latter — the surface here gently rounded and not marked off from the likewise gently rounded doublure, which is produced internally as a continuous band round the front of the cephalon; posteriorly the borders grow less thick and are each excavated by a weak longitudinal furrow reaching slightly beyond posterior border furrow and dividing the surface into a narrow outer border-rim — which decreases in width posteriorly, where the doublure is sharply deflexed — and a broader, gently rounded inner ridge, which grows wider and flatter posteriorly. Lateral border furrows strongly marked anteriorly, forming direct continuations of the axial furrows, growing very shallow posteriorly. Genal angles (slightly fractured in the specimen) not produced into spines, but narrowly rounded or obtusely pointed. Facial sutures very fine, as usual in the Phacopidæ;[1] anterior branches diverging strongly anteriorly, cutting axial furrows obliquely, in front of latter curving round and continuing parallel with frontal margin completely around anterior end of cephalon, the sutures from the two sides being continuous; posterior branches curving obliquely outwards and forwards behind eye lobes and beyond latter nearly straight outwards and downwards to lateral borders, and then obliquely backwards to cut lateral margins a little in front of level of posterior border furrows.

Surface of glabellar lobes ornamented with tubercles of different sizes — the larger ones sub-equal — most closely set, though not exactly crowded, on the frontal lobe, especially on its anterior and antero-lateral portions (inside the facial sutures), more sparingly distributed on the lateral lobes. Occipital ring and inner portions of cheeks with a few small tubercles. Outer portions of cheeks inside border furrows very finely pitted. Lateral borders and lateral portions of posterior borders smooth.

Dimensions. — The dimensions of the type specimen are: length of cephalon along median line 7,5 mm., width of do. at base 12 mm., length of glabella just over 6 mm., width of front of glabella (between facial sutures) 7 mm., width of glabella at base just over 3 mm.

Remarks and Affinities. — This new species is founded on a single cephalon in the Upsala Museum, which, though not complete, shows most of the characters clearly. The specimen was collected by the late

[1] It appears doubtful whether in the members of this family the »facial sutures» are real open sutures or only vestiges, perhaps lines of weakness along which the test open at the ecdysis. Already BARRANDE (1852, p. 505) has pointed out that in *Phacops* s. lat. BARR. the portions which constitute the cephalon are scarcely ever found detached and that this indicates a difference in the nature of the facial sutures as compared to the normal condition, and with regard to *Dalmanites* s. lat. BARR. he stated (Op. cit., p. 533) that the portions of the cephalon are rarely found detached. In the specimens (belonging to different species and genera) examined by the writer, the sutures have generally the appearance of being in a state of symphysis.

Professor P. T. CLEVE in 1862 and is labelled Osmundsberg. It occurs in a small piece of half-burnt limestone and it is not possible to decide from the appearance whether it is Leptæna Limestone. It seems justifiable, however, to assume that this is the case, as no other kind of limestone occurs at Osmundsberg or in the immediate neighbourhood, excepting some minor occurrences in the slope of the hill, which probably have never been quarried. It is possible, though, that it is from the Lower Leptæna Limestone at Sinksjön (Cf. above, p. 164) and not from the Upper Leptæna Limestone at Osmundsberg proper. As is well known, the genus *Pterygometopus* belongs especially to the lower part of the Ordovician, and therefore one would expect to find it represented in the Lower rather than in the Upper Leptæna Limestone. A few species of the genus occur, however, also in the higher strata of the Ordovician; e. g. *Pt. retardatus* REED (REED, 1914 p. 49, Pl. VIII, figs. 5—7) and *Pt. Brongniarti* PORTL. (REED, 1906, p. 154; MARR 1915, p. 199), and other fossils in the Upsala Museum collected by CLEVE in the same year and labelled Osmundsberg are evidently from the Upper Leptæna Limestone. The characters of the species do not seem to give any clue as to its probable geological age, since it does not seem to be especially closely related to any of the species hitherto described.

Horizon and Locality. — ?Upper Leptæna Limestone; ?Osmundsberg.

Genus **Chasmops** McCOY.

Chasmops Macrourus SJÖGREN. Pl. XI, figs. 22—24.

1851. *Phacops macroura,* SJÖGREN in ANGELIN, Pal. Svec., p. 9, Pl. VII, figs. 3—4.
?1860. *Homalonotus elongatus,* EICHWALD, p. 1410, Pl. LIV, fig. 3.
?1860. *Chasmops macrourus,* EICHWALD, p. 1432.
?1861. *Chasmops conicophthalmus,* ROEMER, p. 70 (pars), Pl. VIII, figs. 2 b—c (non fig. 2 a).
1881. *Phacops (Chasmops) macroura,* SCHMIDT, p. 114, Pl. III, figs. 10 a—b. Pl. IV, fig. 9 (fig. 8?), Pl. X, fig. 19.
? 1881. *Phacops (Chasmops) maxima,* SCHMIDT, p. 112, Pl. III, figs. 11 a—b, Pl. IV, figs. 1—3, 5—7, Pl. X, figs. 17—18, Pl. XI, fig. 13, Pl. XV, figs. 34—35, p. 235, text-fig. 14.
1884. *Phacops (Chasmops) maximus,* TÖRNQUIST, p. 11, Pl. I, figs. 7—8.
1888. *Phacops macroura,* WIGAND, p. 49 (pars?), Pl. VII, figs. 1 b—c (1 a? 1 d?).
? 1888. *Phacops maxima,* WIGAND, p. 47, Pl. VI, figs. 12—13.
1890. *Phacops (Chasmops) macroura,* POMPECKI, p. 25 (pars), Pl. I, figs. 7—8, 11 (figs. 9—10?).
? 1890. *Phacops (Chasmops) maxima,* POMPECKI, p. 26, Pl. I, figs. 12—13 a.
? 1906. *Phacops macroura?,* OLIN, p. 42.
1907a. *Chasmops maximus,* WIMAN, p. 106.
? 1907. *Phacops (Chasmops) maxima,* SCHMIDT, p. 6, text-fig. 2.

Specific Characters. Cephalon broadly sub-oval in outline, its width across bases of genal spines about twice or rather more than twice the length along median line, strongly convex but flattened on top.

Glabella sub-trapezoidal in outline, more than twice as wide in front as at base, its width in front about equal to or greater than length along median line of entire cephalon, flattened on top posteriorly, sloping generally rather gently downwards anteriorly, more strongly antero-laterally. Its front margin in some specimens almost straight or curving slightly backwards at sides, in others very gently arched forwards, in others again arched slightly backwards in the middle; in the vertical plane either almost straight, or — which is ordinarily the case — arched more or less upwards, or straight in middle and sloping downwards at sides. Frontal lobe of glabella large, sub-triangular, about two thirds the length of entire glabella, rapidly narrowing posteriorly to less than one fourth its frontal width; its antero-lateral extensions generally more or less obliquely truncated by the axial furrows — in some specimens more rounded — overhanging lateral lobes and parts of the cheeks. Anterior lateral glabellar lobes without or with slight independent convexity, extending rather more than half along sides of glabella, sub-triangular, their inner sides making angles of about 70° to 85°, their postero-lateral corners almost reaching occipital furrow. Second lateral glabellar lobes represented by small nodules near inner ends of second lateral furrows. Basal lateral glabellar lobes small, though much larger than second ones, sub-triangular, forming the free lateral extremities of a transverse, very slightly rounded, rather narrow band lying in front of occipital furrow. Anterior and second pairs of lateral glabellar furrows strong, not meeting each other, but generally connected by short, weak, longitudinal grooves; anterior pair nearly twice as long as second pair, slightly to rather strongly undulating. Axial furrows rather narrow, not deep, diverging anteriorly, generally bending more strongly outwards in front of lateral extremities of anterior lateral glabellar furrows.

Occipital furrow rather strong. Occipital ring of moderate, nearly uniform width, produced laterally a little outside base of glabella, rather strongly arched transversally, flattened longitudinally. Anterior border of cephalon narrow, arched upwards, its middle portion generally upturned, marked off by distinctly impressed, rather narrow furrow.

Cheeks sub-triangular, their surfaces sloping upwards from axial furrows to eye lobes, outside and in front of latter sloping very steeply downwards, the inner posterior portions, behind the eye lobes, nearly horizontally extended. Eye lobes of regular size, sub-conical, with their posterior ends almost opposite occipital furrow and the anterior ends a little behind middle of glabella. Palpebral lobes very prominent, bent upwards. Eyes strongly convex longitudinally, supported by narrow lower eyelids, which are marked off below by strong furrows. Posterior borders narrow and gently rounded from axial furrows to opposite posterior extremities of eye lobes, then growing flattened and rapidly widening, their posterior margins and the upper margins of the genal spines forming continuous curves. Posterior border furrows rather narrow, deeply impressed. Lateral borders rather wide, flattened, bent steeply downwards. Lateral border furrows wide and shallow, growing narrower and weaker posteriorly, curving upwards at bases of genal spines to meet posterior border furrows. Genal angles produced into long, flattened, broad-based, tapering, pointed spines, directed backwards and very slightly outwards and with the surfaces sloping steeply — sometimes almost vertically — downwards laterally. Anterior branches of facial sutures sub-parallel from eye lobes to antero-lateral corners of glabella, then curving inwards to unite in front, and at first following lower margins of frontal glabellar lobes, but in middle separated from latter by narrow band-like portion; posterior branches slightly sigmoidally curved and running in impressed grooves outwards and downwards from eye lobes to lateral borders, then bending sharply backwards to cut margins nearly opposite lateral extremities of posterior border furrows.

Doublure of cephalon rather wide, flattened, and bent upwards in front of median portion of glabella, at sides narrower and gently rounded.

Pygidium strongly convex, sub-triangular in outline with gently rounded antero-lateral angles; its length about equal to or slightly exceeding the anterior width; its posterior margin behind the five or six last pair of ribs generally bent more or less strongly upwards, and when viewed from behind angulated in centre; the pointed extremity often upturned. Axis moderately convex, its width in front somewhat more than one third the greatest width of pygidium, gently tapering posteriorly to rounded extremity; composed of 16 to 18 axial rings, which grow narrower posteriorly, and a short terminal piece. Axial furrows narrow, distinctly impressed anteriorly, growing weaker posteriorly, and dying out before reaching extremity of axis. Side lobes with a slight flattening in front adjacent to axial furrows then curving steeply downwards laterally with convex surfaces, but generally growing slightly concave near margins anteriorly; with a pair of distally facetted half-ribs on anterior edge, followed first by 16 to 18 pairs of regular ribs — growing successively narrower posteriorly and directed more and more strongly backwards — and then by one narrow, median unpaired rib (or post axial ridge). Interpleural furrows — excepting the hindmost ones, which often are very weak — strongly impressed from axial furrows to inner margin of doublure, then growing suddenly very shallow and bending more strongly backwards, not reaching margins. Pleural furrows weak, scarcely impressed (not discernible in all specimens and not observed on the hindmost pairs of ribs), reaching to inner margin of doublure.

Surface of cephalon and pygidium granulated, except in the furrows, and, in some specimens, having in addition small, rounded tubercles on the glabella, the largest tubercles occurring on the neck of the central lobe. (The tubercles seem to be somewhat larger on internal casts than on the surface of the test.)

Dimensions. — In the largest cephalon found in Macrourus Limestone in Öland and known to the writer, the length along the median line between the anterior and posterior margins is 32 mm. and the width across the genal spines approximately 60 mm.; in two other cephala from Öland the distance along the median lines between the margins seems to have been about 25 mm.; most of the others are considerably smaller. In the largest pygidium from Öland (which is incomplete) the length seems to have been at least 43 mm., and in another fairly large one it seems to have been about 31 mm.

Remarks. — This species was originally founded by SJÖGREN on specimens found in boulders (of Macrourus Limestone) in Öland and it was first figured and briefly described in ANGELIN's work of 1851 (p. 9, Pl. VII, figs. 3—4). SCHMIDT has later on (1881, p. 114, Pl. III, figs. 10 a—b, Pl. IV, figs. 8—9, Pl. X, fig. 19) figured some specimens, found in Öland and in North Germany, which he considered referable to *Ch. macrourus*, and pointed out in what manner he considered this species as differing from his species *Ch. maximus* (SCHMIDT, 1881, p. 112, Pl. III, figs. 11 a—11 b, Pl. IV, figs. 1—3, 5—7, Pl. X, figs. 17—18, Pl. XI, fig. 13, Pl. XV, figs. 34—35, text-fig. 14), which was founded on specimens from the East Baltic Area. [See also WIGAND, 1888, p. 49, Pl. VII, figs. 1 a—d, and POMPECKI, 1890, p. 25, Pl. I, figs. 7—11]. It seems, however, very doubtful to me whether *Ch. maximus* SCHMIDT really is specifically distinguishable from *Ch. macrourus* SJÖGREN; at any rate SCHMIDT's interpretation of the latter species does not give a true conception of its characters. The above description, therefore, based on numerous Ölandian specimens, may be advantageous. It may be worth mentioning that a great part of this material belongs to the old collection in the State Museum of Natural History, and it appears probable that in it there are specimens on which the species was originally founded. I do not know, however, whether the actual type specimens, after which the figures in ANGELIN's work were drawn, are among these, though it seems quite likely; it appears probable that the figures are restorations drawn after several specimens. [The figure of the pygidium shows the characters of the form better than those of the cephalon.]

Specimens closely resembling those from Öland have been found in the Macrourus Limestone in Östergötland at several localities (Ulfåsa, Ask, Motala), at Vikarbyn and Fjecka[1] in Dalarne, and in boulders from the North Baltic Area.[2] According to ANGELIN (Op. cit.), the species occurs at Kinnekulle, and LINNARSSON (1869, p. 33) has also recorded it, though with a mark of interrogation, as found in boulders of Chasmops Limestone at Kinnekulle. In the old collection in the State Museum of Natural History, there are a few pygidia evidently belonging to this species and

[1] The specimens from Fjecka which TÖRNQUIST in 1884 (p. 11, Pl. I, figs. 7—8) attributed to *Ch. maximus* belong apparently to *Ch. macrourus*.

[2] Specimens recorded by WIMAN (1907 a, p. 106) as *Ch. maximus*.

labelled Västergötland, and perhaps these are the specimens on which ANGELIN based his statement. [The boulders mentioned by LINNARSSON seem to consist of a harder limestone than the fragments in which these pygidia occur.] Some cephala found in the Chasmops-beds at Röstånga in Skåne have tentatively been referred to *Ch. macrourus* by OLIN (1906, pp. 28, 42), and, according to several authors, specimens referable to this species have been found in boulders in North Germany.

Ch. macrourus is represented also in the Lower Leptæna Limestone in Dalarne, but only a few pygidia, from Kullsberg, have so far been recognized. These — which are in ISBERG's collection and in the Upsala Museum — agree closely in characters with the pygidia from the Macrourus Limestone.

As already stated, I have much doubt whether *Ch. maximus* SCHMIDT is separable from *Ch. macrourus* SJÖGREN, but, since I have not seen any of the specimens on which SCHMIDT founded his species[1], I am not in a position to decide this question definitely. SCHMIDT's (1881, p. 114) statements regarding the manner in which he considered the cephalon of *Ch. macrourus* to differ from that of his species are as follows: — »Das Kopfschild unterscheidet sich durch stärkere Wölbung der Glabella in allen ihren Theilen und durch geringere Breite derselben, da diese höchstens der ganzen Länge des Kopfschildes gleichkommt. Der Vorderrand des Frontallobus ist nicht geradlinig, sondern bogenformig convex, seine Seitentheile abgerundet, nicht in nach Vorn vorgezogenem Winkel ausgezogen. Dem entsprechend sind auch die Dorsalfurchen gleichmässig gerade. Der Kopfumschlag ist in der Mitte ebenfalls abgeflacht, aber nicht concav, der Vorderrand nicht so stark aufgeworfen wie bei *maxima*. Die Wangenhörner sind steil geneigt, aber nicht vertical gestellt.» — In all these features the cephala observed by the writer vary. Some of them agree closely with SCHMIDT's descriptions of the cephala, from the East Baltic Area, which he referred to *Ch. maximus*, and although I have noticed one or the other of the characters which according to him distinguish *Ch. macrourus* in several specimens, I have seldom seen all of them occurring together in the same specimen. A comparatively strongly convex glabella with forwards convex anterior margin and a relatively narrow frontal lobe may, for instance, have the antero-lateral extremities of the latter more distinctly angulated than another which is flatter, much wider in front, and has the anterior margin straight or arched backwards in the middle — or, a rather strongly convex glabella having a relatively narrow frontal lobe with rounded antero-lateral extremities may have the anterior margin straight or arched backwards in the middle. Moreover, the shape of the antero-lateral exten-

[1] Neither have I had the opportunity to see the specimens referred to *Ch. macrourus* by SCHMIDT and figured by him. I see no reason to doubt that at least those from Öland belong to our species, but it does not seem improbable that among the material on which he based his description there are specimens — found in South Germany — which do not belong here (Cf. below, p. 406).

sions of the frontal lobe and the direction of the anterior portions of the axial furrows may be very different on different sides of the same specimen. To judge from SCHMIDT's statements and figures — of which latter some do not in all respects agree with his description — the East Baltic specimens (»*Ch. maximus*») also vary considerably in most of the features mentioned, and it may be pointed out that the glabella is relatively wider in front in one of the figures which according to him represents the cephalon of *Ch. macrourus*, than in one figure the original of which he unreservedly referred to *Ch. maximus*.

SCHMIDT remarked, however, that the pygidia differ more distinctly than the cephala. His description of the pygidium of his species is as follows (Op. cit., p. 113). »Das pygidium von *P. maxima* ist dreiseitig, wenig länger als breit, am Ende abgestutzt, 15—18-gliedrig. Die Rachis endet ziemlich breit; die Glieder sind bis zum Ende deutlich zu erkennen; sie ist etwa 2 1/2 mal schmäler als das ganze Pygidium. Die Seitenlappen sind nach der Rachis zu schwach gewölbt, fast horizontal, nach den Seiten zu stark abwärts gewölbt (T. X, F. 18). Die Pleuren»(ribs)»verlaufen nicht ganz bis zum Rande, sind breit und flach, ohne erkennbare Mittelfurche. Die vorderen sind schwach nach hinten gebogen, die hinteren, schmäleren, verlaufen der Achse fast parallel. Die hinter dem Rachisende liegende abgestutzte Spitze des Pygidiums ist meist etwas aufgeworfen und selten vollständig erhalten. Die Seitenlappen sind verhältnissmässig selten gleichmässig gewölbt; häufig ist der Eine seitlich eingeknickt, der andere flacher gedrückt als es bei regelmässig ausgebildeten Exemplaren der Fall sein sollte.» Regarding the pygidium of *Ch. macrourus*, he says (Op. cit., p. 115): »Es ist ebenfalls dreieckig, ungefär ebenso breit wie lang, endet aber immer spitz und die Seitenlappen fallen gleichmässig seitwärts ab (T. X, F. 19). Auch ist die Zahl der Rachisglieder fast constant 18 und die Rachis selbst verschmälert sich stärker nach dem hinteren Ende zu».

In the pygidia of *Ch. macrourus* seems the relation between length and width to vary a little, but, at least in some, the length is greater than the frontal width. In the shape of the axis most of those observed agree with the figures given by SCHMIDT as representing the pygidium of *Ch. maximus*, but variations do occur, and in some the axis grows relatively narrower posteriorly. 18 axial rings and pairs of regular ribs seem most often to be developed, but I have seen well-preserved specimens with 16 or 17 only, and to judge from SCHMIDT's figures 18 is the most usual number also in the pygidia which he referred to *Ch. maximus*. That he had not seen any interpleural furrows in the latter may depend on their state of preservation. Moreover, it seems as if he had not observed these furrows in the specimens which he referred to *Ch. macrourus* either, and, as mentioned above (p. 401), they are not visible in all the specimens examined by the writer. The difference in the curvature of the side lobes may also depend upon the different states of preservation.

In the pygidia from the Macrourus Limestone which do not appear to have been pressed, the side lobes are only slightly flattened just in front adjacent to the axial furrows. I have, however, noticed several specimens which obviously are deformed by pressure, and which in the curvature of these portions agree with the description of *Ch. maximus*, and, to judge from SCHMIDT's statements, it appears as if the East Baltic specimens, which he referred to this species, were generally pressed.

Finally, as regards the shape of the hindmost portion of the pygidium, it appears probable that the abrupt posterior truncation shown in some of these East Baltic specimens is also the result of pressure. It seems as if only relatively few of the pygidia which SCHMIDT referred to *Ch. maximus* had the posterior end preserved, and, to judge from his figures, as if it was not abruptly truncated in all of these, but rather differently shaped in different specimens. The pygidia from the Macrourus Limestone vary also considerably in the character of the posterior end. In the typical pygidia of our species the posterior margin behind the last pairs of pleuræ is bent more or less steeply upwards[1] — in posterior aspect angulated in the centre — and the posterior slope from the end of the axis is rather slight. There are, however, several specimens in which the margin is not, or only slightly, bent upwards posteriorly (there are also intermediate forms). In these the surface slopes rather steeply downwards either all the way from the end of the axis to the extremity of the pygidium, or, in specimens having the margin bent slightly upwards, to near the extremity, where the slope then becomes more gentle. In the pygidia of this type the extremity appears very acutely pointed when the specimen is seen in dorsal aspect. The pygidium from Öland figured from behind by SCHMIDT (Op. cit. Pl. X, fig. 19) seems to be of this type, and it appears probable that the other pygidia which he referred to *Ch. macrourus*, were similar. In the type of pygidia first mentioned the tip is also, in well-preserved specimens, acutely pointed, but it is generally bent obliquely upwards, and when the specimen is viewed in dorsal aspect, the end of the pygidium appears therefore rather obtusely pointed or even truncated. In some specimens the test is thickened just at the upturned tip, and, if it is removed here, the end of the pygidium appears much more truncated both in dorsal and in posterior aspect. Pressure might probably cause a still more distinct truncation of the extremity, and in the material from Öland there is a pygidium with rather badly preserved surface and obviously deformed by pressure, which in this feature agrees closely with those of SCHMIDT's figures that really show an abrupt posterior truncation.

WIGAND (1888, p. 49, Pl. VII, figs. 1 a—d, p. 47, Pl. VI, figs. 12—13) and POMPECKI (1890, p. 25, Pl. I, figs. 7—11, p. 26, Pl. I, figs. 12—13 a) have described and figured specimens found in boulders in North

[1] That this is the case in the type specimen of the pygidium is indicated in ANGELIN's (1851, Pl. VII. fig. 3) figure.

Germany, some as belonging to *Phacops* (*Chasmops*) *macrourus* SJÖGR. others as belonging to *Phacops* (*Chasmops*) *maximus* SCHMIDT[1], but their statements partly confirm the supposition that SCHMIDT's species is identical with SJÖGREN's. WIGAND (Op. cit., p. 49) states that the cephala which he considers referable to *Ch. macrourus* differ rather distinctly (»sich ziemlich scharf — — — unterscheiden lassen») from those which he attributes to *Ch. maximus*. To judge from his description of the former — according to which the glabella is strongly convex in all parts and has, except in one specimen, a length exceeding the width of the frontal lobe — it appears, however, doubtful whether they are referable to our species, and, regarding the pygidia, he (Op. cit. p. 50) remarks: »Die Pygidien von *Ph. macroura* zeigen eine grosse Ähnlichkeit mit denen von *Ph. maxima*, so dass eine Anzahl der Funde nicht sicher einer von diesen beiden Arten zugetheilt werden kann.» Of the specimens attributed to *Ch. macrourus* by POMPECKI, the pygidia — which, according to his description and figures, have the side lobes more or less gently convex, and are considerably wider than long — do not seem to belong to this species. As to the cephala, of which at least those figured appear to belong to *Ch. macrourus*, some do not, according to his statements and figures, strictly agree with SCHMIDT's description of this species, but have the anterior margin of the glabella straight to slightly concave in the middle, thus agreeing in this feature with his description of *Ch. maximus*.

Whether *Ch. macroura* SALTER (1864 a, p. 37, Pl. IV, figs. 18—23) is identical with SJÖGREN's species, I am not in a position to decide, since I have not seen any of the British specimens. To judge from the descriptions and figures available, there seem to be some differences.

Horizons and Localities. — Lower Leptæna Limestone; Kullsberg in Dalarne. Macrourus Limestone; Öland (in boulders), Östergötland (Ask, Ulfåsa, Motala), Dalarne (Fjecka, Vikarbyn), Upland (in boulders from the North Baltic Area). Chasmops Beds[2]; Västergötland (Kinnekulle?), ?Skåne (Röstånga). ?Jewe Formation, Kegel Formation; ?East Baltic Area. North Germany (in boulders).

Chasmops angulatus n. sp. Pl. XI, figs. 25—26.

Specific Characters. — Cephalon semi-elliptical in outline, its width across bases of genal spines nearly twice the length along median line, median portion somewhat flattened, outer portions steeply bent down.

[1] It may be worth mentioning that in the pygidia figured by them as belonging to *Ch. maximus* the extremities are not preserved.

[2] I do not know whether the specimens from Västergötland are from beds corresponding in age to the Macrourus Limestone of Öland etc. or, possibly, from a lower part of the Chasmops Limestone; those from Skåne are from the upper part of the Chasmops Beds.

Glabella bounded at sides by strongly defined axial furrows, flattened convex, sloping rather gently downwards anteriorly, sub-trapezoidal in outline, subtruncate in front and with almost straight sides, nearly twice as wide at front end as at base; its width in front greater than the length. Frontal lobe of glabella large, about five eighths the entire length of glabella, sub-triangular, rapidly narrowing posteriorly to less than one fourth its frontal width. Anterior lateral glabellar lobes gently convex, raised above frontal lobe, extending about half along sides of glabella, sub-triangular, their inner angles, where they unite with the central lobe, about 85°, the postero-lateral angles, at axial furrows, about 65°. Second lateral glabellar lobes represented by small, very indistinct nodules near inner ends of second lateral glabellar furrows. Basal lobes represented by faint swellings at the ends of a transverse, rather narrow, rounded band lying in front of occipital furrow. Anterior and second pairs of lateral glabellar furrows strong, very slightly undulating, not connected with each other; anterior pair about one and a half times as long as second pair.

Occipital furrow of moderate width, not strongly impressed. Occipital ring rather wide in middle, somewhat narrower at sides, produced laterally a little beyond base of glabella, strongly arched transversally, higher than glabella on median line with the surface sloping from posterior edge to occipital furrow. Cephalic border (its anterior portion imperfectly preserved) flattened with the surface sloping obliquely downwards towards the sides, relatively wide in front, growing narrower posteriorly and continued as narrow rims along lower edges of genal spines; distinctly, though not sharply, defined in front, more indistinctly defined posteriorly.

Cheeks sub-triangular in outline, strongly convex, the surface sloping up from all sides to the relatively small eye lobes (incompletely preserved), which are situated above level of glabella, rather close to latter with their posterior ends nearly opposite posterior extremities of anterior lateral glabellar lobes and their anterior ends a little behind middle of glabella. Posterior borders of cheeks gently rounded, rather narrow, almost parallel-sided, and nearly horizontally extended from axial furrows to opposite lateral extremities of eye lobes, then growing flatter, bending strongly downwards and gently backwards, and gradually increasing in width to bases of genal spines; their posterior margins meeting upper (inner) margins of genal spines at obtuse angles. Posterior border furrows strong, not reaching lateral borders, but ending opposite upper margins of genal spines. Genal spines (imperfectly preserved) relatively narrow at base, very gradually tapering posteriorly, with flattened surfaces sloping steeply downwards to the border-rims. Anterior branches of facial sutures sub-parallel and running on inner walls of narrow, shallow grooves from eye lobes to anterior border, then curving obliquely inwards across border to unite in front; posterior branches very slightly sigmoidally curved and running on posterior walls of rather deep and broad grooves — which grow weaker adjacent to borders — outwards and downwards to lateral borders, then bending sharply backwards to cut lateral margins at level of occipital furrow. Doublure of free cheeks narrow, increasing in width anteriorly, rounded. The portion of the doublure lying in front of the glabella (which is very imperfectly preserved) appears to have been more flattened or angulated.

Surface of cephalon, except in the furrows, very finely granulated, and on most portions — not on anterior and lateral borders and genal spines — ornamented also with sparsely distributed, rather small, and indistinctly defined tubercles.

Dimensions. — The dimensions of the cephalon described are approximately: length along median line 18 mm.; width across bases oi genal spines 34,5 mm., length of glabella 13 mm., frontal width of do. 15,5 mm., basal width of do. 8 mm.

Remarks and Affinities. — This new species is founded on a single cephalon in the State Museum of Natural History, which, though fragmentary, shows the chief characters distinctly. It does not appear to be especially closely related to any species of *Chasmops* previously described, and therefore a detailed comparison with any of them seems unnecessary.

Horizon and Locality. — On the label accompanying the specimens described, Dalarne is the only locality-name given. The specimen occurs in a small piece of limestone, not containing any other fossils, and it is not possible to decide from the appearance of the rock whether it is from the Upper or from the Lower Leptæna Limestone, though the latter alternative appears the more probable.

Genus **Josephulus** n. gen.

Genotype: **Josephulus gracilis** n. sp.

Josephulus gracilis n. sp. Pl. XI, fig. 21.

Specific Characters. — Cephalon convex, sub-semielliptical in outline; its length along median line about two thirds the width at base; genal angles produced into slender, tapering spines (their entire length not known).

Glabella strongly convex from back to front, bent down anteriorly, more gently convex from side to side posteriorly, more than one and a half times as long as wide at base, sub-clavate in outline, expanding anteriorly to about twice its basal width; base about one third entire width of cephalon; anterior margin arched forwards; sides concave. Three pairs of short, deep lateral glabellar furrows present, beginning in axial furrows at about equal distances apart and extending about equally far inwards; anterior pair beginning in axial furrows at about one third the length of glabella from occipital furrow, directed rather slightly forwards; following pairs almost transverse in direction; basal pair situated closer to occipital furrow than to preceding pair. Frontal glabellar lobe large, transverse, sub-pentagonal in outline, more than half the length of glabella; its antero-lateral portions curved steeply downwards and acutely pointed at the extremities. Lateral glabellar lobes small; anterior pair somewhat shorter at axial furrows than within; second pair sub-quadrangular; basal pair (badly preserved) apparently extending somewhat farther towards the sides than preceding pair and with the outer portions very slightly swollen and sub-nodular. Axial furrows deep, of moderate width, curved inwards, concave outwards, strongly divergent in front of second lateral glabellar lobes. Occipital furrow of moderate strength, almost transverse. Occipital ring of moderate width, slightly narrowing towards the sides, rather strongly arched transversally, gently rounded longitudinally. [Whether there is an anterior border to the cranidium, is not observable on the specimen.]

Cheeks (only the fixed portions known) sub-triangular, strongly convex in both directions, slightly elevated above axial furrows and curving steeply downwards anteriorly and laterally. Eye lobes (not preserved) apparently small, situated far forwards, in front of the anterior lateral glabellar lobes, a little below the highest points of the cheeks, with their anterior extremities close to the axial furrows, and marked off within by narrow palpebral furrows (traceable on one side of the specimen). Posterior borders narrow, rounded, and almost horizontally extended from axial furrows to level of antero-lateral extremities of frontal glabellar lobe, then growing flatter, bending steeply downwards and slightly increasing in width to bases of genal spines. Lateral borders on fixed cheeks of moderate width, gently rounded. Posterior and lateral border furrows narrow, sharply impressed, meeting at slightly acute angles. The course of the facial sutures is only partly observable on the specimen; the anterior branches seem to have run nearly straight forwards from the eyes, very close to the antero-lateral extremities of the frontal glabellar lobe, but they do not cut the latter; the posterior branches curve outwards, downwards, and very slightly backwards to the lateral borders — or to near the borders — then they appear to bend strongly backwards and to cut the margins a little in front of the bases of the genal spines.

Portions of fixed cheeks in front of posterior border furrows marked by rather small rounded pits; the interspaces between the pits and the other portions of the cranidium, excepting the furrows, rather finely granulated.

Dimensions. — The dimensions of the cranidium examined are: distance along median line between posterior cephalic margin and anterior margin of glabella 4 mm., width across bases of genal spines 6 mm.

Remarks and Affinities. — The above description is drawn up from a single, small cranidium from Kallholn in the Upsala Museum, which apparently not only represents a new species but a new genus as well.[1] The form, which I propose to call *Josephulus gracilis*, appears to be referable to the family Phacopidæ, but since it does not show any close resemblance to any of the previously described members of this family, and since the course of the sutures in front of the glabella is not observable on the specimen, this point cannot be decided definitely. Its affinities seem, however, to be with *Pterygometopus* and *Chasmops* rather than with any other genera hitherto described, and I have therefore provisionally placed it in the sub-family Pterygometopinæ of the family Phacopidæ. The glabella resembles rather closely several species of *Pterygometopus* in its shape and, except in the direction of the anterior lateral furrows, in its lobation also, but it is distinctly defined at the antero-lateral corners — as in *Chasmops* and in most of the other Phacopidæ — and not cut by the anterior branches of the facial sutures. As mentioned in the description of the species, the eye lobes are apparently small and situated far forward, which is contrary to the case in *Pterygometopus* and *Chasmops,* but, as illustrated in other groups of Phacopids, rather closely related forms — even such as appear to belong to the same genus — can in this respect show great differences (Cf. REED, 1905; WEDEKIND 1911, 1914).

It is conceivable that the small pygidium from Boda described above (p. 210; see also Pl. V, fig. 62) as »*Cyphaspis*»? sp. ind. d. belongs to this new species. As already pointed out, it recalls in some characters certain species of *Pterygomotopus*.

Horizon and Locality. — Upper Leptæna Limestone; Kallholn.

[1] As a diagnosis of the genus based on our present knowledge of the form necessarily would be very inadequate, I have found it better not to give one.

Palæontological Evidence on the Age of the Leptæna Limestone in Dalarne, as furnished by the Trilobites.

The Leptæna Limestone occurs in the Palæozoic district north of the lake of Siljan in Dalarne as isolated masses, generally forming small elongated hills or ridges in the landscape. On account of this mode of occurrence, and because of the considerable tectonic disturbances that have taken place in this area, and of the peculiar fauna, dissimilar to that of any other Swedish beds, the correlation of the Leptæna Limestone to other strata has been a matter of much dispute. In 1884 (p. 121) STOLPE suggested that these masses of Leptæna Limestone might be compared to some sort of coral insels, and in the following year NATHORST (1885, p. 558) brought forward the same hypothesis expounding the facts speaking in favour of the Leptæna Limestone being old coral reefs. Everything taken into account, it seems reasonable to assume that the masses of Leptæna Limestone actually are old reef-buildings, though perhaps not coral reefs.[1] However, this is not the occasion to enlarge upon the reasons in favour of this theory, or to enter on a discussion of the question which organisms have played the most prominent part as reef-builders, nor to give an account of certain other theories put forth to explain the nature of these limestone masses.[2]

In a geological guide to the Nittsjö district published several years ago (1910), the present writer put forth the opinion, prevailing at that time, that the Leptæna Limestone »reefs» were formed contemporaneously with the Brachiopod Shales in other districts of Sweden, and with Etage F (the Lyckholm (F_1) and Borkholm (F_2) Formations) of the East Baltic Area, and that in the district in question it was substituted by the so called Klingkalk (»clinc-limestone»), or by Brachiopod Shales. When

[1] Naturally, Leptæna Limestone is not everywhere the same as »reef» limestone. The »Encrinite» limestones which forms the substratum of the »reefs», cannot be regarded as »reef» rocks, and the red shales which often occur in what appears to be the highest parts of the younger »reefs», are also regarded as belonging to the Leptæna »Limestone».

[2] Summaries of the different opinions that have been brought forward concerning the geological age and the nature of the Leptena Limestone, have been given by MOBERG (1910, pp. 95—102) and TÖRNQUIST (1919).

publishing that work I had collected a certain amount of fossils in the Leptæna Limestone, but as yet I had made no close study of any group of these fossils. Soon afterwards, however, when I had begun to study the trilobites more in detail, and had had the opportunity to make further collections of fossils at different localities, I found that, though part of the Leptæna Limestone was approximately of the geological age mentioned, another part obviously was formed at an earlier period. The same opinion has later been brought forward by RAYMOND and ISBERG (Cf. also TÖRNQUIST 1919). RAYMOND (1916 d, Pl. VIII) seems to regard the lower part of the Leptæna Limestone as homotaxial to the upper part of the Trinucleus Shales, and ISBERG (1917, p. 231) summarizes his opinion of the Leptæna Limestone in Dalarne as follows: »that it is a fossil reef-building formed during the Trinucleus- and Harpes-stages, that certain reefs have been interrupted rather soon in their growth, while, on the other hand, others have had a long period of development, and that the klingkalk is equivalent with part of the Leptæna Limestone only. Hence it follows also that the contact of the limestone with divers younger beds is of a primary nature and is — generally, at least — to be attributed neither to exogeneous nor to endogeneous movements.» (Translated).

I cannot, however, quite agree with either of these authors. On the contrary I am inclined to believe 1) that the Leptæna Limestone »reefs» were formed during two different periods interrupted by a time when no reef-building took place; 2) that the older reefs (the Lower Leptæna Limestone) are to be correlated with the upper part of the Chasmops Beds and, perhaps, with the lowest part of the Trinucleus Beds also, the reef-building having ceased, however, before the Black Trinucleus Shales were deposited; 3) that the younger reefs (the Upper Leptæna Limestone) are approximately of the same geological age as the Brachiopod Shales, the Klingkalk, and Etage F. The West Baltic Leptæna Limestone, as well as the Keisley Limestone in England, the Kildare Limestone in Ireland, and KIÆR's Etage 5 in Norway, correspond apparently to the Upper Leptæna Limestone in Dalarne, whereas at least one of the boulders of Leptæna Limestone known from the North Baltic area (Cf. below p. 419) seems to be of the same age as Lower Leptæna Limestone.

The hills Kallholn, Osmundsberg, Lissberg, and the hill on which Boda church is situated, are built of Upper Leptæna Limestone; reef-like masses of this limestone occur also at Vestanå, Arfvet, Unskarsheden, Östbjörka, Klittberg (north-east of Boda church), and in several other places.[1] The hill Kullsberg is built up of Lower Leptæna Limestone, and other hills or ridges of this limestone occur at Furudal, in the village

[1] Here are mentioned only the localities occuring in the list showing the distribution of the species of trilobites (p. 413); particulars of the site of the localities will be found in TÖRNQUIST's work of 1883, in a paper of 1910 by the present writer, and in the topographical map-sheet Mora.

List of Species described

showing their distribuation in the Leptæna Limestone of Dalarne.[1]

* indicates that the locality where this species has been found, is not known. ± ∓ indicate that the specimens in question have either (±) been found only in the lowest beds, thin-banded limestones interstratified with shales, or (∓) both in these and in the »reef-rock» proper.	Kallholn	Osmundsberg	Boda	Unskarsheden	Vestanå	Lissberg	Arfvet	Dalbyn	Klittberg	Östbjörka	Kullsberg	Furudal	Amtjärn	Sätra	Sinksjön	**Upper Lept. Lmst.**	**Lower Lept. Lmst.**
Remopleurides latus OLIN v. *kullsbergensis* n. v.	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	+
Remopleurides emarginatus TQT	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	+	–
Remopleurides dalecarlicus HOLM in Mus.	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–
Remopleurides latifrons HOLM in Mus.*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	?	–
Remopleurides minimus n. sp.	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–
Telephus Wegelini ANG.?	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	+	–
Brachyaspis? Leptænarum n. sp.	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–
Stygina angustifrons n. sp.	–	+	+	–	–	–	–	–	–	–	–	–	–	–	–	+	–
Illænus gigas HOLM	–	–	–	–	–	–	–	–	–	+	+	–	+	–	+	–	+
Illænus cf. *gigas* HOLM	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	+
Illænus Wimani n. sp.	–	–	–	–	–	–	–	–	–	–	+	+	–	–	–	–	+
Illænus Roemeri VOLB.	+	+	+	–	–	–	+	–	+	–	–	–	–	–	–	+	–
Illænus fallax HOLM	–	–	–	–	–	–	–	–	–	+	+	+	+	+	+	–	+
Illænus dalecarlicus n. sp.	+	+	–	?	–	–	–	–	–	–	–	–	–	–	–	+	–
Illænus cf. *dalecarlicus*	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–
Illænus Linnarssoni HOLM	+	+	+	+	–	+	?	–	+	–	–	–	–	–	–	+	–
Illænus oviformis n. sp.	+	+	+	–	–	–	–	–	–	+	–	–	–	–	–	+	–
Illænus avus HOLM	–	+[2]	–	–	–	–	–	–	–	+	+	+	∓	–	+	+[2]	∓
Illænus avus HOLM v. *lissbergensis* n. v.	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	+	–
Illænus cf. *parvulus* HOLM	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–
Illænus sp. ind. a	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	+
Illænus sp. ind. b	–	–	–	–	–	–	–	–	–	–	+	–	–	+	–	–	+
Illænus sp. ind. c	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	+	–
Bumastus nudus ANG.	–	+	–	–	–	+	–	–	–	–	–	–	–	–	–	+	–
Bronteus laticauda WAHLNB.	+	+	+	+	+	–	–	+	+	–	–	–	–	–	–	+	–
Holotrachelus punctillosus TQT	+	+	+	+	–	–	–	+	–	+	–	–	–	–	–	+	–
Pharostoma obtusa MCCOY (= *Leptænarum* TQT)[3]	+	+	+	–	–	+	+	–	–	–	–	–	–	–	–	+	–

[1] In this list I have omitted a few localities mentioned in the preceding chapter, these localities being represented only by one or two determinable species of trilobites in some collection or other. As regards most of them I do not know exactly which places are meant, since the locality names given on the labels accompanying the specimens are names of villages, and within some of these villages, at least, Leptæna Limestone has, or may very likely have been exposed in more than one place. — As to the occurrences of Lower Leptæna Limestone at Östbjörka and Osmundsberg see p. 416.

[2] Cranidia and pygidia of the short type only (Cf. above, pp. 126, 131).

[3] Cf. p. 423.

* indicates that the locality where this species has been found, is not known. ± ∓ indicate that the specimens in question have either (±) been found only in the lowest beds, thin-banded limestones interstratified with shales, or (∓) both in these and in the »reef-rock» proper.	Kallholn	Osmundsberg	Boda	Unskarsheden	Vestanå	Lissberg	Arfvet	Dalbyn	Klittberg	Östbjörka	Kullsberg	Furudal	Amtjärn	Sätra	Sinksjön	**Upper Lept. Lmst.**	**Lower Lept. Lmst.**
Pharostoma foveolata TQT.	−	−	−	−	−	−	−	−	−	−	+	+	+	−	+	−	+
Calymene cf. (*senaria* v.) *Stacyi* SCHMIDT	−	−	−	−	−	+	−	−	−	−	−	−	−	−	−	+	−
Proëtus modestus TQT.	+	+	+	+	−	+	−	−	−	+	−	−	−	−	−	+	−
Proëtus remotus n. sp.	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−	+	−
Proëtus convexus n. sp.	+	−	+	+	−	+	−	−	−	+	−	−	−	−	−	+	−
Proëtus kullsbergensis n. sp.	−	−	−	−	−	−	−	−	−	−	+	−	−	−	−	−	+
Proëtus parvigena n. sp.	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−	+	−
Proëtus pentagonoides n. sp.	+	+	−	+	−	−	−	−	−	−	−	−	−	−	−	+	−
Proëtus Ainæ n. sp.	−	−	−	−	−	+	−	−	−	−	−	−	−	−	−	+	−
Proëtus sp. ind. a	+	−	−	+	−	−	−	−	−	−	−	−	−	−	−	+	−
Proëtus sp. ind. b	−	−	−	−	−	−	−	−	−	−	+	−	−	−	−	−	+
Proëtus? sp. ind. c	−	−	−	−	−	−	−	−	−	+	−	−	−	−	−	+	−
Proëtus sp. ind. d	+	−	−	−	−	−	−	−	+	−	−	−	−	−	−	+	−
Proëtus? sp. ind. e	−	−	−	−	−	−	−	−	+	−	−	−	−	−	−	+	−
»*Phaëtonides*» sp. ind.	−	−	−	−	−	+	−	−	−	−	−	−	−	−	−	+	−
Isbergia planifrons n. sp.	+	+	?	−	−	−	−	−	−	−	−	−	−	−	−	+	−
Isbergia parvula n. sp.	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−	+	−
Cyphaspis trigoda n. sp	−	−	+	−	−	−	−	−	+	−	−	−	−	−	−	+	−
Cyphaspis Holmi n. sp.	−	−	−	−	−	−	−	−	−	+	−	−	−	−	−	+	−
Törnquistia Nicholsoni REED	+	−	+	−	−	−	−	−	−	−	−	−	−	−	−	+	−
Törnquistia altifrons n. sp.	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−	+	−
Törnquistia depressa n. sp.*	−	?	−	−	−	−	−	−	−	−	−	−	−	−	−	+	−
Törnquistia cf. *depressa* n. sp.	−	−	−	−	−	−	−	−	−	−	+	−	−	−	−	−	+
»*Cyphaspis*» sp. ind. a	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−	+	−
»*Cyphaspis*» sp. ind. b	+	−	+	−	−	−	−	−	−	+	−	−	−	−	−	+	−
»*Cyphaspis*» sp. ind. c	−	−	−	−	−	−	−	−	−	+	−	−	−	−	−	?	−
»*Cyphaspis*»? sp. ind. d.	−	−	+	−	−	−	−	−	−	−	−	−	−	−	−	+	−
Harpes costatus ANG.	+	+	−	+	−	−	−	−	−	−	−	−	−	−	−	+	−
Harpes Wegelini ANG.	+	−	−	−	−	−	+	−	−	−	−	−	−	−	−	+	−
Ampyx foveolatus ANG.*	−	−	−	−	−	−	−	−	−	−	−	−	−	−	?	−	+
Ityophorus undulatus n. sp.	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−	+	−
Acidaspis evoluta TQT.	+	−	−	?	−	+	−	−	−	+	−	−	−	−	−	+	−
Acidaspis Clevei n. sp.	−	−	−	−	−	−	+	−	−	−	−	−	−	−	−	+	−
Acidaspis laticapitata n. sp.	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−	+	−
Acidaspis bispinosa MCCOY	−	+	−	−	−	−	−	−	−	−	−	−	−	−	−	+	−
Acidaspis sp. ind. a	−	−	−	−	−	−	−	−	−	−	−	−	+	−	−	−	+
Acidaspis? sp. ind. b	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−	+	−
Trochurus Törnquisti GÜRICH	+	+	+	−	−	−	−	−	−	−	−	−	−	−	−	+	−
Dicranogmus æqualis TQT.	−	−	−	−	−	+	−	−	−	−	−	−	−	−	−	+	−

* indicates that the locality where this species has been found, is not known. ± ∓ indicate that the specimens in question have either (±) been found only in the lowest beds, thin-banded limestones interstratified with shales, or (∓) both in these and in the »reef-rock» proper.	Kallholn	Osmundsberg	Boda	Unskarsheden	Vestanå	Lissberg	Arfvet	Dalbyn	Klittberg	Östbjörka	Kullsberg	Furudal	Amtjärn	Sätra	Sinksjön	**Upper Lept. Lmst.**	**Lower Lept. Lmst.**
Platylichas planifrons ANG.	−	−	−	−	−	−	−	−	−	−	+	+	+	−	+	−	+
Platylichas Wegelini HOLM in Mus.	−	−	−	−	−	−	−	−	−	−	−	+	−	−	?	−	+
Platylichas nasutus WIGAND	−	−	−	−	−	−	−	−	−	−	−	−	±	−	−	−	±
Platylichas robustus n. sp.	−	−	−	−	−	−	−	−	−	−	+	−	−	+	−	−	+
Platylichas bottniensis WIMAN?*	−	−	−	−	−	−	−	−	−	−	?	−	−	−	−	−	?
Platylichas cicatricosus LOVÉN	−	−	−	−	+	+	−	−	−	−	−	−	−	−	−	+	−
Platylichas latus TQT	−	−	−	−	−	−	−	−	−	−	+	+	−	+	−	−	+
Platylichas angulatus n. sp.	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−	+	−
Platylichas sp. ind. a	−	−	−	−	−	+	−	−	−	−	−	−	−	−	−	+	−
Platylichas sp. ind. b	−	−	−	−	−	+	−	−	−	−	−	−	−	−	−	+	−
Platylichas? sp. ind. c	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−	+	−
Platylichas sp. ind. d	−	−	−	−	−	−	−	−	−	−	+	−	−	−	−	−	+
Dicranopeltis elegans TQT	−	+	?	−	−	+	−	−	−	−	−	−	−	−	−	+	−
Lichas laciniatus WAHLNB.	−	+	+	−	−	+	−	−	−	−	−	−	−	−	−	+	−
Lichas affinis ANG.	+	+	+	−	?	+	−	−	−	+	−	−	−	−	−	+	−
Lichas? sp. ind.*	−	−	−	−	−	−	−	−	−	−	?	−	−	−	−	−	?
Amphilichas dalecarlicus ANG.	+	−	+	−	−	−	+	−	−	+	−	−	−	−	−	+	−
Amphilichas Wahlenbergi n. sp.	+	+	?	−	−	?	+	−	−	−	−	−	−	−	−	+	−
Amphilichas latifrons n. sp.	+	?	−	−	−	−	−	+	−	+	−	−	−	−	−	+	−
Amphilichas atavus n. sp.	−	−	−	−	−	−	−	−	−	−	−	−	+	−	−	−	+
Amphilichas parvulus n. sp.	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−	+	−
Amphilichas lineatus ANG.	+	+	+	+	−	+	−	−	−	−	−	−	−	−	−	+	−
Amphilichas periformis n. sp.	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−	+	−
Isocolus Sjögreni ANG.	+	+	+	−	−	−	+	−	−	+	−	−	−	−	−	+	−
Encrinurus striatus ANG.	+	+	+	+	−	+	−	−	−	−	−	−	−	−	−	+	−
Cybele brevicauda ANG.	−	+	−	−	−	−	−	−	−	−	−	−	−	−	−	+	−
Cybele cf. *revaliensis* SCHMIDT	−	±	−	−	−	−	−	−	−	−	−	−	−	−	−	−	±
Cheirurus Clasoni TQT	+	+	−	+	+	+	+	−	−	−	−	−	−	−	−	+	−
Cheirurus punctatus ANG.*	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	+	−
Cheirurus Törnquisti n. sp.	−	−	+	−	−	−	−	−	−	−	−	−	−	−	−	+	−
Cheirurus glaber ANG.*	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	+	−
Cheirurus sp. ind. a	−	−	−	−	+	−	−	−	−	−	−	−	−	−	−	+	−
Cheirurus sp. ind. b	−	−	+	−	−	−	−	−	−	−	−	−	−	−	−	+	−
Cheirurus sp. ind. c	−	−	−	−	−	−	−	−	−	+	−	−	−	−	−	+	−
Ceraurus latifrons n. sp.	−	−	−	−	−	−	−	−	−	−	+	−	±	−	−	−	∓
Pseudosphærexochus granulatus ANG.	−	−	−	−	−	−	−	−	−	−	+	+	+	+	−	−	+
Pseudosphærexochus conformis ANG.	+	−	+	−	−	−	−	−	−	−	−	−	−	−	−	+	−
Pseudosphærexochus conformis ANG. v. *major* n. v.	+	−	−	−	−	−	+	−	−	−	−	−	−	−	−	+	−

* indicates that the locality where this species has been found, is not known. ± ∔ indicate that the specimens in question have either (±) been found only in the lowest beds, thin-banded limestones interstratified with shales, or (∔) both in these and in the »reef-rock» proper.	Kallholn	Osmundsberg	Boda	Unskarsheden	Vestanå	Lissberg	Arfvet	Dalbyn	Klittberg	Östbjörka	Kullsberg	Furudal	Amtjärn	Sätra	Sinksjön	**Upper Lept. Lmst.**	**Lower Lept. Lmst.**
Pseudosphærexochus tuberculatus n. sp.	+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+	—
Nieszkowskia cf. *cephaloceras* NIESZK.*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	?
Nieszkowskia? sp. ind.	+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+	—
Pompeckia Wegelini ANG.	+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+	—
Pompeckia minor n. sp.	+	—	—	—	—	—	—	—	—	+	—	—	—	—	—	+	—
Sphærexochus calvus McCOY	+	+	+	+	—	+	—	—	+	—	—	—	—	—	—	+	—
Sphærexochus Hisingeri n. sp.	—	—	—	—	—	—	—	—	—	—	+	+	—	—	—	—	+
Sphærexochus tuberculatus n. sp.	—	—	—	—	—	—	—	—	—	—	—	—	±	±	—	—	±
Hemisphærocoryphe granulata ANG.	—	—	—	—	—	—	—	—	—	+	+	+	+	+	+	—	+
Sphærocoryphe punctata ANG.	+	+	+	—	—	—	—	—	∔	—	—	—	—	—	—	+	—
Deiphon Angelini n. sp.	—	—	—	—	—	+	—	—	—	—	—	—	—	—	—	+	—
Pterygometopus Schmidti n. sp.*	—	?	—	—	—	—	—	—	—	—	—	—	—	—	—	?	—
Chasmops macrourus SJÖGR.	—	—	—	—	—	—	—	—	—	—	+	—	—	—	—	—	+
Chasmops angulatus n. sp.*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	?
Josephulus gracilis n. sp.	+	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+	—

of Sätra at the south-western end of the lake Hosjön[1], south-east of the lake Amtjärn, close to the north-eastern shore of the lake Sinksjön, and apparently also at Östbjörka.

Most of the fossils which have been collected at Östbjörka are from the Upper Leptæna Limestone, but in several collections there also occur specimens labelled Östbjörka which represent species belonging to the fauna of the Lower Leptæna Limestone. As already mentioned above (p. 131), Leptæna Limestone has, however, been exposed in several places within the precincts of this village (Cf. TÖRNQUIST, 1883, p. 59), and the limestone does not seem to form a continuous mass, although some of the exposures appear to be connected with each other (Cf. above, pp. 194—5). We are therefor entitled to assume that »reefs» of different geological ages are to be found at Östbjörka. Evidently the basal beds of the Lower Leptæna Limestone occur also in the south or south-western slope of the hill Osmundsberg being here overlaid with black or grey Trinucleus Shales, in between which and the rock forming the main part of the hill (the Upper Leptæna Limestone) there appears to be a strike fault (Cf. p. 339).

[1] ISBERG (1917, 1918) calls this locality Hosjön or the Hosjö-reef; however, this name does not seem suitable, as the hill Kullsberg, also, is in the close neighbourhood of this lake (its southermost point almost touches the northern bank) and, consequently, I have found it advisable to keep the locality-name, Sätra, used on the labels in the Upsala Museum.

Illænus avus HOLM is one of the most common fossils in the Lower Leptæna Limestone. A few unusually large specimens [cranidia and pygidia belonging to the short type (Cf. above pp. 128, 131) and one free cheek] referable to this species have been found also in the Upper Leptæna Limestone at Osmundsberg. This species has a long vertical range and is consequently of small statigraphical value. Also, a form which appears to represent a distinct variety of *Illænus avus* has been found at Lissberg. Possibly it will become evident that some specimens of *Platylichas* found in the Lower Leptæna Limestone and others from the Upper Leptæna Limestone ought to be regarded as distinct varieties of the same species rather than as separate species (Cf. above, pp. 283, 286, 288). With these exceptions the Lower and the Upper Leptæna Limestone do not seem to have in common any single species of trilobites (Cf. the list p. 413). It is true that the trilobite faunas show a certain general correspondence and that there are a few species which agree rather closely in their general characters, but this seems only natural on account of the lithological similarity of the two formations. With regard to the occurrence of fossils belonging to other classes, also, the Lower and the Upper Leptæna Limestone show distinct differences, even if some long-ranging species are common to both. It is, however, not possible to make a detailed comparison as yet, since these fossils up to now have been only insufficiently studied. This is especially the case with the fauna of the Lower Leptæna Limestone, the forms which have been described being nearly all of them from the Upper Leptæna Limestone. — No »reef-rocks» containing what might be considered a transitional fauna, are known.

List of Lower Leptæna Limestone Trilobites occurring in the Chasmops Beds etc.

( ) indicates that the identification is somewhat uncertain. * indicates that the species is represented by a variety in the Lower Leptæna Limestone.	Echinosphærites Lmest.	Macrourus Limestone	Chasmops Beds in Skåne	Kucker Formation	Itfer Formation	Jewe Formation	Kegel Formation	Wesenberg Formation	North Baltic Lept. Lmest.	Red Trinucleus Shales	Östersjö Limestone
**Remopleurides latus* OLIN	—	—	×	—	—	—	—	—	—	—	×
Illænus gigas HOLM	—	×	—	—	—	—	—	—	—	—	—
Illænus Wimani n. sp.	—	—	—	—	—	—	—	—	×	—	—
Illænus fallax HOLM	×	×	—	—	—	—	—	—	—	—	—
Illænus avus HOLM	?	×	—	×	×	—	×	×	(×)	(×)	×
? *Platylichas bottniensis* WIMAN	×	—	—	—	—	—	—	—	—	—	—
Hemisphærocoryphe granulata ANG.	?	×	—	?	?	?	—	—	—	—	—
Chasmops macrourus SJÖGR.	—	×	?	—	—	(×)	(×)	—	—	—	—

The Lower Leptæna Limestone has yielded a great number of trilobite species, although considerably fewer than the Upper Leptæna. The majority of them are not known from any other bed, but some have, however, been found also in the Chasmops Limestone in different districts of Sweden. The affinity with the fauna of the older Chasmops Limestone, the Echinosphærites Limestone, seems, however, to be very slight. TÖRNQUIST (1884) reports 13 (14) species of trilobites from this bed in Dalarne, of which only one, *Illænus fallax,* has been found in the Lower Leptæna Limestone (it also occurs in the North Baltic Macrourus Limestone); and from the older North Baltic Chasmops Limestone WIMAN (1917 a, list No. 6) lists 19 determinable species, of which one, *Platylichas bottniensis,* seems to occur in the Lower Leptæna Limestone. Considering the small number of the species known from the Macrourus Limestone and its lithologically different nature, the number of trilobites species it has in common with the Lower Leptæna Limestone, is remarkably great. TÖRNQUIST (Op. cit.) records 6 species from the Macrourus Limestone in Dalarne, and WIMAN (Op. cit.) 4 species from the East Baltic area, of which 3, resp. 2, occur in the Lower Leptæna Limestone.

Echinosphærites and Macrourus Limestones occur also in Östergötland and in Öland, but the faunas of these beds have been very insufficiently worked out as yet. From the Macrourus Limestone in the former district, however, are known *Illænus gigas* and *Illænus avus,* besides *Chasmops macrourus* (*Illænus avus* seems also to have been found in the Echinosphærites Limestone), from Öland, the zone-species and apparently *Ill. avus*, (Cf. HOLM, 1886, pp. 148, 154, MOBERG, 1906, p. 110, and above p. 120); a few species not known from the Leptæna Limestone have also been found there.

From the Chasmops Beds in Västergötland a considerable number of species are listed, but there exists no modern monograph on the subject, and the beds have been very insufficiently studied from a stratigraphical point of view. *Chasmops Macrourus* has been found, as already mentioned (Cf. above, p. 402), and HOLM (1882, pp. 70, 88) records *Illænus gigas* and *Illænus fallax,* and *Hemisphærocoryphe granulata* seems also to occur there. According to LINNARSSON (1869, pp. 45—46, 61) it seems as if the two latter species occured in beds containing *Echinosphærites aurantium* GYLLENH. (Echinosphærites Limestone), and as if *Illænus fallax* had been found in younger beds also. The two species of *Illænus* just mentioned have also been found in boulders of Chasmops Limestone in Jämtland. — Finally, as regards the Chasmops Beds of Skåne, they have not been sub-divided, but it appears from OLIN's (1906) statements as if his species *Remopleurides latus,* of which a variety has been found at Kullsberg, as well as the form recorded by him as *Phacops macrourus* SJÖGR.? had been found in the upper beds only.

As shown above (pp. 403—406), *Chasmops maximus* SCHMIDT, founded on specimens from the Jewe and Kegel formations, appears to be identical with *Chasmops macrourus* SJÖGR. *Illænus avus* occurs in the Kegel but also in older as well as in considerably younger beds, and even, as has already been mentioned, in the Upper Leptæna Limestone. Possibly the form described by SCHMIDT as *Cyrtometopus pseudohemicranium* NIESZK. var. *dolichocephala,* which occurs in the Jewe but also in the Itfer and Kucker Formations, is referable to *Hemisphærocoryphe granulata* (Cf. above, p. 389).

The occurence of *Illænus Wimani* in a boulder of North Baltic Leptæna Limestone is of interest as indicating that the bed from which it comes, may be of the same geological age as the Lower Leptæna Limestone in Dalarne. No specifically determinable fossils have been found in this boulder. WIMAN (1907 a, p. 150) mentions a very small cranidium of a species of *Dindymene,* but this genus is represented from neither the Upper nor the Lower Leptæna Limestone in Dalarne.

With the exception of *Remopleurides latus,* which form belongs to the fauna of the Chasmops Limestone also, and the long-ranging *Illænus avus,* not a single species of trilobites known from the Trinucleus Shales, the Östersjö Limestone, or the East Baltic Wesenberg Formation, has, as far as I know, been found in the Lower Leptæna Limestone.

The fact that all Leptæna Limestone has been considered to be of about the same geological age, has, however, evidently led some authors to ascribe also certain forms of trilobites occuring in beds equivalent to the Upper Leptæna Limestone to species belonging to the fauna of the Lower Leptæna Limestone — or vice versa. I have already, when describing the species in question, pointed out these cases of erroneous identification, and I shall here add a few remarks only. I have above (p. 114) expressed my doubt whether the specimens recorded from the Keisley and the Kildare Limestones as *Illænus fallax* HOLM, were really referable to that species. Since the early part of this work had gone to press, I have had the opportunity to examine the two specimens from the Keisley Limestone that REED (1896, p. 413) ascribed to HOLM's species. One of them, the hypostoma, is rather badly preserved, and, as far as I could see, does not bear any special likeness to that apparently belonging to *Illænus fallax* — it even seems to me to be an open question whether it belongs to any species of *Illænus* at all. The other, the small pygidium, differs perceptibly from that of *Ill. fallax,* as it is shorter and broader and the axis is considerably narrower and more strongly raised. Presumably the specimen (or specimens) from the Kildare Limestone belongs to the same form. In his work of 1897 (p. 74) KIÆR listed *Sphærocoryphe* cf. *granulata* ANG. from his Etage 5 a in Ringerike, which name probably refers to the species called by this name by SCHMIDT and which, as pointed out above (p. 390), is entirely different from ANGELIN's species. In a later work KIÆR (1902, p. 85) has recorded *Sph. granulata* both from Etage 5 a and 5 b in Asker and probably he means the same form as in his first work.

The basal beds of the Lower Leptæna Limestone — thin-banded limestones interstratified with thin layers of shales — differ distinctly from the

»reef-rocks» proper with regard to the facies of the fauna. Probably the dissimilarity is mainly due to the lithological difference of the beds but also, to some extent, to the disparity in age. The trilobites found in these beds do not tell us anything in this regard. The only specifically determinable species known from older strata that has been found here, is *Illænus avus,* which occurs in great abundance, but this long-ranging species is of no value from a stratigraphical point of view; moreover, it occurs also in other beds of very different lithological nature. Neither can we attach any importance to the find of the fragmentary pygidium described above (p. 338) as *Cybele* cf. *revaliensis* SCHMIDT. It is true that SCHMIDT's species is found in beds of considerably greater geological age, but in several characters the specimen in question resembles also the pygidia of the species of *Cybele* which occur in the Jewe and Kegel Formations. — Of the three other species of trilobites known from these basal beds, one is not known from any other strata, one occurs also in the compact Leptæna Limestone, and the third has been found in a boulder in North Germany, the geological age of which is undecided.

As pointed out above (p. 417), nearly all the species described from the Leptæna Limestone in Dalarne — with the exception of a few trilobites — are evidently based on specimens found in the Upper Leptæna Limestone. Consequently, the faunistical resemblance, so often pointed out, between the Leptæna Limestone and the higher Ordovician strata of the East Baltic Area, the Kildare Limestone etc. applies to the Upper Leptæna Limestone. It might be pointed out in this connexion that SCHMIDT, who several times has emphasized the correspondence between the Leptæna Limestone and Etage F (the Borkholm F_2 and Lyckholm F_1 Formations), seems chiefly to have known Osmundsberg, where he himself has collected fossils (Cf. SCHMIDT 1881, pp. 38, 40, 219, and 1882, p. 524). Speaking of the faunistical correspondence between the Leptæna Limestone and Etage F_2, SCHMIDT (1881, p. 40) has the following passage: »Unter den Petrefacten des Leptænakalks sind manche die bisher bei uns nur in der eigentlichen Lyckholmer Schicht gefunden sind, worauf ich kein Gewicht lege, da die Fauna der beiden Schichten auch bei uns nur ein Ganzes bildet.» The Lyckholm Formation is evidently much richer in fossils than the Borkholm; and it seems also as if in neither of the beds the fauna had been adequately worked out. Only 13 species of trilobites are recorded from F_2, and, in the case of several of them, a few specimens only seem to have been found. Only one of these species, viz. *Illænus Roemeri*[1], is known for certain to occur in the Upper Leptæna Limestone. However, it seems probable that also *Calymene Stacyi*[2]

[1] HOLM (1886) has stated only that this species occurs in F_1, but it has been recorded from F_2 by SCHMIDT in his work of 1881 (p. 40) and later by TWENHOFEL (1916, p. 310).

[2] This form was originally described by SCHMIDT (1894, p. 23) as *Calymene senaria* var. *Stacyi* — and under that name it has been spoken of above (p. 165) — but later (1907, p. 56) he refers it to a separate species, which seems to be more correct.

List of Upper Leptæna Limestone Trilobites occuring in the West Baltic Leptæna Limestone, the Keisley Limestone etc.

( ) indicates that the identification is somewhat uncertain	West Baltic Lept. Lmest.	Keisley Limestone	Kildare Limestone	Borkholm Formation	Lyckholm Formation	Norway[1] Etage 5 a	Norway[1] Etage 5 b	Brachiopod Shales	Östersjö Limestone	Red Trinucleus Shales
Remopleurides emarginatus TQT . .	–	–	–	–	(×)	–	–	–	–	–
Illænus Roemeri VOLB.	–	×	–	×	×	×	–	–	×	×
Illænus Linnarssoni HOLM	–	–	–	–	×	×	×	–	–	–
Bronteus laticauda WAHLNB.	–	–	–	–	×	×	×	–	–	–
Holotrachelus punctillosus TQT . . .	–	×	×	–	–	–	–	–	(×)	–
Pharostoma obtusa M'COY (= *Leptænarum* TQT[2])	×	–	×	–	–	–	–	–	–	–
Proëtus modestus TQT	×	–	–	–	–	–	–	–	–	–
Isbergia planifrons n. sp.	–	–	×	–	–	–	–	–	–	–
Cyphaspis trigoda n. sp.	(×)	–	–	–	–	–	–	–	–	–
Törnquistia Nicholsoni REED	–	×	×	–	–	–	–	–	–	–
Harpes costatus ANG.	–	(×)	?	–	×	×	–	–	?	–
Harpes Wegelini ANG.	–	(×)	–	–	–	×	–	–	–	–
Acidaspis evoluta TQT	(×)	–	–	–	–	–	–	–	–	–
Acidaspis laticapitata n. sp.	×	–	–	–	–	–	–	–	–	–
Acidaspis bispinosa M'COY	–	–	×	–	–	–	–	–	–	–
Trochurus Törnquisti GÜRICH . . .	–	–	×	–	–	–	–	–	–	–
Lichas laciniatus WAHLNB.	×	×	–	–	–	–	–	×	–	–
Lichas affinis ANG.	–	–	–	–	–	–	–	×	–	–
Amphilichas dalecarlicus ANG. . . .	–	–	–	–	×	–	–	–	–	–
Amphilichas lineatus ANG.	–	–	–	–	×	–	–	–	–	–
Cheirurus glaber ANG.	–	×	–	–	–	–	–	–	–	–
Pseudosphærexochus conformis ANG. .	×	×	–	?	?	–	–	–	–	–
Sphærexochus calvus M'COY	–	×	×	–	×	–	–	–	–	(×)
Sphærocoryphe punctata ANG. . . .	–	?	×	–	–	–	–	–	–	–
Deiphon Angelini n. sp.	×	–	–	–	–	–	–	–	–	–

is to be found there (Cf. above, p. 165). The form which SCHMIDT has referred to *Pseudosphærexochus conformis* ANG. may possibly belong there, although, as has been pointed out above (p. 362), this does not seem very likely to judge from the description and figures available — these may, however, be somewhat incorrect. The form described above (p. 114) as a distinct species, *Illænus dalecarlicus,* might perhaps have been regarded as a variety of *Illænus angustifrons* (Cf. p. 117), and on the whole

[1] According to KIÆR 1897, 1901.
[2] Cf. p. 423.

it shows closer affinities with the variety *depressa,* known chiefly from F_2, than with the type form from F_1.

In the preceding chapter several more instances have been given of species from the Upper Leptæna Limestone appearing to be closely related to species that occur both in F_1 and F_2, and I will now confine myself to a few remarks on the three species that in the East Baltic Area have been found in F_2 only. SCHMIDT has recorded only two such species but, as shown above (pp. 257, 282, 288), the cranidia and the pygidium ascribed by SCHMIDT to *Lichas (Platylichas) cicatricosus* LOVÉN do not belong to the same species. The cranidia bear a strong resemblance to those described above (p. 286) as *Platylichas angulatus,* and seem to represent a closely allied species. Apparently the pygidium on which the identification with LOVÉN's species was based, represents a species of *Amphilichas,* and it probably belongs to one of the species of this genus occurring in the Upper Leptæna Limestone. From SCHMIDT's description and figure of the specimen, which is but imperfectly preserved, one can form a conception of its general characters only. SCHMIDT himself, however, has had the opportunity to compare it with a pygidium collected in the Upper Leptæna Limestone at Gryssen (Östbjörka), and seems to be perfectly satisfied that it belongs to the same species as this. The latter, of which he has given two figures (1907, p. 102, text-figs. 14, 14 a), appears to belong to the same type as the pygidia attributed to *Amphilichas Wahlenbergi* (above p. 318) or possibly to the very similar type which seems to belong to *Amphilichas latifrons* (Cf. above p. 321). As regards *Platylichas margaritifer* NIESZK., SCHMIDT, in the last part of his Revision (1907, p. 43, 93), stated that it occurs in the Leptæna Limestone, but he gives no reasons for this statement. Earlier (1885, p. 120) he has mentioned, however, that among the material from the Leptæna Limestone at his disposition, there was a new species closely related to the one now in question. Probably it is this one which he later on has referred to NIESZKOWSKI's species. Whether this identification is right or not, I am not in a position to ascertain. I myself have, however, seen no form from the Leptæna Limestone that appears to be referable to, or especially closely allied to *Platylichas margaritifer.* It is true that the cranidium of *Pl. latus* TQT (from the Lower Leptæna Limestone) in its general characters resembles that of the species in question, and the same is the case, although to a lesser degree, with the cranidium from Lissberg described above (p. 288) as *Platylichas* sp. ind. a., but the pygidia which seem to be referable to these forms, differ markedly from that of the East Baltic species. Possibly it may be one or the other of these forms that SCHMIDT attributed to *Pl. margaritifer.* On the other hand it is quite likely that the species really occurs in the Leptæna Limestone.

The close relationship between the fauna of the Leptæna Limestone in Dalarne (viz. the Upper Leptæna) and that of the West Baltic Leptæna Limestone, respectively those of the Keisley and the Kildare Limestones, has already several years ago been shown by resp. WIMAN (1907) and REED (1896, 1897). With regard to the trilobites I have been able to make some additions to the list of species[1] common to these formations and to correct a few errors. In this connexion I must point out that the species described above as *Pharostoma Leptænarum* TQT ought to be called *Ph. obtusa* M^C^COY. Since that part of my work had gone to press I have had the opportunity to examine M^C^COY's (1846, Pl. IV, fig. 6) type specimen from the Kildare Limestone, and I have satisfied myself that TÖRNQUIST's species is identical with M^C^COY's. Consequently, TÖRNQUIST's name must be dropped, as having been proposed later. The species listed from Etage 5 in Norway are those recorded by KIÆR, I have, however, not included *Cybele brevicauda* in the list, on grounds that will be clear from what has been said above (p. 337).

No trilobites have been found in the »Klingkalk» and the Brachiopod Shales in Dalarne. In the Brachiopod Shales of Västergötland and Östergötland[2] occur *Lichas affinis* and *L. laciniatus*, typical — at least in the first-named district — for the beds called Brachiopod Shales s. str. by LINNARSSON (1869) = the zone of *Meristella crassa* and *Homalonotus platynotus* (TROEDSSON, 1921). The Upper Leptæna Limestone and these beds have several other fossils in common, among these *Meristella crassa.* No trilobite species are known common to the Leptæna Limestone and the upper part of the Brachipod Shales s. l., the Acidaspis Shales or the zone of *Assidaspis centrina* and *Climogr. scalaris* v. *norm.* As they are of a very different lithological nature, no great similarity can be expected, however, and no specifically determinable forms have been recorded from this upper part except such occurring in the lower zone also. Neither have any trilobite known from the Leptæna Limestone been recorded from the Staurocephalus Shales (regarded by some as the lowest part of the Brachiopod Shales, by others as belonging to the Trinucleus Beds). The Staurocephalus Shales will seem — partly, at least — to be equivalent to Etage 5 in Norway and the Lyckholm Formation, and as the Upper Leptæna Limestone shows so great a faunistical similarity to these latter formations, it appears as if part of it might be equivalent to the Staurocephalus Shales.

An interesting exposure, from a stratigraphical point of view, of the Lower Leptæna Limestone, is the cutting at the Amtjärn Quarry, which previously has been mentioned by the present writer (1910, p. 447) and by ISBERG (1917, p. 202). This quarry, which is quite small and no longer

[1] The forms from the West Baltic Leptæna Limestone given in the list above and not mentioned in the descriptions of the respective species as occurring there, are such which I have only lately been able to identify. (They are all in the State Museum of Natural History.)

[2] As often has been pointed out, the »Brachiopod Shales» of Östergötland — to a great extent consisting of limestones — will probably prove to have more species in common with the Leptæna Limestone; as yet they are only insufficiently studied.

worked, was opened up for the extraction of the compact (»reef») limestone. A little to the west of the quarry is typically developed Echinosphærites Limestone, dipping steeply towards the east. Then comes, between this and the »reef» limestone, the basal beds of the Lower Leptæna Limestone consisting of a series of green and red thin-banded limestones interstratified with thin layers of shales. In the shaly parts fossils of several kinds abound, while in the limestone bands few fossils occur other than joints of columns of Cystideans — these, however, are very plentiful. The »reef» limestone has a considerable thickness north of the quarry growing thinner towards the south. In the northern wall of the quarry it has a thickness of little more than 6 m. only, and in the south wall the basal beds are overlaid by »reef» limestone of a thickness rather less than 1,5 m. About 8 m farther east, in the entrance to the quarry, we find Black Trinucleus Shales about 6 m. thick, then 4 m. greenish-grey Trinucleus Limestone with some shaly parts. Among the blocks east of the quarry there are Red Trinucleus Shales, which the workmen declare to have been cut through at the entrance. The beds between the »reef» limestone and the Black Shales have evidently undergone a disturbance. Next to the limestone is a bed consisting of nodules of limestone and pieces of shales; several fossils occur of the sort found in the basal beds. Then comes thin-banded limestones interstratified with shales, and one or a few bands of »reef» limestone. A couple of other »crush-beds» occur higher up, and in between them bands of limestone and shales, some portions apparently consisting of small fragments pressed together. Some of the limestone-bands appear to be Leptæna Limestone while the others — among them those closest to the Black Trinucleus Shales — seem to belong to Trinucleus Beds.[1] Several of the limestone-bands are broken, the incline of the different layers is also somewhat different, and the layers on the north and the south side of the entrance do not quite correspond. It will seem as if some parts of the beds west of the first »crush-zone» had been broken loose and squeezed down in the Trinucleus bed. Thrusts in a strict sense seem hardly to have taken place. Even if no quite definite conclusions can be drawn from this part of the section, it indicates that the reef building had finished ere the deposition at least of the Black Trinucleus Shales took place.

As pointed out by several authors (e. g. SCHMALENSÉE, 1884, p. 289, TÖRNQUIST, 1886, p. 85), Black Trinucleus Shales occur in the northern part of Kullsberg, high up in the hill. Whether it is part of the solid rock or not, is, however, uncertain. In the western slope of the hill, also, though considerably lower down, Black Trinucleus Shales have been found in several places, where holes for telephon poles had been dug, and, ac-

[1] The limestone here is petrographically rather like that which overlays the Black Trinucleus Shales, and in other places also within this district it seems as if the Black Trinucleus Shales were underlaid by grey limestone, not developed as »Masur» Limestone. (Cf. WARBURG, 1910, p. 444.)

cording to ISBERG (1917, pp. 215, 227) they rest on Leptæna Limestone. A sheet of Black Trinucleus Shales is found on top of the Leptæna Limestone in one place at Sätra. I have previously (1910) expressed the opinion that it has been brought there by the ice, and I still consider it not to be in its original place where it is now, but I find it quite plausible that it originally may have rested somehow and somewhere on this reef, and not have been brought very far.

Amtjärn excepted, I have seen no exposure from which a definite opinion could be formed as to which strata over- or underlay the Leptæna Limestone — either the lower or the upper. However, apart from the conclusions that can be drawn from the palæonthological evidence, it seems to me quite unthinkable that reef-building could have gone on anywhere while formations in the nature of the Black Trinucleus Shales were being deposited in the immediate neighbourhood.

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Explanation of Plates.

I have used the following abbreviations:

U. M. = Museum of the Palæontological Institute of Upsala.
L. M. = Museum of the Geological Institute of Lund.
R. M. = State Museum of Natural History. Stockholm.
S. G. U. = Museum of the Geological Survey of Sweden.
St. H. = Geological Museum of the University of Stockholm.
I. = Mr. O. ISBERG's private collection at Lund.

Plate I.

Fig.		Page
1—6.	*Remopleurides latus* OLIN var. *kullsbergensis* n. var. . . . . 1. Dorsal view of nearly complete individual × 1. Kullsberg. I. 2—3. Frontal and lateral views of cephalon of the same specimen × 1. 4. Portion of thorax of the same specimen × 2. (Textfig. 15. Free cheek of same specimen). 5—6. Dorsal and lateral views of pygidium × 4. Kullsberg. R. M.	83
7—8.	*Remopleurides dalecarlicus* HOLM in Mus. . . . . Dorsal and lateral views of cranidium × 1. Osmundsberg. R. M.	88
9—11.	*Remopleurides emarginatus* TQT . . . . 9. Dorsal view of cranidium × 2. Boda. L. M. 10—11. Dorsal and frontal views of another cranidium × 1. Boda. L. M.	87
12—13.	*Remopleurides latifrons* HOLM in Mus. . . . . Dorsal and anterior views of cranidium × 2. R. M. (Locality unknown.)	89
14—15.	*Remopleurides minimus* n. sp. . . . . Dorsal and anterior views of cranidium × 4. Kallholn. U. M.	89
16—18.	*Telephus Wegelini* ANG.? . . . . Dorsal, lateral, and anterior views of cranidium × 3. Boda. S. G. U.	90
19—20.	*Illænus* cf. *gigas* HOLM . . . . Cranidium viewed in different aspects × 1. Sätra. U. M.	104
21—25.	*Illænus Wimani* n. sp. 21. Thoracic segment. 22—25. Pygidium and cranidium seen in different aspects × 1. Furudal. U. M.	105
26—29.	*Illænus Roemeri* VOLB. 26. Imperfect individual × 1. 27. Rostrum of same specimen × 1. 28. Anterior view of cephalon of nearly complete, enrolled individual × 1. 29. Lateral view of same specimen × 1. Kallholn. S. G. U.	108

Plate II.

Plate III.

Fig.		Page
	from a cast of a natural mould. Kallholn. 8. Restoration of cephalon. 9. Thoracic segment. Kallholn. 10. Hypostoma. Kallholn. 11. Pygidium showing doublure. Probably from Osmundsberg. 12. Pygidium. Osmundsberg. 13. Imperfect free cheek. Probably from Osmundsberg. 14. Natural mould of dorsal surface of imperfect free cheek with part of doublure preserved anteriorly. Kallholn. 15. Doublure of genal spine and natural mould of dorsal surface of portion of free cheek. Probably from Osmundsberg. All figures drawn in natural size. The original of fig. 9 belongs to ISBERG's collection, the others to the Upsala Museum.	
16—25.	*Holotrachelus punctillosus* TQT	147
	16—18. Nearly complete individual seen in different aspects. × 1. Kallholn. S. G. U. 19. Pygidium × 3. Östbjörka. R. M. 20. Pygidium [ascribed by ANGELIN (1854, p. 90, Pl. XLI, fig. 15*) to his species *Cheirurus conformis* × 2. Probably from Osmundsberg. U. M. 21. Pygidium × 1. Kallholn. U. M. 22. Portion of thoracic segment × 1. Kallholn. U. M. 23. Hypostoma turned upside-down × 1. Kallholn. U. M. 24—25. Hypostoma turned upside-down and in usual position (25 slightly restored) × I. Unskarsheden. R. M.	

Plate IV.

1—9.	*Pharostoma Leptænarum* TQT (= *Ph. obtusa* McCOY. Cf. above, p. 423)	155
	1. Portion of thorax × 4. Boda. L. M. 2. Pygidium × 4. Osmundsberg. R. M. 3. Pygidium ×4. Arfvet. U. M. 4. Pygidium × 4. (Locality unknown). U. M. 5. Cranidium × 3. Osmundsberg. R. M. 6. Cranidium × 3. Kallholn. U. M. 7. Cranidium of young individual × 4. Kallholn. U. M. 8. Cranidium of young individual × 6. Kallholn. U. M. 9. Larva × 17. Kallholn. U. M.	
10.	*Calymene* cf. *Stacyi* SCHMIDT. Natural mould of portion of pygidium × 1. Lissberg. S. G. U.	165
11—20.	*Calymene foveolata* TQT	161
	11—12. Dorsal and lateral views of incomplete thoracic segment with the profil in outline. 13. Cranidium with the postero-lateral portions restored from another specimen. 14—15. Pygidium viewed in different aspects. 16. The type specimen. 17. Imperfect cranidium. 18—19. Pygidium viewed in different aspects. 20. Pygidium. All the figures are in natural size. The original of fig. 16 is from Furudal and belongs to the Museum of the Geological Survey. The others belong to the Upsala Museum and have been collected at Kullsberg, except the original of fig. 17, which is from Amtjärn.	
21—26.	*Harpes Wegelini* ANG.	224
	21. Cranidium × 1. Kallholn. U. M. 22—23. Dorsal and frontal views of cranidium apparently having the brim ab-	

Fig. Page

normally developed on one side × 1. Kallholn. U. M. 24. Left eye lobe of same specimen × 4. 25—26. Lateral and dorsal views of cranidium × 1. Kallholn. S. G. U.

Plate V.

1—6. *Harpes costatus* ANG. 214
1—2. Dorsal and lateral views of cranidium × 1 Lissberg. S. G. U. [In fig. 1 the brim is too broad posteriorly.] 3—5. Anterior, lateral, and dorsal views of cranidium × 1 Kallholm. U. M. 6. Portion of brim, showing the pittings. Enlarged. Kallholn. U. M.

7. *Proëtus remotus* n. sp. Cranidium × 2. Kallholn. I. 170

8—13. *Proëtus convexus* n. sp. 170
8. Entire individual × 2. Kallholn. U. M. 10. Nearly entire individual × 2. Kallholn. U. M. 9. Portion of thorax of same specimen × 4. 11. Lateral view of cephalon × 2. Östbjörka. R. M. 12. Free cheek × 2. Kallholn. U. M. 13. Pygidium × 4. Boda. U. M.

14, 17. *Proëtus* sp. ind. a. 180
14. Pygidium showing doublure × 2. Kallholn. U. M. 17. Pygidium × 4. Kallholn. U. M.

15—16, 18. *Proëtus modestus* TQT. 167
15. Free cheek × 4. Boda. R. M. 16. The type specimen × 2. Kallholn. S. G. U. 18. Pygidium × 4. Lissberg. S. G. U.

19—20. Dorsal and lateral views of incomplet cephalon apparently belonging to *Proëtus convexus* × 2. Östbjörka. R. M. . 170 (173)

21. *Proëtus* sp. ind. d. Hypostoma × 4. Kallholn. I. 182

22. *Proëtus pentagonoides* n. sp. Cranidium × 1. Unskarsheden. R. M. 176

23. *Proëtus convexus*. Cranidium × 2. Kallholn. U. M. 170

24—25. *Proëtus kullsbergensis* n. sp. 173
24. Cranidium × 2. 25. Pygidium × 4. Kullsberg. U. M.

26—31. *Proëtus Ainæ* n. sp. 178
26. Cranidium × 2. St. H. 27. Free cheek × 2. S. G. U. 28. Portion of hypostoma probably belonging to this species, drawn from a cast of a natural mould × 4. St. H. 29. Cranidium × 2. S. G. U. 30. Pygidium × 3. St. H. 31. Pygidium drawn from a cast of a natural mould × 2. St. H. The originals of the figures are all from Lissberg.

32—33. *Proëtus parvigena* n. sp. 175
Lateral and dorsal views of cephalon and portion of thorax × 4. Kallholn. I.

34—35. *Cyphaspis Holmi* n. sp. 193
34. Cranidium × 3. Östbjörka. R. M. 35. Cranidium × 3. Östbjörka (Gryssen). R. M.

Plate VI.

Plate VII.

Fig.		Page
	viewed in different aspects × 1. Arfvet. R. M. 23. Fragment of pygidium ascribed by ANGELIN (1854, p. 74, Pl. XXXVIII, fig. 9 b) to this species and probably belonging to it. × 1. Arfvet. R. M. 24—25. Cephalon viewed in different aspects × 1. Kallholn. S. G. U. Fig. 24 is not quite satisfactory. A better figure of the same specimen is given above (p. 310, text-fig. 21). 26. Fragmentary pygidium × 1. Östbjörka. R. M. Regarding this specimen see above p. 314, foot-note.	
27.	*Dicranopeltis elegans* TQT. Pygidium × 2. Osmundsberg. S. G. U.	291
28—30.	*Platylichas angulatus* n. sp.	286
	Cranidia × 1. Kallholn. U. M. 29—30. The same specimen viewed in different aspects.	
31.	*Dicranopeltis elegans* TQT. The type specimen (cranidium) × 1. Osmundsberg. L. M.	291
32—33.	*Amphilichas periformis* n. sp. Anterior and dorsal views of cranidium × 4. Kallholn. I.	329
34—36.	*Amphilichas parvulus* n. sp.	324
	34—35. Cranidium viewed in different aspects × 4. Kallholn. I. 36. Imperfect cranidium × 2. Kallholn. U. M.	
37—38.	*Amphilichas atavus* n. sp. Anterior and dorsal view of cranidium × 2. Amtjärn. I.	323
39—41.	*Platylichas sp. ind.* d.	290
	Hypostomata. 39. Fragmentary specimen × 1. Kullsberg. R. M. 40. Nearly complete × 2. Kullsberg. U. M. 41. Nearly complete × 2. Kullsberg. I.	

Plate VIII.

1—8.	*Lichas affinis* ANG.	302
	1—2. Cranidium viewed in different aspects × 1. Lissberg. St. H. 3—4. Pygidia × 1. Lissberg. St. H. 5. Pygidium slightly differing from the typical ones, possibly representing a distinct variety (Cf. above, p. 306) × 1. Östbjörka L. M. 6. Free cheek × 2. Lissberg. St. H. 7. Hypostoma probably belonging to this species × 1. Lissberg. S. G. U. 8. Cranidium × 1. Lissberg. St. H.	
9—10.	*Dicranopeltis elegans* TQT. Cranidium viewed in different aspects × 2. Lissberg. S. G. U.	291
11—13.	*Lichas affinis* ANG.	302
	11. Cranidium × 1. Östbjörka. L. M. [This specimen has previously been figured by Törnquist (1884, Pl. I, fig. 31)] 12. Imperfect thoracic segment × 1. Kallholn. U. M. 13. Pygidium of same specimen × 1.	
14—20.	*Lichas laciniatus* WAHLNB.	295
	14. Pygidium × 1. Lissberg. S. G. U. 15. Imperfect pygidium showing doublure × 1. Lissberg. St. H. 16—17. Cranidium viewed in different aspects × 1. Lissberg. St. H. 18. Imperfect pygidium × 1. Lissberg. St. H. 19. Hypostoma	

Plate IX.

Plate X.

Fig.		Page
1—7.	*Pseudosphærexochus conformis* ANG.	360
	1—3. Cranidium viewed in different aspects × 1. 4. Hypostoma, probably belonging to this species × 2. 5. Imperfect thoracic segment × 1. 6. pygidium × 1. 7. Free cheek × 2. The originals of all the figures are from Kallholn, and in the Upsala Museum.	
8—15.	*Pseudosphærexochus granulatus* ANG.	356
	8—9. Cranidium viewed in different aspects × 1. 10. Pygidium × 1. 11—12. Cranidium viewed in different aspects. 13. Hypostoma apparently belonging so this species × 2. 14. Imperfect thoracic pleura probably belonging to this species × 2. The »posterior articulating band» indicated in the figure may be the lower edge of the test, which is not preserved on the dorsal surface of the pleura. 15. Pygidium × 2. Some portions drawn after a cast of the natural mould. The originals of all the figures are from Kullsberg and in the Upsala Museum.	
16.	Hypostoma × 2, possibly belonging to *Hemisphærocoryphe granulata* ANG. Kullsberg. U. M.	388 (389)
17—18.	*Pseudosphærexochus granulatus* ANG.	356
	The type specimen (cranidium) viewed in different aspects × 1. Furudal. R. M.	
19.	*Pseudosphærexochus conformis* ANG. Imperfect thoracic segment × 2. Kallholn. U. M.	360
20.	*Pseudosphærexochus tuberculatus* n. sp. Cranidium × 4. Kallholn. I.	363
21.	*Pseudosphærexochus tuberculatus?* var. Lateral view of cranidium × 1. Kallholn. I.	363 (364)
22—23 a.	*Pseudosphærexochus conformis* ANG. var. *major*. n. var.	362
	22. Lateral view of cranidium × 1. 23—23 a. Cranidium viewed obliquely from above with the profil in outline × 1. Kallholn. U. M.	
24—25.	*Pseudosphærexochus tuberculatus* n. sp.	363
	Imperfect cranidium (the type specimen) viewed in different aspects × 1. Kallholn. U. M.	
26—28.	*Pompeckia minor* n. sp.	374
	26—27. Imperfect cephalon viewed in different aspects × 2. 28. Lateral view of cranidium showing genal spine × 2. Kallholn. U. M.	
29.	Incomplete pleura (the end is not preserved) probably belonging to *Pseudosphærexus conformis*.	362
30—31.	*Nieszkowskia* cf. *cephaloceras* NIESZK.	365
	Imperfect cranidium viewed in different aspects × 1. U. M. Locality unknown.	
32—33.	*Nieszkowskia?* sp. ind.	366
	Imperfect and apparently abnormally developed cranidium viewed in different aspects × 1. Kallholn. U. M.	

Fig. Page

34. *Pseudosphærexochus tuberculatus?* var. 363 (364)
Imperfect cranidium, possibly representing a variety of *Pseud. tuberculatus* × 1. Kallholn. U. M.

35—39. *Hemisphærocoryphe granulata* ANG. 388
35. Imperfect cephalon viewed obliquely from the side × 1. I. Locality unknown. 36—38. Cranidium viewed in different aspects × 2. Östbjörka. U. M. 39. Imperfect cranidium viewed obliquely from the side × 1. Kullsberg. U. M.

40—42. *Deiphon Angelini* n. sp. 394
40—41. Imperfect cranidium viewed in different aspects × 2. 42. Imperfect cranidium showing portion of genal spine × 6. Lissberg. S. G. U.

43—49. *Sphærocoryphe punctata* ANG. 390
43. Cranidium × 1. Kallholn. 44. Portion of fixed cheek viewed in anterior aspect × 4. Boda. U. M. 45—46. Cranidium viewed in different aspects × 2. In fig. 46 the glabella and the occipital ring is viewed more straight from the side than the cheek. In fig. 45 a portion of the genal spine is restored (drawn after another specimen). Kallholn. U. M. 47—48. Pygidium viewed in different aspects (both obliquely from behind) × 4. Kallholn. U. M. 49. Pygidium viewed from above × 3. Kallholn. U. M.

Plate XI.

1—4. *Sphærexochus tuberculatus* n. sp. 385
1—2. Cranidium (type specimen) viewed in different aspects × 1. 3. Pygidium × 1. 4. Free cheek × 1. Amtjärn Quarry. U. M.

5—15. *Sphærexochus calvus* MC COY. 378
5. Cranidium × 1. Kallholn. U. M. 6—8. Cephalon with portion of thorax attached viewed in different aspects. × 1. Osmundsberg. R. M. 9. Portion of glabella and fixed cheek showing genal point × 2. Kallholn. U. M. 10. Pygidium (internal cast) × 2. Lissberg. S. G. U. 11. Pygidium × 2. Osmundsberg. U. M. 12. Pygidium × 2. Lissberg. S. G. U. (In this specimen the portions between the posterior parts of the pleuræ are not preserved). 13. Fragmentary pygidium × 1. Locality unknown. R. M. This specimen was figured by ANGELIN (1854, Pl. XXXVIII, fig. 16 a) as *Sph. angustifrons.* 14. Pygidium (internal cast) × 2. Boda. U. M. 15. Portion of glabella and fixed cheek showing genal point × 4. Lissberg. S. G. U.

16—19. *Sphærexochus Hisingeri* n. sp. 384
16, 19. Cranidia × 1. Kullsberg. U. M. 17. Pygidium × 1. Kullsberg. L. M. 18. Pygidium × 1. Locality unknown. This specimen was figured by ANGELIN (1854, Pl. XXXVIII, fig. 17) as *Sphærexochus angustifrons?* var.

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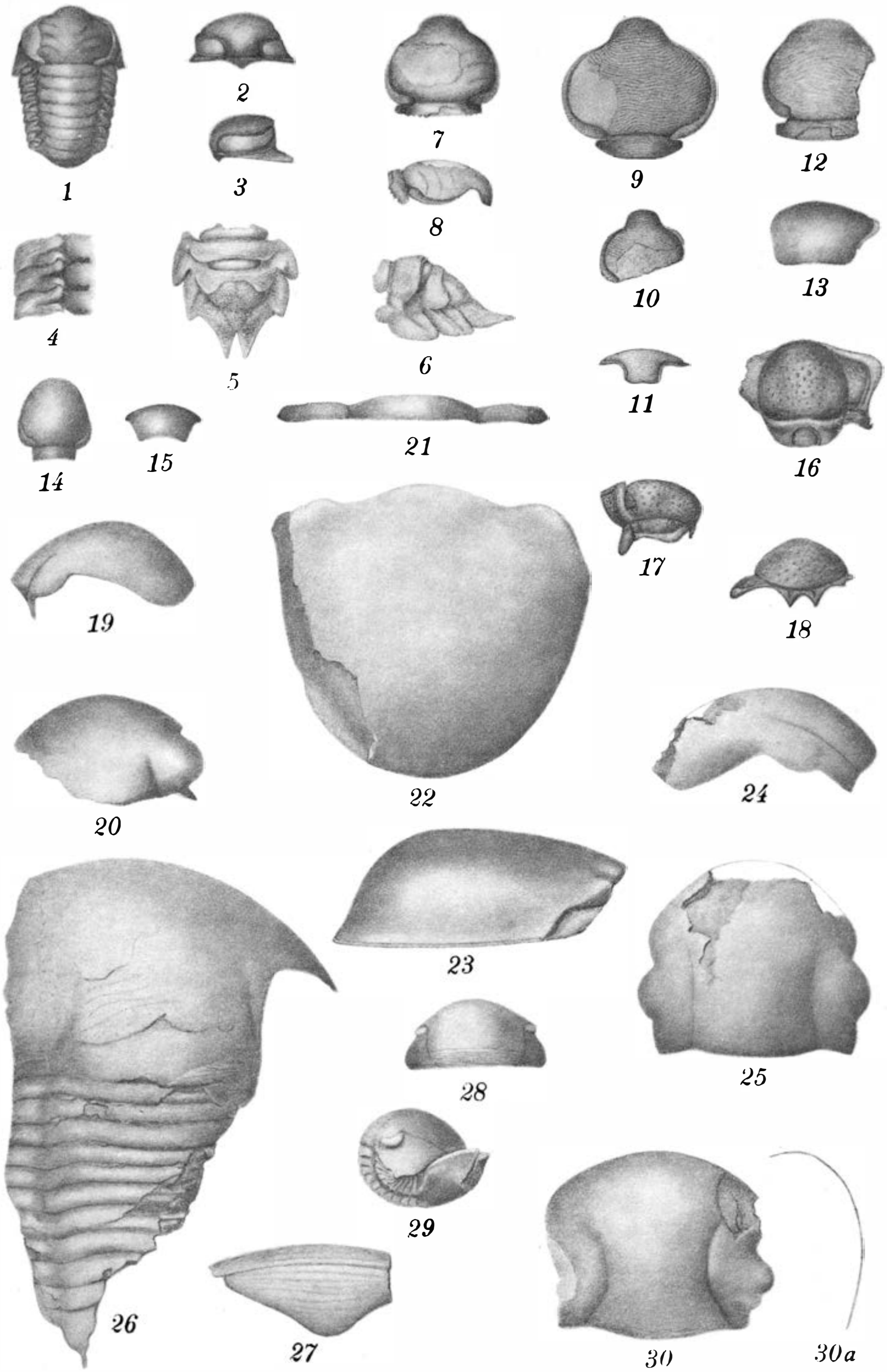

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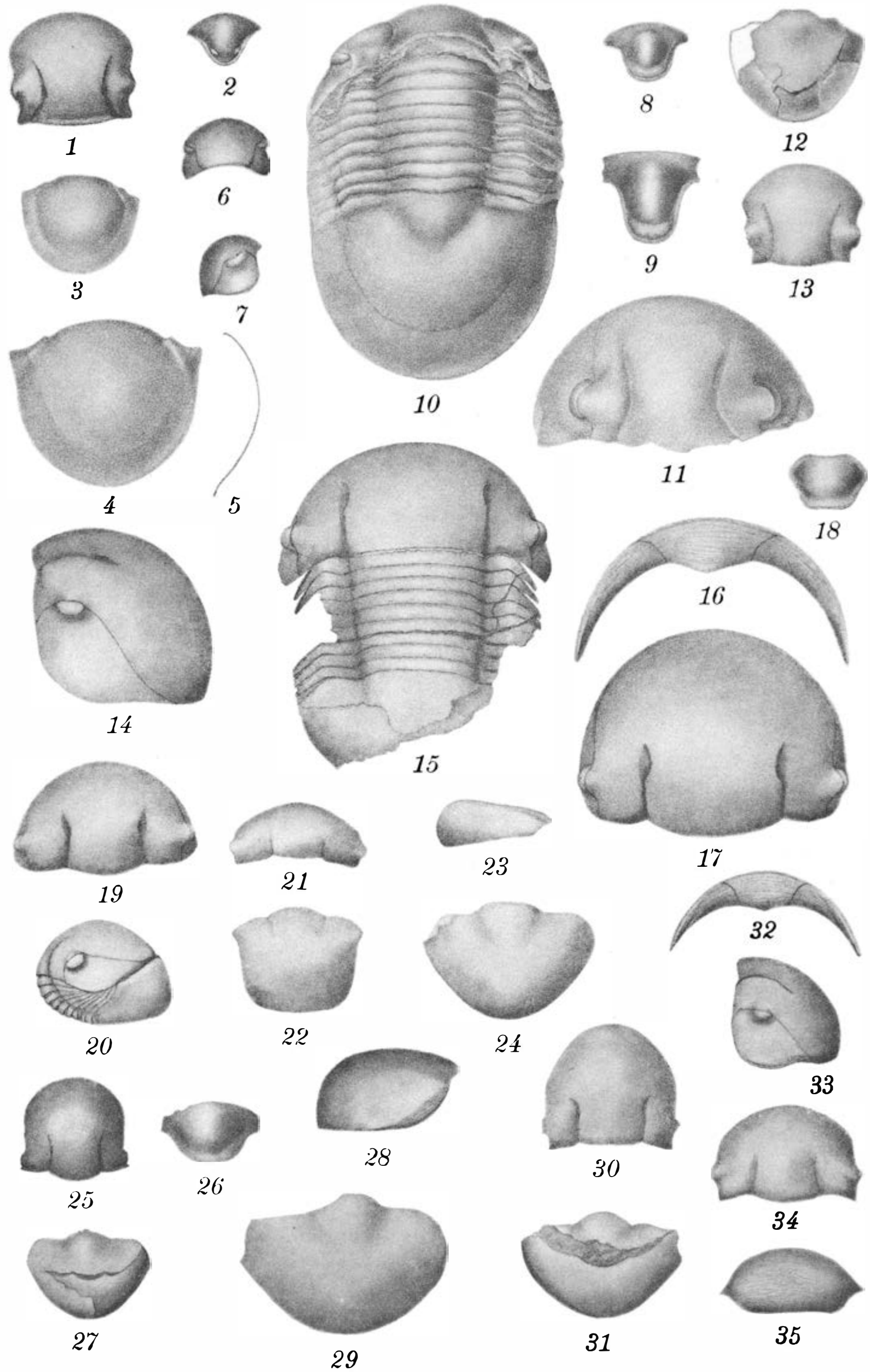

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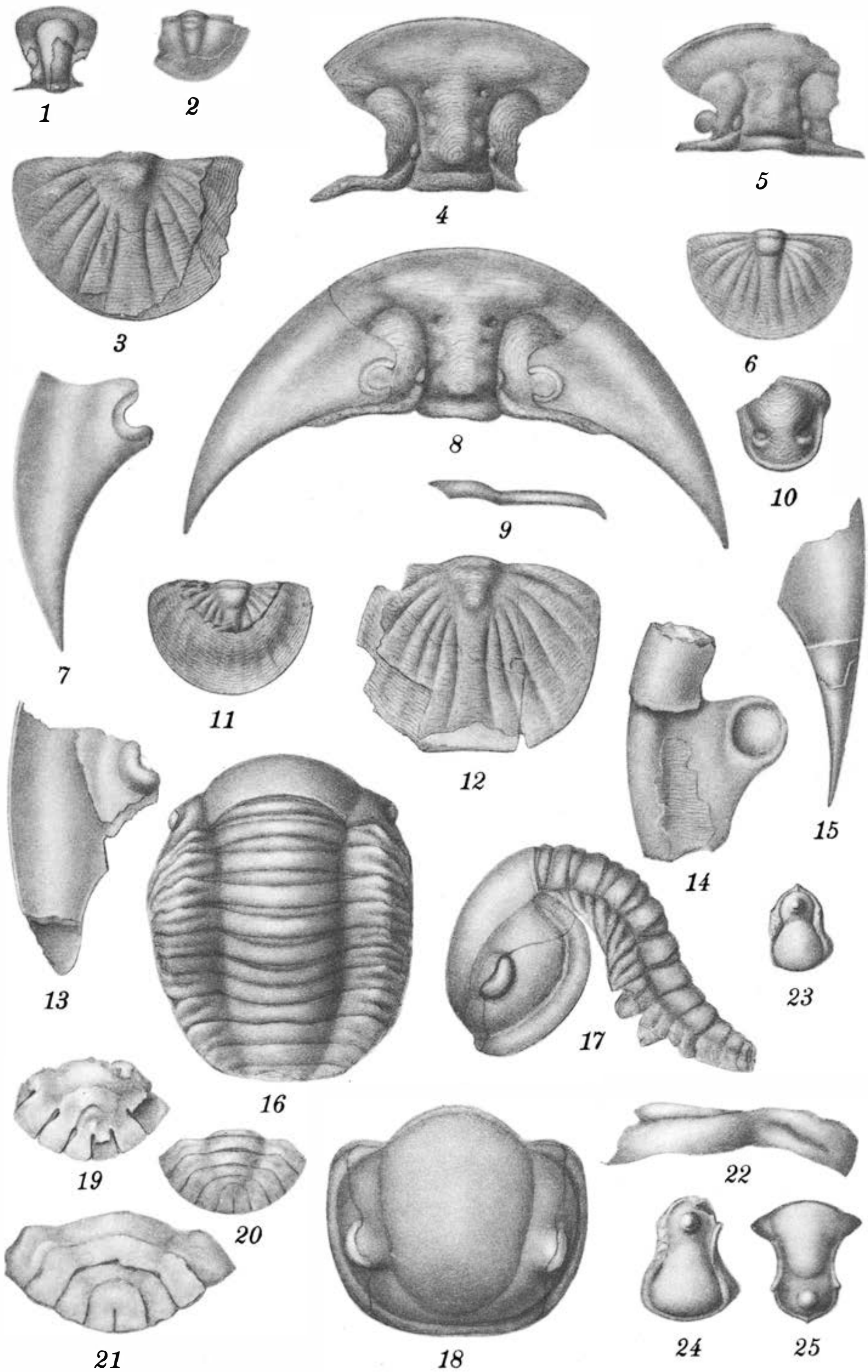

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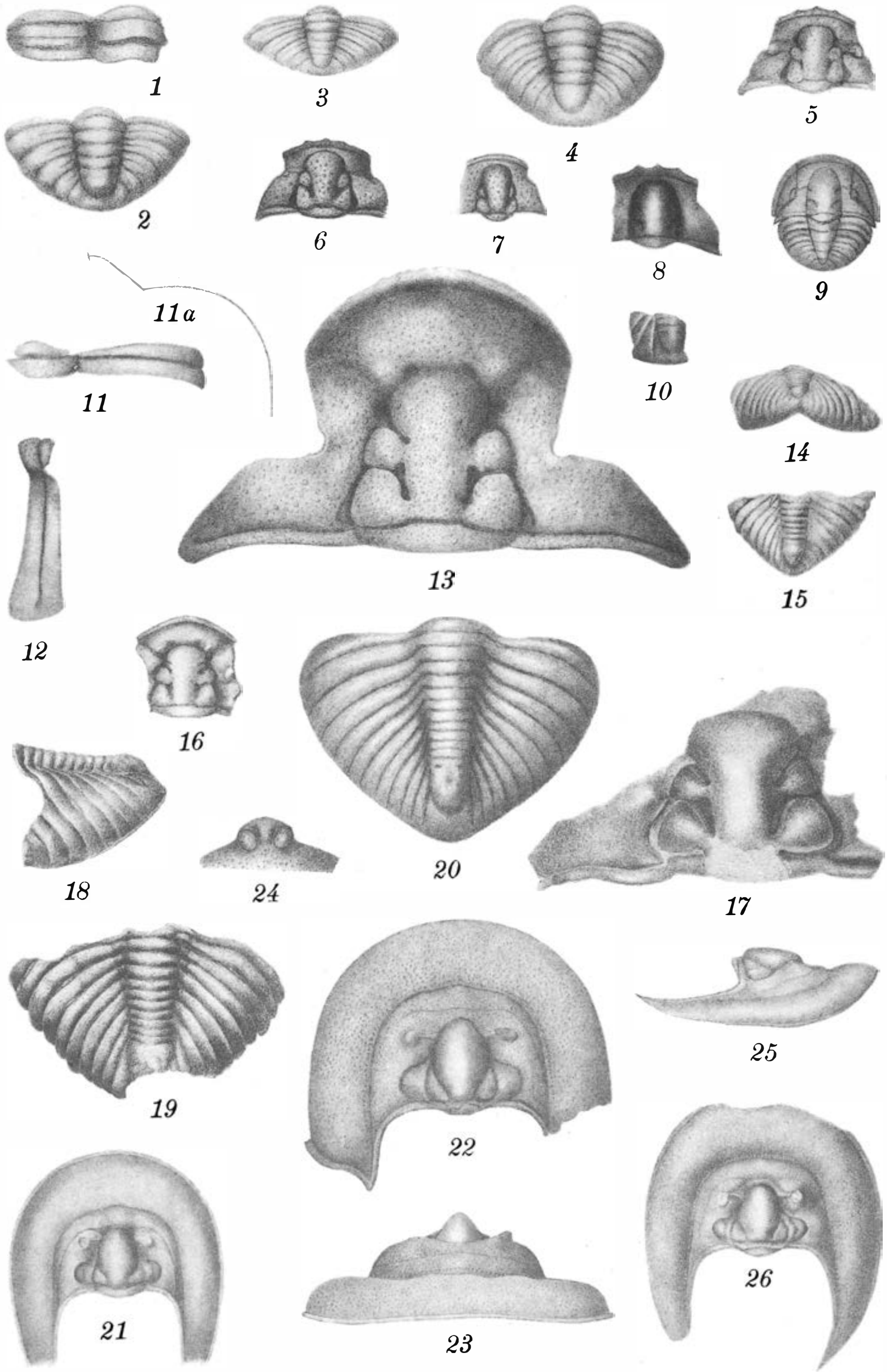

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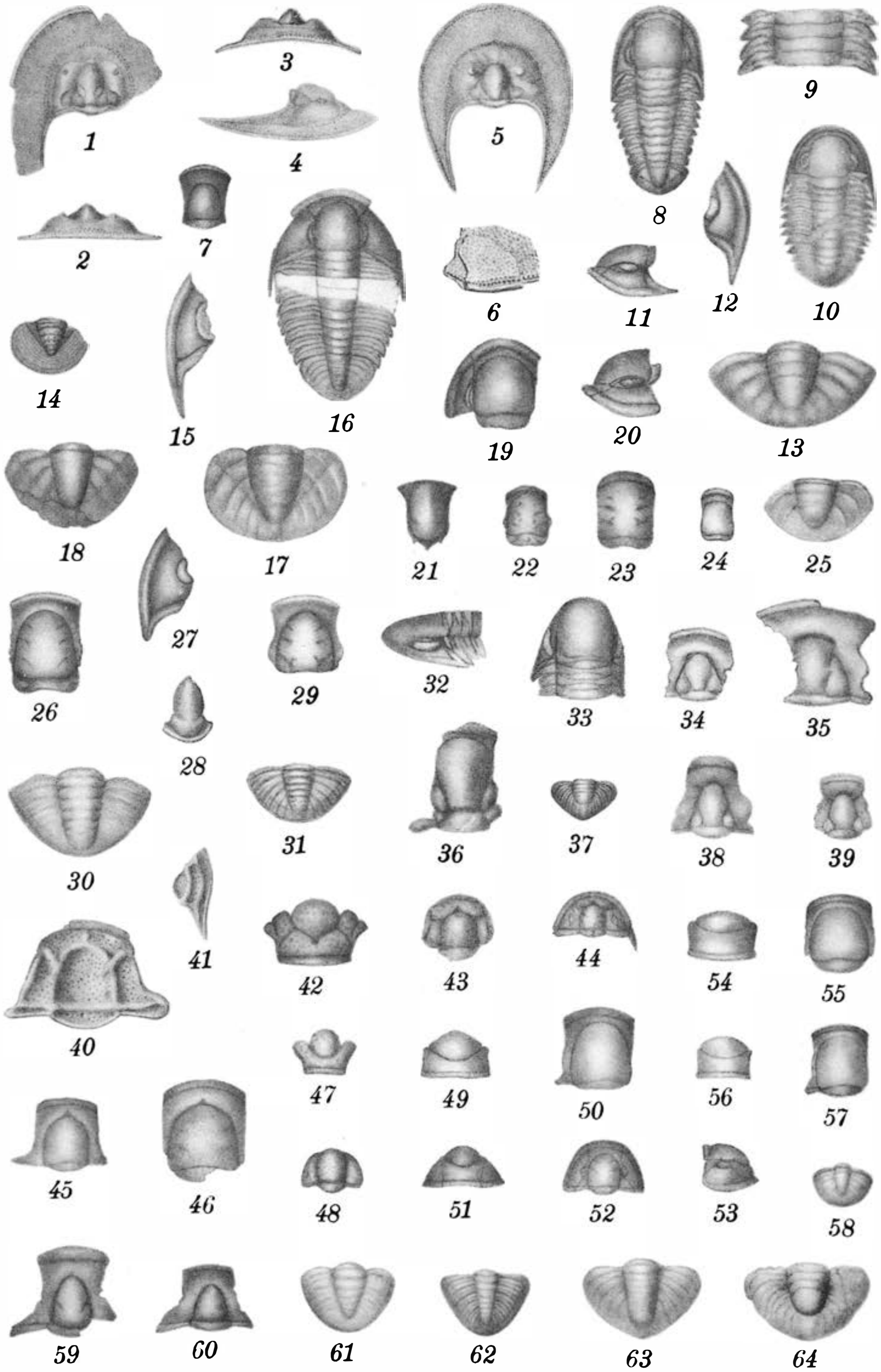

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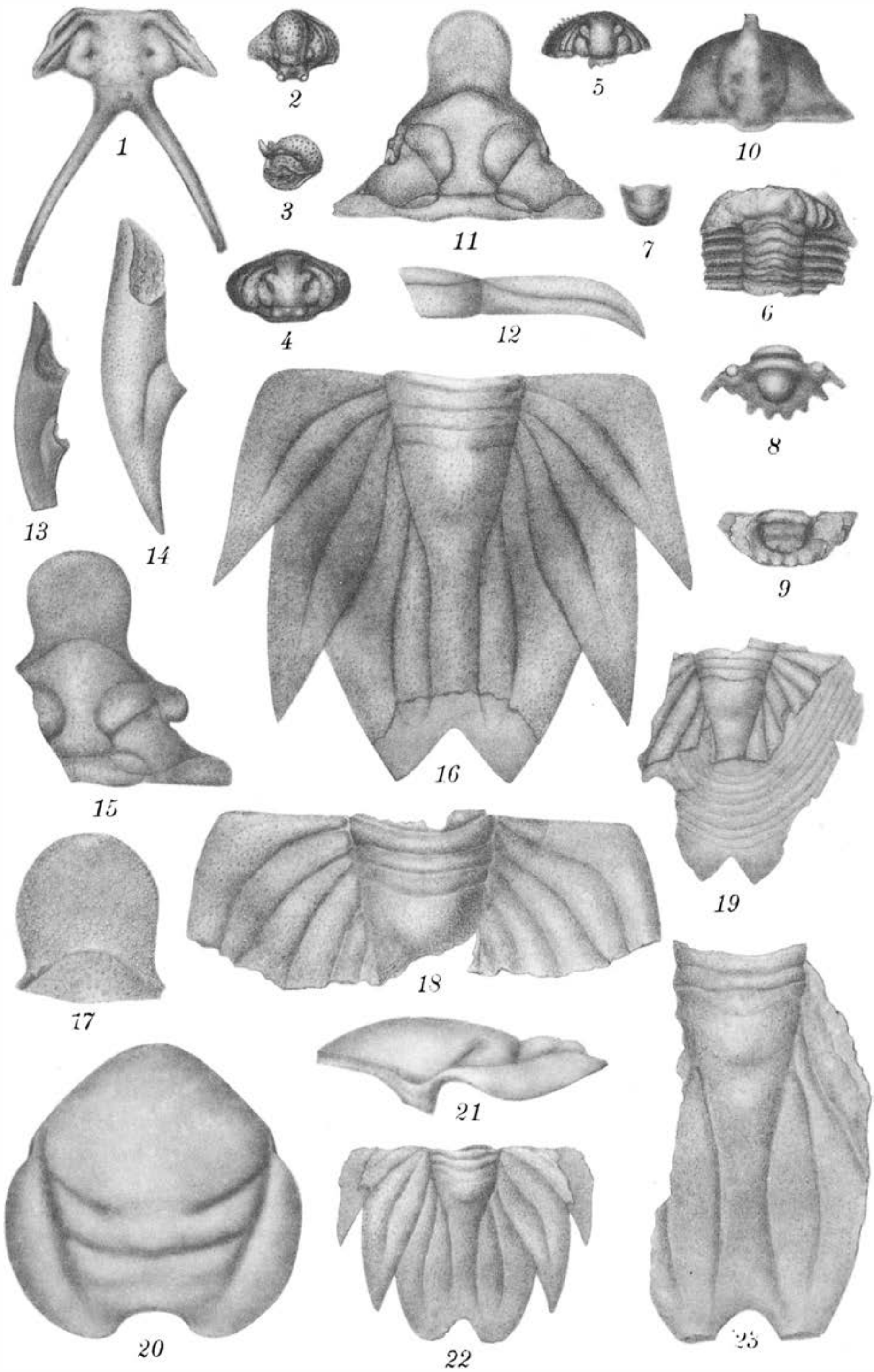

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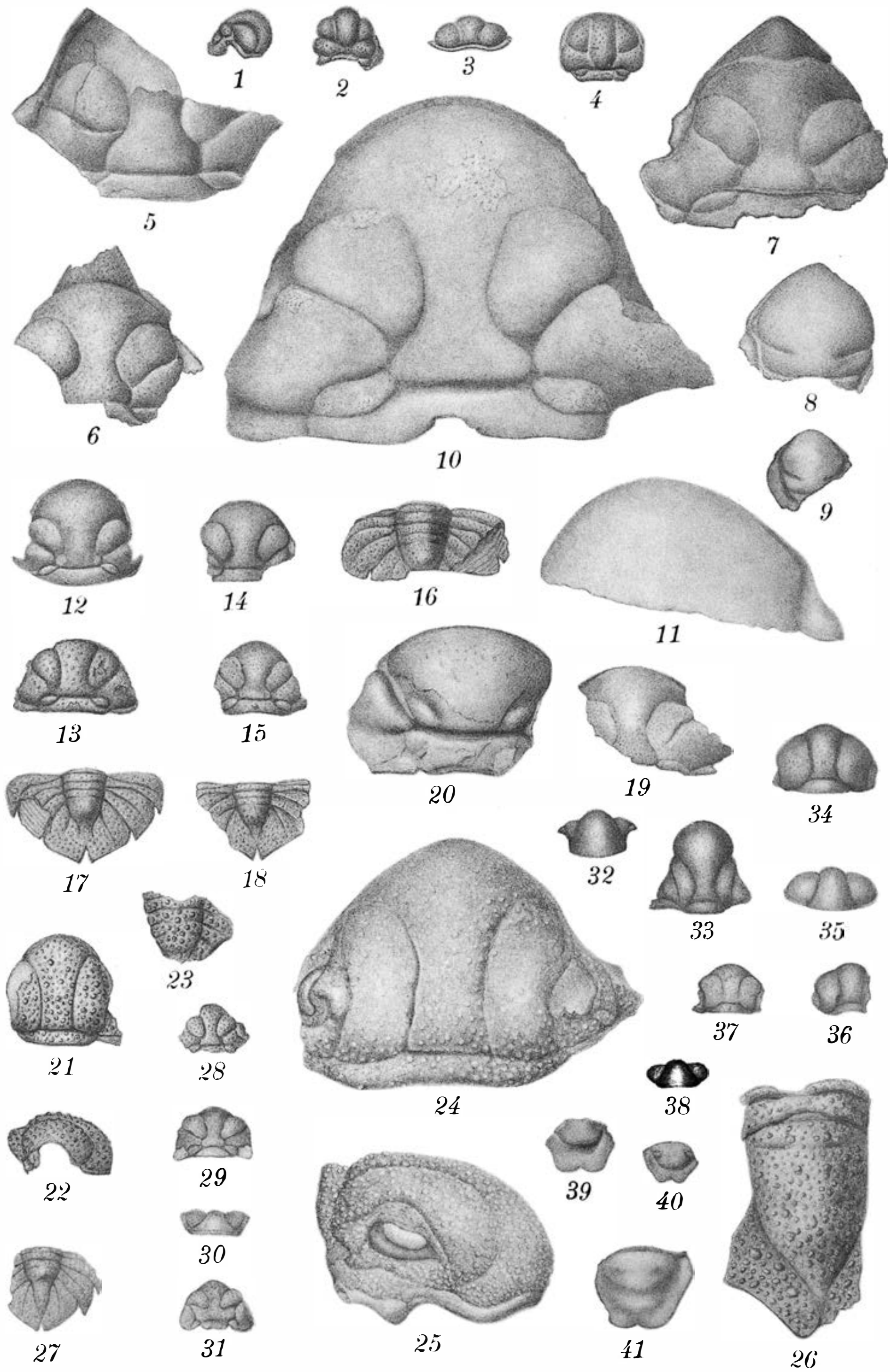

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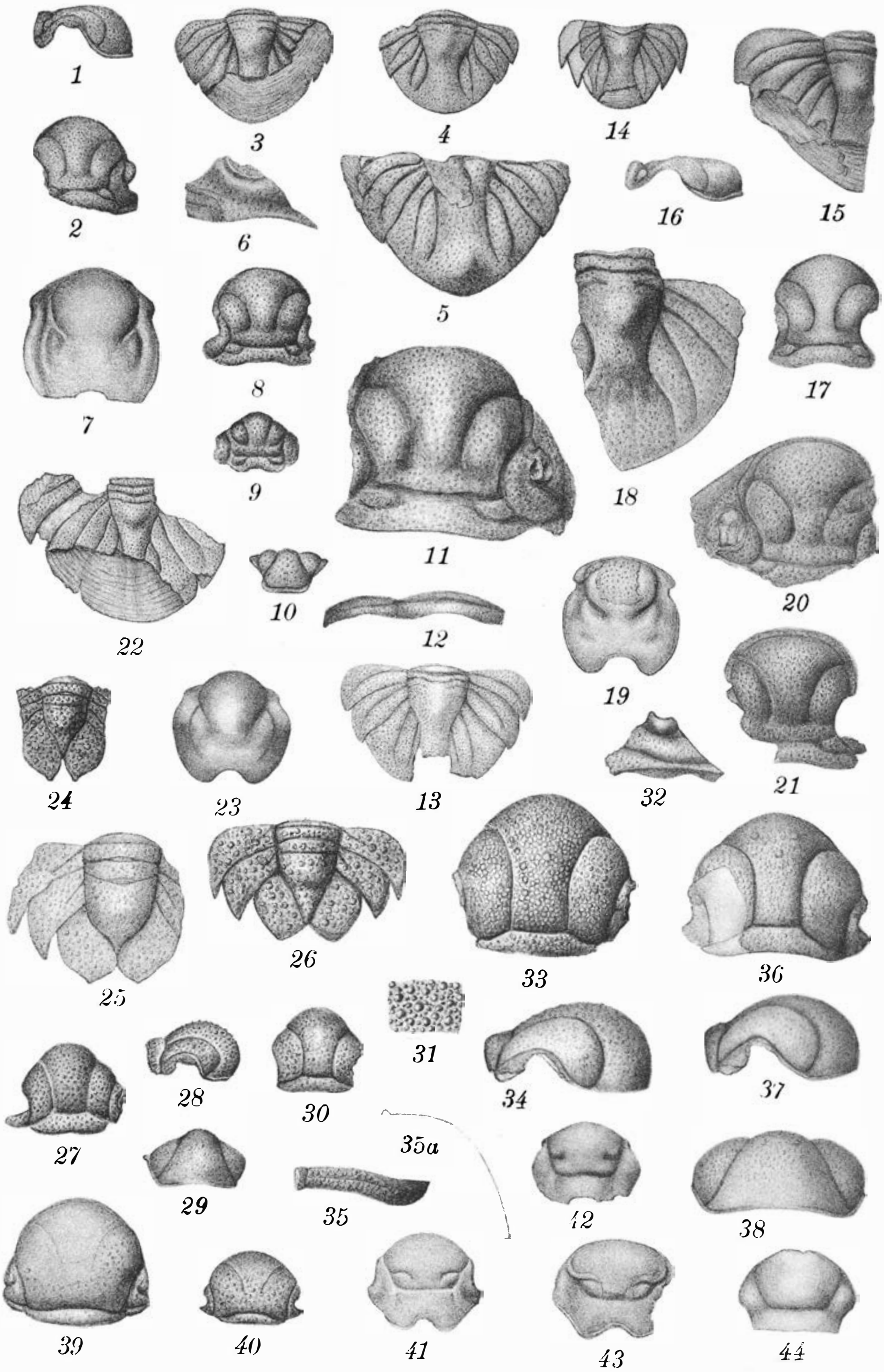

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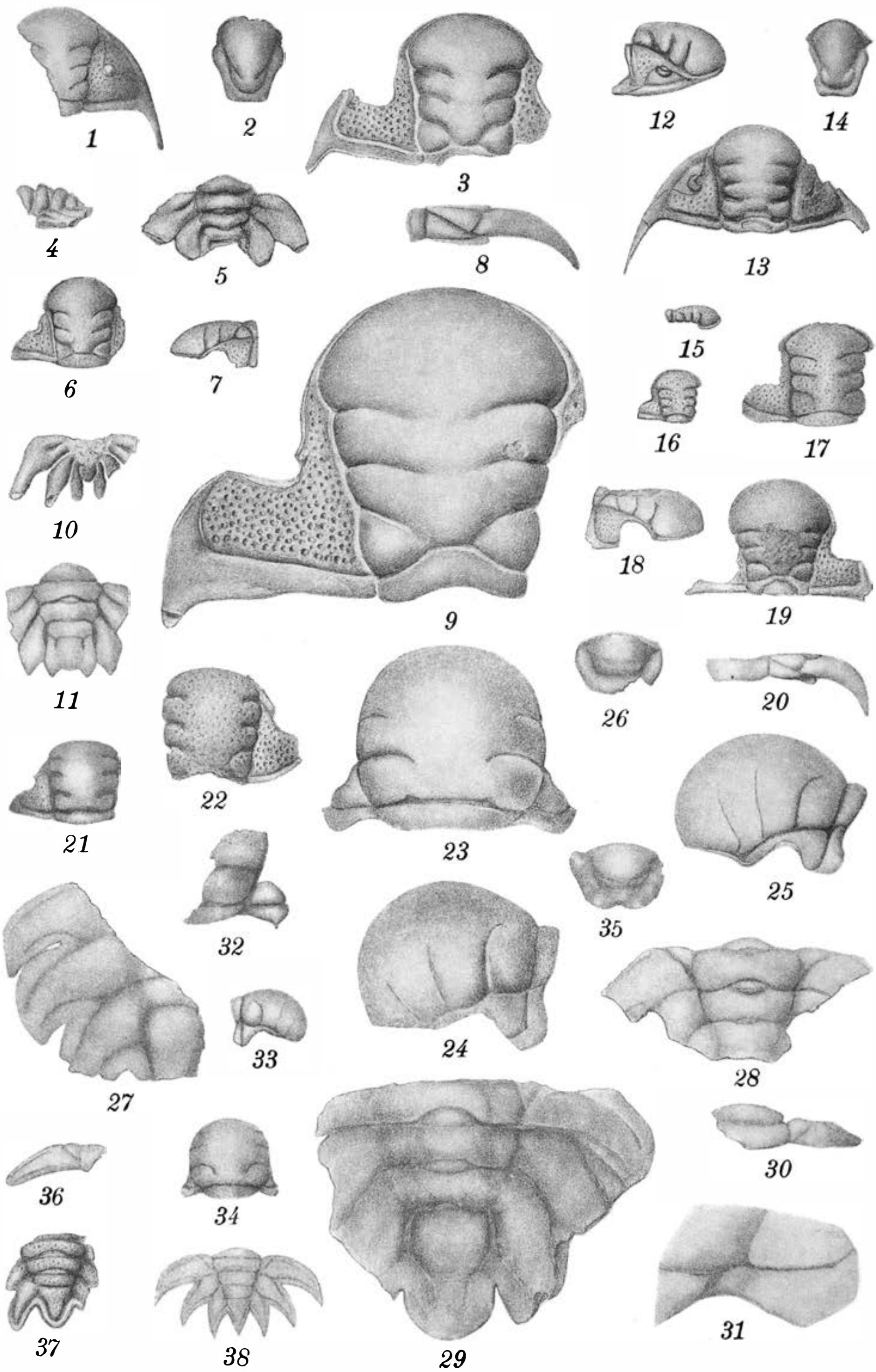

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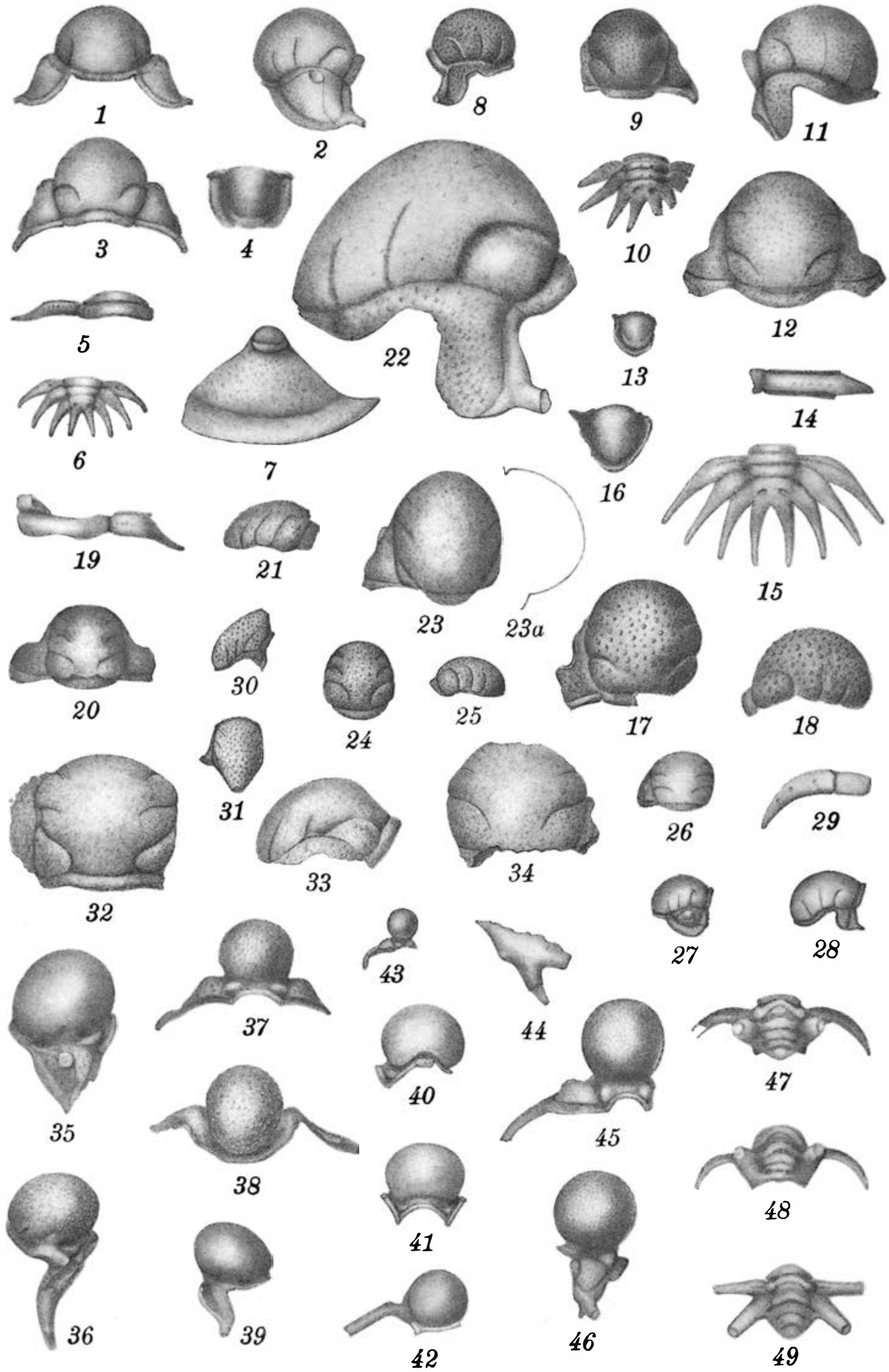

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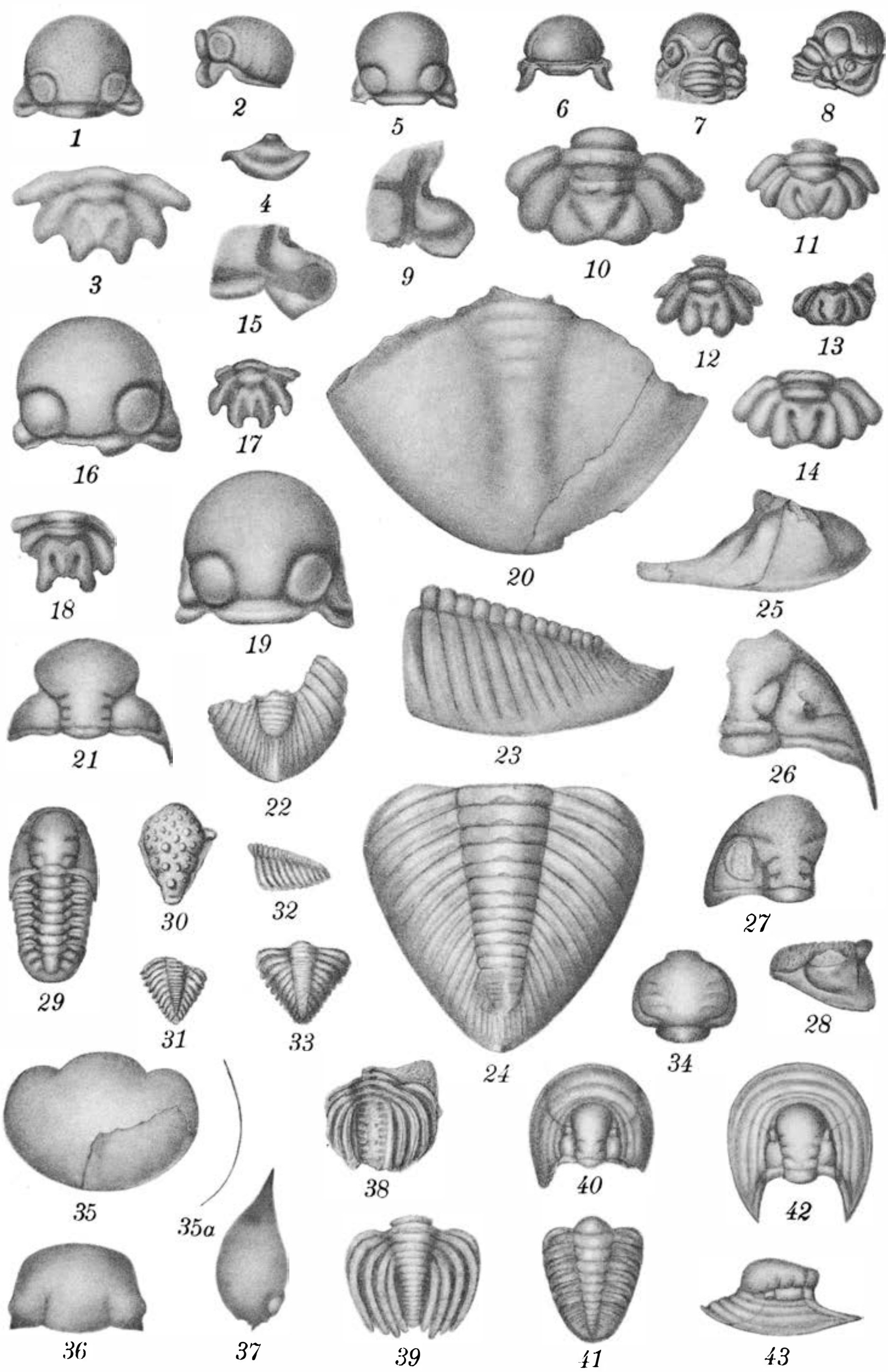

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