

SVERIGES GEOLOGISKA UNDERSÖKNING

SER. C.

Avhandlingar och uppsatser.

N:o 498

ÅRSBOK 42 (1948) N:o 7.

NON-AGNOSTIDEAN TRILOBITES
OF THE MIDDLE CAMBRIAN
OF SWEDEN

BY

A. H. WESTERGÅRD

I

With Four Plates

Pris 2 kronor

STOCKHOLM 1948

KUNGL. BOKTRYCKERIET. P. A. NORSTEDT & SÖNER

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Abstract. — The following genera are dealt with: *Burlingia*, *Schmalenseeia*, *Proceratopyge*, *Dorypyge*, *Corynexochus*, *Dolichometopus*, *Andrarina*, *Nericia* nov., *Conocephalina*, *Acrocephalites*, *Ullaspis* nov., and *Toxotis*.

In 1946 the writer published the account of the Agnostidea of the Middle Cambrian of Sweden (Ser. C, No. 477 of the Geological Survey). The present paper is the first part of a contemplated revision of the remaining trilobites of the same series. The genera are taken in arbitrary order.

As always, the writer has had the privilege to use all the collections of the Paleozoological Department of the Swedish Museum of Natural History and of the Geological-Mineralogical Institution of the University of Lund, where the originals of most of the earlier described forms are kept. The material on which the new genera *Nericia* and *Ullaspis* are based was collected and generously presented to the Geological Survey by Mr. Torsten Tjernvik.

The stratigraphy of the Swedish Middle Cambrian was presented in the memoir mentioned above; it also states the location of the various localities.

Burlingiidae WALCOTT, 1908.

This very small group comprises but two genera, *Burlingia* known from the Middle Cambrian of British Columbia and Sweden, and *Schmalenseeia* from the Middle and early Upper Cambrian of Sweden. Only two species of each have so far been described.¹

Burlingia WALCOTT, 1908.

Genotype: *B. hectori* WALCOTT, 1908.

Burlingia laevis WESTERGÅRD, 1936. — Pl. I, fig. 1.

1936. *Burlingia laevis* WESTERGÅRD, S. G. U., ser. C, no. 394, p. 32, pl. 12, figs. 8, 9. (Description and figs. of the complete dorsal shield.)

No material has been found to supplement that on which the original description was based.

Zone of *Paradoxides pinus*. Borgholm and Mossberga, Öland. Infrequent.

Schmalenseeia MOBERG, 1903.

Genotype: *S. amphionura* MOBERG, 1903 (as far as hitherto known confined to the lowest portion of the zone of *Agnostus pisiiformis*).

¹ Kobayashi (1935, p. 92) has called attention to the fact that *Triopus draboviensis* BARRANDE and *Dustlia insignis* JAHN, both from the Ordovician (D—d2) of Bohemia, are more or less suggestive of the Burlingiidae. The resemblance is but homomorphic, however, as the Bohemian forms, whose taxonomic position has been disputed, are not referable to the Trilobitae. (Cf. Jahn, Akad. Wissensch. Wien, Sitzungsber. Math.-Naturw. Cl., Bd. 102 (1893), Abt. 1, pp. 591—603).

Schmalenseeia acutangula sp. n. — Pl. 1, figs. 2—6.

1929. *Schmalenseeia acutangula* WESTERGÅRD, S. G. U., ser. C, no. 355, p. 8, foot-note 1. (Cranidium briefly characterized and distinguished from that of the genotype; no figure.)

Diagnosis. — Distinct from the genotype by having a smooth brim lacking a longitudinal ridge, a short occipital spine, the palpebral lobes situated more closely to the glabella, and acute genal angles.

Description. — Carapace subelliptical, ratio of length and breadth 4:3, fairly flat; dorsal furrows shallow; test smooth.

Cephalon almost semicircular, length slightly more than half the breadth, occupying about two-fifths the total length; genal angles terminating in broad and very short spines. Glabella inconsiderably tapering, rounded in front, anteriorly moderately convex and tending to become bluntly keeled, posteriorly of lower convexity; three pairs of well impressed glabellar furrows, the posterior pair sometimes continuous. Occipital furrow shallow; the scar of a broken occipital spine (apparently directed strongly upwards) usually visible. Brim about half as long as the glabella, in the largest specimens proportionately shorter, flat and smooth; border absent. Palpebral lobes narrow, somewhat varying in length, slightly crescent-shaped and upturned, located close to the glabella. Facial suture and free cheeks as in the genotype.

Thorax of eight segments. Axis almost parallel-sided, in the posterior segments slightly narrowing, gently convex, occupying one-fifth to one-fourth the total breadth; rings smooth. Pleura forming broad and shallow flat-bottomed furrows, the anterior and posterior margins being raised into thread-like ridges, truncate, with pointed posterior corners.

Pygidium probably of seven segments (inclusive of the end-lobe), the segmentation being almost or quite effaced in the posterior portions of the axis and the pleural lobes.

Size. — The holotype, fig. 2, is 4.0 mm long (cranidium 1.6, thorax 1.4, and pygidium 1.0 mm) and 3.0 mm broad; largest cranidium found 2.4 mm long, indicating a total length of 6 mm.

Remarks and Affinities. — Two almost complete specimens, a thorax with attached pygidium, and a great many fragments, in particular cranidia, have been found.

S. acutangula is readily distinguished from *S. amphionura* by the dissimilarities mentioned in the diagnosis. In the acute genal angles the former resembles *Burlingia*. The number of thoracic segments is eight in *acutangula* and was stated to be seven in *amphionura*, a statement based on the single complete specimen found (Westergård, 1922, pl. 1, fig. 19). However, as this is a young individual but 2.8 mm long and as the largest detached cranidia indicate a total length of 6 mm, the number may be eight also in full-grown specimens of the latter.

Horizon and Localities. — Zones of *Ptychagnostus atavus*, *Hypagnostus parvifrons*, and *Ptychagn. punctuosus*. — Scania: Brantevik and Gislövs-hammar (boulders); Baskemölla; S. Sandby (boring). — Jämtland: Hillsand. — Fairly infrequent in the lowest zone in Scania, otherwise rare.

Ceratopygidae RAYMOND, 1913.

The family was discussed by the present writer in 1947.

Proceratopyge WALLERIUS, 1895.

Genotype: *P. conifrons* WALLERIUS, 1895.

As regards the generic diagnosis and the geographical distribution see Westergård, 1947.

Proceratopyge conifrons WALLERIUS, 1895. — Pl. 1, figs. 7—16.

1895. *Proceratopyge conifrons* WALLERIUS, Zonen med *Agnostus laevigatus*, p. 57, pl., figs. 6 a, b. (Description and figs. of cranium and pygidium. Zone of *Lejopyge laevigata*, upper portion. Gudhem and Djupadalen, Västergötland.)
 1895. *Toxotis pusilla* WALLERIUS, partim, idem, p. 59, pl., fig. 7 b. (Only the pygidium, which is a transitory pygidium of the associated *P. conifrons*.)
 1922. *Proceratopyge conifrons* WALLERIUS, Westergård, S. G. U., ser. Ca, no. 18, pl. 2, figs. 1, 2. (New figs. of cranium and pygidium of Wallerius's specimens; the former is the lectotype).

R e m a r k s. — A fairly large material — dismembered fragments but no complete specimen — of this species has been collected at Gudhem and other localities in the Falbygden area of Västergötland.

Young specimens do not display the ocular ridges, and in the adult the ridges are as a rule almost or quite imperceptible; several topotypes with defined ocular ridges are present, however. The pygidium is about twice and a half as broad as long, sometimes even broader; it has four axial rings inclusive of the end-portion (which, exceptionally, is divided by a very weak transverse furrow).

O n t o g e n y. — The youngest cranium observed, at an early stage of the meraspid period, is 0.7 mm long (fig. 7). The glabella is narrow, sub-cylindrical, extending almost to the margin, smooth but with a distinct median tubercle far back; occipital segment faintly defined; border absent; palpebral lobes barely perceptible. In fig. 8, 0.95 mm long, the occipital segment, border, and palpebral lobes are well-defined; otherwise the specimen agrees with the former. Fig. 9, 1.5 mm long, at a late stage of the meraspid (or an early stage of the holaspid?) period, differs from the adult but in having proportionately narrower glabella and almost imperceptible glabellar furrows.

The transitory pygidium of specimens at two stages of the meraspid period is seen in figs. 13—15. In fig. 14, 1.1 mm long, but the foremost axial ring of the true pygidium (from a morphological point of view) is distinctly delimited; in front of this there are four coalesced thoracic segments. Fig. 13, one of Wallerius's specimens of *Toxotis pusilla*, represents the same stage of growth as does fig. 14; it is less well preserved than the latter and both spines are broken. Fig. 15, 1.0 mm long and representing the stage next in order, has four rings in the pygidial axis and three coalesced thoracic segments.

A f f i n i t i e s. — *P. conifrons* is readily distinguished from other congeneric Swedish forms by its broad pygidium. It is most closely allied to *P. similis* WESTERGÅRD (1947), from which it differs in having four instead of five rings in the pygidial axis; furthermore, the glabella is apparently less conical and the anterior branches of the facial suture diverge forward (in full-grown

specimens) instead of being sub-parallel. The species seems also to compare fairly well with *P. lata* WHITEHOUSE (1939) from the early Upper Cambrian of Australia.

Horizon and Localities. — Zone of *Lejopyge laevigata*, upper portion. Gudhem, Torbjörntorp, Djupadalen, and Ödegården, all in the Falbygden area of Västergötland. Not infrequent.

Two not very well preserved cranidia from the *Agnostus pisiiformis* zone of Scania (probably Andrarum) are possibly referable to *P. conifrons*.

Proceratopyge magnicauda sp. n. — Pl. 1, figs. 17, 18.

1947. *Proceratopyge magnicauda* WESTERGÅRD, S. G. U., ser. C, no. 489, pl. 2, fig. 11. (Fig. of the holotype; no diagnosis. Zone of *Lejopyge laevigata*. Andrarum, Scania.)

Diagnosis. — Distinct from the genotype by lacking a median ridge on the brim and having a large multi-segmentate subtriangular pygidium.

Description. — Carapace ovate in outline; cephalon and thorax subequal in length and but slightly longer than the pygidium.

Glabella slightly conical, rounded in front, occupying about three-fourths of the length of the cranidium; posterior pair of glabellar furrows faint, short, parallel to the axial line, anterior pairs imperceptible; a weak median tubercle visible between the furrows mentioned. Occipital furrow (but partly preserved) marked as a pair of impressions at some distance from the dorsal furrows. Brim posteriorly slightly convex and anteriorly slightly concave; border faintly defined. Fixed cheeks somewhat less than half as broad as the glabella; palpebral lobes of moderate size, at equal distance from the anterior and posterior margins of the cephalon; ocular ridges defined, oblique. Posterior limb subequal in breadth to the occipital ring. Anterior branches of the facial suture slightly diverging forwards.

Thoracic axis convex, almost parallel-sided (somewhat conical in the holotype, probably due to the specimen being flattened), occupying about one-fourth the total breadth; axial rings apparently smooth. Pleura terminating in short spines also in the posterior segments.

Pygidium large, triangular in outline; ratio of length and breadth 4 : 7. Axis convex, slightly conical, bluntly pointed, extending to the border, with seven smooth rings (including the end-portion). Pleural lobes with five pairs of pleural furrows and three pairs of interpleural grooves. Border moderately broad, gently concave.

Size. — The holotype, fig. 17, with the thorax somewhat shortened owing to compression, has an apparent length of 36 mm (cranidium 13 and pygidium 12 mm).

Remarks. — Only the specimens illustrated exist. The holotype is preserved in shale, somewhat flattened, and practically wanting the test.

The species is distinct from all Swedish congeneric forms by its large subtriangular pygidium. It compares fairly well with *P. rectispinatus* (the genotype of *Lophnorites* TROEDSSON, 1937) from the Upper Cambrian of Central Asia, the dissimilarities being confined to less significant details: in our form

the ocular ridges are more oblique, the palpebral lobes situated slightly more backwards, and the pygidium is relatively longer.

Horizon and Locality. — Zone of *Lejopyge laevigata*. Andrarum, Scania. Rare.

Corynexochidae ANGELIN, 1854.

Dorypyginae KOBAYASHI, 1935.

Kobayashi regarded Dorypyginae, in which he included the genera *Olenoides* MEEK, *Dorypyge* DAMES, *Kootenia* WALCOTT, and *Holteria* WALCOTT, as a subfamily of Oryctocephalidae (BEECHER) RAYMOND, apparently because of these genera having marginal spines on the pygidium in conformity to the latter group. On the other hand, as regards the cephalon Dorypyginae differs from Oryctocephalidae but resembles Corynexochidae, and as the characters of the cephalon in other groups have proved to be of higher taxonomic value than has the shape of the pygidial border R. & E. Richter (1941 b) removed Dorypyginae into Corynexochidae.

Dorypyge DAMES, 1883.

Genotype: *D. richthofeni* DAMES, 1883.

The genus was originally described from China and since then a great number of species from eastern Asia, Siberia, Bornholm, England and Wales, and eastern and western North America have been included in it, several of which have subsequently been removed into *Olenoides* MEEK and *Kootenia* WALCOTT, however. A historical review of this question was given by Lake (1938). The group was revised by Resser in 1942, rather a difficult task as many forms are very imperfectly known. He recognized but a number of forms from eastern Asia and an imperfectly known species from North Wales (Nicholas, 1916) as true species of *Dorypyge*. Furthermore, two species from Bornholm described by Grönwall (1902), *D. oriens* from the Exsulans limestone and *D. danica* from the zone of *Bailiella aequalis* (= lower part of our zone of *Ptychagnostus punctuosus*), in addition to the English *D. rushtonensis* COBBOLD (Cobbold & Pocock, 1934) and two undescribed species from south-eastern Newfoundland, were retained in *Dorypyge*, «although they likely represent another genus» (Resser, 1942, p. 21). Even if this suggestion proves to be correct, there will be no doubt but that the Swedish species to be described belongs in *Dorypyge*.

The genus in a restricted sense seems to be confined to the (late?) Middle Cambrian; it has long been known from the West Pacific and Acado-Baltic Provinces, and recently it was recorded also from Australia (Whitehouse, 1945).

Dorypyge aenigma (LINNARSSON, 1869). — Pl. 2, figs. 1—8.

1869. *Trilobites aenigma* LINNARSSON, Vet.-Akad. Handl., vol. 8, no. 2, p. 83, figs. 63, 64. (Description and figs. of two fragments of the pygidium. *Paradoxides forchhammeri* beds. Hällekis, Kinnekulle, Västergötland.)

1931. *Dorypyge aenigma* (LINNARSSON), Westergård, S. G. U., ser. Aa, no. 172, p. 44. (Species identified as a member of *Dorypyge*.)

Description. — Cranidium greatly convex transversely and longitudinally. Dorsal furrows well impressed, deepening into a pair of pits near the anterior corners of the glabella, shallow in front. Glabella rises high above the cheeks, slightly widened in its middle portion, extends to the border, gently rounded in front; two pairs of very weak glabellar furrows indicated on the largest specimen present (17 mm long), imperceptible on small specimens. Occipital furrow deep; occipital ring broadening to the middle, with the scar of a median spine apparently directed obliquely upwards. Border moderately convex, narrow in front of the glabella, broadening towards the sides. Fixed cheek moderately arched, less than half as broad as the glabella; palpebral lobe fairly small, upturned, placed slightly more closely to the posterior than to the anterior margin; palpebral furrow shallow. Ocular ridges obsolete. Free cheek subtriangular in shape; border convex, increasing slightly in breadth backwards, almost as broad as the ocular platform; marginal furrow broad and shallow; genal angle prolonged into a stout spine that is bent slightly outwards at its base and then curved slightly inwards. Anterior branches of the facial suture converging forwards (on a dorsal view of specimens retaining the original convexity, due to the anterior angles being turned sharply down), posterior branches running obliquely outwards and cutting the posterior margin at a distance from the dorsal furrow slightly less than the width of the occipital ring.

Hypostoma moderately convex, with a pair of large and flat anterior wings. Middle body inconsiderably widened anteriorly, bounded throughout by a well-defined furrow (in one specimen shallow in front). Lateral borders slightly widened about half-way between the rounded posterior corners and the anterior wings. Surface of the middle body faintly wrinkled, at the rear quite smooth; lateral and posterior borders with faint ridges and scattered small granules.

Thorax known only from a few detached segments of which that in fig. 4 is the one best preserved. Axis strongly convex, bearing a median spine. Pleuron geniculate, proximal part horizontal, distal part bent down at an angle of 30° to 40°; pleural furrow broad and shallow near the dorsal furrow, narrowing and deepening outwards, dividing the pleuron into two steep-sided ridges subequal in size; anterior ridge prolonged into a fairly coarse, almost straight and horizontal spine, bounded anteriorly by a depressed narrow flat strip that is thread-like in its proximal part and increases in breadth outwards; posterior ridge obliquely truncated.

Pygidium fairly large, sub-trapezoidal in outline; ratio of length and breadth (spines excluded) 4 : 7. Axis occupying slightly more than one-third of the total breadth at the anterior margin, strongly convex, bounded by deep dorsal furrows, at the rear dipping almost perpendicularly to the border, divided by deep furrows into four rings, of which the three anterior ones are equal in sagittal length, the fourth twice as long as the former, and the first somewhat broader than the succeeding ones; median spines absent. Pleural lobes moderately arched, with four pairs of narrow pleural furrows extending across the border to the margin, the three anterior pairs deep, the fourth pair shallow.

Ribs steep-sided and almost flat-topped, lacking all traces of interpleural grooves, terminating in strong straight horizontal spines, the last pair coarser and longer than the remainder. Border well-defined, almost horizontal at the sides, narrower and slanting downwards behind the axis.

Or n a m e n t. — Surface of the test on cephalon, thorax, and pygidium ornamented with close-set fairly coarse granules subequal in size, except in the bottom of all furrows and on the palpebral lobes, which are quite smooth.

S i z e. — Largest cranidium found 17 mm and largest pygidium 11 mm long (spines excluded).

R e m a r k s. — The fragments of the pygidium illustrated by Linnarsson are kept in the collections of the Geological Survey; the specimen fig. 63, which is somewhat more complete than the illustration, is the lectotype.

A f f i n i t i e s. — *D. aenigma* compares fairly well with the genotype. In the cranidium the differences seem to be mainly confined to the glabellar furrows being less defined — absent in young specimens — and the granules on the test slightly coarser and more evenly distributed in the former than in the latter. In the pygidium the dissimilarities are more conspicuous: in the genotype the pleural furrows do not cross the border, the ribs have well-defined interpleural grooves, and there is a sixth pair of short and blunt marginal spines behind the axis.

Nicholas (1916) described a form, *D. cf. richthofeni*, from the *Paradoxides davidis* zone (?) in North Wales, which was later discussed by Lake (1938); unfortunately it is known but from small fragments of the cranidium and pygidium too incomplete for specific determination. Lake suggested that the species is probably identical with *D. aenigma*. It is true that the Welsh form resembles the Swedish one as far as a comparison is possible, but it should be noted that the former seems to occur at a considerably lower horizon (at the base of, or immediately below, the zone of *Paradoxides davidis*?) than does the latter.

D. aenigma is sharply distinct from Grönwall's Bornholm forms and also from the English *D. rushtonensis* COBBOLD, which is approximately contemporaneous with our species.

H o r i z o n a n d L o c a l i t i e s. — Zone of *Solenopleura brachymetopa* (Andrarum limestone and Exporrecta conglomerate. The specimens in figs. 1—7 occur in a greenish gray slightly glauconitic limestone which wholly or partly replaces the conglomerate mentioned at a few localities in Västergötland). — Scania: Andrarum; Kiviks-Esperöd. — Västergötland: Hälleklis and Råbäck, Kinnekulle; Dämma, Northern Billingen; Mösseberg; Torbjörntorp; Djupadalen; Ödegården. — Very rare in Scania, infrequent in Västergötland.

Corynexochinae (ANGELIN, 1854) RAYMOND, 1928.

Corynexochus ANGELIN, 1854.

Genotype: *C. spinulosus* ANGELIN, 1854.

Resser revised this group in 1936 and removed several of the forms earlier included in *Corynexochus* into *Bonnia* WALCOTT (the Lower Cambrian species)

†1—481975. *S. G. U. Ser. C. No 498, Westergård.*

and *Bonnaspis* RESSER; *Corynexochus* was thereby confined to the Middle Cambrian in the Acado-Baltic Province (Scandinavia, England and Wales, southern France, and south-eastern Newfoundland).

Corynexochus spinulosus ANGELIN, 1854. — Pl. 3, figs. 7—9.

1854. *Corynexochus spinulosus* ANGELIN, partim, Pal. Scand., fasc. II, p. 59, pl. 33, figs. 9, 9 a; not fig. 11. (Diagnosis and figure of cranidium from the Andrarum limestone. Andrarum, Scania.)
 1902. *Corynexochus spinulosus* ANGELIN, Grönwall, D. G. U., II. Raekke, no. 13, pp. 139, 216, pl. 4, figs. 3, 4. (Description and figs. of cranidium — one of Angelin's specimens — and associated pygidium distinct from that tentatively referred to the species by Angelin.)
 1916. *Corynexochus spinulosus* ANGELIN, Walcott, Cambr. Geol. and Paleont., vol. 3, no. 5, p. 323, pl. 55, figs. 1, 1 a—b. (Grönwall's description translated into English and copies of his figs.)

Remarks. — The cranidium illustrated by Grönwall has exactly the length, 5.3 mm, of that depicted by Angelin and as it in all probability is one of Angelin's specimens it is the lectotype; it belongs to the Paleozool. Dept. of the Swedish Museum of Nat. Hist. (No. Ar. 1951 a).

Grönwall's description may be supplemented in some details. The well impressed dorsal furrows deepen into a pair of pits a little behind the rounded corners of the glabella and are very weak in front of the pits. In some specimens the glabella is relatively more widened anteriorly and, accordingly, the dorsal furrows are not so straight as in the lectotype. The glabellar furrows are usually faint or even obliterated, rarely so distinct as in the lectotype. Occipital node faint and obtuse, sometimes almost indiscernible. The surface of the test is smooth and punctate, on the cheeks occasionally also exhibiting scattered small granules with a pit in the top.

Thorax unknown. *C. minor* (WALCOTT) from the *Paradoxides davidis* zone in south-eastern Newfoundland, a true *Corynexochus*, has seven thoracic segments; the axis is convex with a very short median node or spine on each segment; the pleura are geniculate, furrowed, and pointed.

The pygidium¹ illustrated by Grönwall in all probability belongs to this species; it is but 1.5 mm long and obviously a young specimen. The border is fairly well defined, a feature which may be variable, however. Specimens referable to *C. spinulosus* have the marginal furrow almost or quite effaced as in our fig. 9 and, accordingly, agree better with *C. bornholmiensis* GRÖNWALL.

C. spinulosus is closely allied to *C. bornholmiensis* from the zones of *Hypagnostus parvifrons* and *Ptychagnostus punctuosus*, which may be an ancestral form of Angelin's species. Constant differences seem to be: in *spinulosus* the cranidium and pygidium are more strongly arched, the dorsal furrows are deeper, the breadth of the free cheeks across the palpebral lobes is somewhat narrower, and the posterior branch of the facial suture is bent more strongly outwards than in *bornholmiensis*.

Horizon and Localities. — Zone of *Solenopleura brachymetopa* (Andrarum limestone and Exporrecta conglomerate). — Scania: Andrarum; Kiviks-Esperöd; Baskemölla; Gislövshammar (boring). — Västergötland:

¹ As regards the pygidium referred by Angelin to *C. spinulosus* see p. 15, foot-note 2.

Ödegården; Djupadalen; Hällekis, Kinnekulle; Munkesten, Hunneberg. — Närke: Ullavi.

Zone of *Lejopyge laevigata*. — Scania: Andrarum.

Infrequent in the lower and very rare in the upper zone.

Corynexochus sp. — Pl. 3, figs. 10, 11; text-fig. 1.

The cranium illustrated, 1.3 mm long, is preserved in shale but retains its original convexity except that the posterior limbs seem to be somewhat flattened. It differs from *C. spinulosus* in the glabella anteriorly being more widened and inflated (the posterior portion is depressed below the surface of the cheeks, which may be an adventitious feature). The palpebral lobes are not retained, but are apparently proportionately smaller than in *spinulosus*.



Text-fig. 1. *Corynexochus* sp. Pygidium associated with the cranium illustrated on pl. 3, fig. 11. Andrarum (boring), Scania. — $\times 8$.

The associated pygidium differs from that of *spinulosus* in its subtriangular outline. Possibly this form is an immature form of Angelin's species. It should be noted, however, that in the features mentioned it is distinct also from the smallest cranium (1.9 mm long) that beyond doubt belongs to *spinulosus*.

Horizon and Locality. — Zone of *Lejopyge laevigata*, about 0.1 m above the Andrarum limestone. Andrarum (boring no. 1; Westergård, 1944 a), Scania.

Dolichometopinae WALCOTT, 1916.

Dolichometopus ANGELIN, 1854.

Genotype: *D. suecicus* ANGELIN, 1854.

A great many species from the Middle Cambrian of eastern and western North America and eastern Asia have been included in *Dolichometopus* (cf. Walcott, 1916 b, pp. 355—374). On the other hand, Resser (1935, p. 22) retained but one of them, *D. acadicus* MATTHEW, in this genus and removed the remainder into various other genera. Thus, in this restricted sense, *Dolichometopus* comprises but two hitherto known forms from the late Middle Cambrian of the Acado-Baltic Province.

Dolichometopus suecicus ANGELIN, 1854. — Pl. 3, figs. 12—16.

- 1854. *Dolichometopus suecicus* ANGELIN, Pal. Scand., fasc. II, p. 72, pl. 37, figs. 9, 9 b—c. (Generic and specific diagnoses; figs. of cranium and pygidium Andrarum limestone. Andrarum, Scania.)
- 1878. *Dolichometopus suecicus* ANGELIN, Brögger, Nyt. Mag. Naturv., vol. 24, p. 46 (30), pl. 3, figs. 12, 12 a. (Figs. of cranium and pygidium. *Paradoxides forchhammeri* beds. Krekling, Norway.)
- 1897. *Dolichometopus suecicus* ANGELIN, Matthew, Trans. Roy. Soc. Canada, 2d. ser., vol. 3, sect. 4, p. 184, pl. 3, figs. 7 a—b. (Fig. of cranium, one of Angelin's specimens.)
- 1916. *Dolichometopus suecicus* ANGELIN, Walcott, Cambr. Geol. Paleont., vol. 3, no. 5, p. 372, pl. 50, figs. 3—4. (Remarks on species; figs. of cephalon and pygidium from the type locality.)

Description. — Cranidium strongly arched transversely and longitudinally; length subequal to the breadth across the palpebral lobes. Dorsal furrows moderately deep. Glabella large, extending to the marginal furrow, slightly clavate to subcylindrical; three pairs of faint glabellar furrows perceptible on young but quite effaced on full-grown specimens retaining the test. Occipital furrow shallow, curving forwards; occipital ring widening to the middle, smooth. Border moderate, gently arched to flat. Fixed cheeks across the palpebral lobes about three-fourths as broad as the glabella, sloping from the dorsal furrows. Palpebral lobes about half as long as the glabella, narrow, at subequal distance from the anterior margin and the posterior marginal furrow; palpebral furrow well-defined; ocular ridges oblique. Anterior branches of the facial suture diverging slightly forwards, posterior branches running outwards and slightly backwards and cutting the posterior margin at a distance from the dorsal furrows somewhat longer than the width of the occipital ring. An imperfect free cheek possibly belonging here has the genal angle bluntly pointed.

Thorax unknown.

Pygidium large, length about two-thirds of the breadth, with evenly rounded posterior margin, moderately arched. Dorsal furrows weak. Segmentation faintly marked in young and practically effaced in full-grown specimens retaining the test. Axis rising inconsiderably above the pleural lobes, occupying barely one-fourth of the total breadth, slightly tapering, extending into the border. Border broad, usually with an interior slightly convex and an exterior flat band.

Test of cephalon and pygidium apparently smooth, under a strong lens minutely punctate.

Size. — Largest cranidium about 31 mm long, largest pygidium 20 mm long and 29 mm broad.

Remarks and Affinities. — All furrows are markedly shallower on specimens retaining the test than on internal casts. Thus, on exfoliated adult specimens the glabellar furrows are sometimes traceable and the segmentation of the pygidium is fairly well defined with up to 5 axial rings and 4 pairs of pleural furrows and very faint interpleural grooves.

D. suecicus compares fairly well with the Canadian *D. acadicus* MATTHEW (1897), which probably occurs at a somewhat lower horizon; the former has a proportionally broader cranidium and glabella and slightly shorter palpebral lobes situated more remote from the glabella.

Horizon and Localities. — Zone of *Solenopleura brachymetopa* (Andrarum limestone and Exporrecta conglomerate). — Scania: Andrarum; Kiviks-Esperöd; Gislövshammar (boring). — Öland: on the shore NW of Ventlinge; Degerhamn. — Västergötland: Ödegården; Djupadalen; Hällekis, Kinnekulle; Byklev and Munkesten, Hunneberg. — Jämtland: Brunflo. — Fairly infrequent.

Norway: Krekling.

Dikelocephalidae MILLER, 1890.**Richardsonellinae** RAYMOND, 1924.

In this subfamily, which was grouped under Dikelocephalidae, Raymond (1937) included *Richardsonella* RAYMOND (1924) and *Highgatea* RAYMOND (1937), the genotypes of which are unfortunately imperfectly known. Rasetti (1944) considered the latter genus to be a synonym of *Loganellus* DEVINE (1863); even though additional and more complete material proves *Highgatea* to be a valid genus, it can hardly be doubted that it is closely allied to *Loganellus*. As stated below, the essential features of the dorsal shield and hypostoma in the Scandinavian form *Andrarina* («*Liostracus*») *costata* closely resemble those in *Loganellus logani*, a fact that was observed by Strand (1929) and induced him to consider these species congeneric. The genus *Nericia* to be described, which has much in common with *A. costata*, may also belong to this subfamily. In the present writer's opinion the reference of Richardsonellinae to Dikelocephalidae is questionable (see also Kobayashi, 1935, p. 309).

Andrarina RAYMOND, 1937.

Genotype: *Liostracus costatus* ANGELIN, 1854.

Raymond suggested *Andrarina* nom. nov. vice *Liostracus* ANGELIN since *Leiostracus* was used as the generic name of a gastropod by Albers in 1850. However, the genotype of *Liostracus* is *L. costatus*, definitively assigned by Linnarsson in 1873, not *L. aculeatus* as suggested by Matthew in 1888 and accepted by subsequent American, English, and Asiatic authors, an inadvertency which has caused a great deal of nomenclative confusion, as *costatus* and *aculeatus* are generically distinct. According to the International Rules *L. costatus* is thus the genotype of *Andrarina* despite Raymond having assigned *L. aculeatus* as the type.¹

Strand (1929) included *A. costata* in *Loganellus* DEVINE, the type of which is *Olenus? logani* DEV. from the Upper Cambrian of Quebec, Canada. Thanks to the courtesy of Professor Heintz of Oslo the present writer has had the opportunity to examine a cast of the holotype of *L. logani*, a practically complete specimen showing the hypostoma in situ.² In general shape the forms agree, the dissimilarities being as follows: *A. costata* has shorter and more truncate glabella and a longer brim, broader fixed cheeks, the palpebral lobes situated more closely to the anterior than to the posterior margin of the cephalon (*vice versa* in *L. logani*), almost transverse instead of oblique ocular ridges, and the posterior branches of the facial suture running more directly backwards; in the thorax, which has twelve segments in both, the fulcrum of the pleura is somewhat more remote from the dorsal furrows and the pleural spines are shorter and broader; in the pygidium and hypostoma no significant differences seem to exist. The dissimilarities are thus not very important and

¹ As regards this question cf. Westergård, 1940, pp. 62—63, foot-note 2, and Rud. Richter, Neues Jahrb. f. Min., etc., Referate III, Jahrg. 1940, pp. 1032—33.

² See also Rasetti, 1944, pl. 38, figs. 13, 14.

opinions may vary as to their taxonomic value, but even if the forms be considered congeneric, *Loganellus* becomes a synonym of *Liostracus* and, consequently, also of *Andrarina* (cf. Rud. Richter, 1940).

In the cranidium *A. costata* differs from *Olenus* in but one essential criterion: the anterior branches of the facial suture diverge forwards instead of being subparallel, a feature found also in some Olenidae, *Parabolinella* BRÖGGER and *Beltella* LAKE. As *A. costata* otherwise agrees with *Olenus* in the cranidium and hypostoma, the present writer (1922) was inclined to consider the former a forerunner of the latter. However, since Strand (1929) proved that the number of thoracic segments is less in the former than in the latter, which in addition to its larger pygidium indicates that the former is more advanced than the latter, this opinion cannot be upheld. But it does not seem out of question that *A. costata* arose from the stock of the Olenidae.

Andrarina costata (ANGELIN, 1854). — Pl. 3, figs. 22, 23; pl. 4, figs 1—4.

1854. *Liostracus costatus* ANGELIN, Pal. Scand., fasc. II, p. 90, pl. 41, figs. 16, 16 a, b. (Inexpressive diagnosis; figs. of impressions of cranidium and pygidium. Zone of *Lejopyge laevigata*. Hönsäter, Kinnekulle, Västergötland.)
 1869. *Liostracus costatus* ANGELIN, Linnarsson, Vet. Akad. Handl., vol. 8, no. 2, p. 71. (Description of the free cheek; records species also from Billingen, Västergötland.)
 1873. *Liostracus costatus* ANGELIN, Linnarsson, G. F. F., vol. 1, p. 245. (Assigns species as the genotype of *Liostracus*.)
 1895. *Liostracus costatus* ANGELIN, Wallerius, Zonen med *Agnostus laevigatus*, pp. 49, 54, text-figs. 6, 10. (Remarks on species; sketches of cephalon and pygidium. Gudhem, Västergötland.)
 1901. *Liostracus costatus* ANGELIN, Holm, S. G. U., ser. C, no. 172, p. 30, text-fig. 22. (New figure of the pygidium illustrated by Angelin.)
 1929. *Loganellus costatus* (ANGELIN), Strand, Norsk geol. tidsskr., vol. 10, p. 354, pl. 2, figs. 7—10 [11?]. (Exhaustive description of the dorsal shield; figs. of cranidium, free cheek, and complete thorax with attached pygidium. Zone of *Lejopyge laevigata*. Mjösen district, Norway.)

R e m a r k s. — New figs. of the specimens illustrated by Angelin are to be seen on pl. 3, figs. 22 and 23; the pygidium is the lectotype.

The hypostoma, which has hitherto been unknown, is of the same type as that of *Olenus*; the highly arched middle body is separated from the slightly upturned anterior border by a fairly broad groove, the middle and posterior furrows are weak, and the lateral borders prominent; maculae indiscernible.

The number of thoracic segments was proved to be twelve by Strand.

The test of the dorsal shield is smooth to the naked eye but under the microscope it usually proves to be either finely punctate or granulate, in the latter case with or without a pit in the top of the minute granules.

The form with a triangular and narrower pygidium identified by Strand as a variety of *costata* [?] has not been observed in the *laevigata* zone at any Swedish locality.

The largest cranidium present is 14 mm long, the largest pygidium 12 mm long and 25 mm broad, indicating a total length of 40 to 50 mm. (An imperfect cranidium probably of this species from Ödegården, Västergötland, is about 19 mm long.)

H o r i z o n a n d L o c a l i t i e s. — Zone of *Lejopyge laevigata*. — Östergötland: Knivinge; Skåningstorp. — Västergötland: Ödegården; Djupadalen;

Torbjörntorp; Gudhem; Karlsfors, Billingen; Hönsäter and Hällekis, Kinnekulle. — Närke: Vrana; Ullavi; Sättran; Östra Rynninge. — Everywhere infrequent.

In the same zone in the Mjösen district and Rendalen, Norway.

Nericia gen. n.¹

Genotype: *N. quinquedentata* sp. n.

D i a g n o s i s. — Carapace ovate, moderately arched. Dorsal furrows well impressed. Test smooth, under a lens minutely punctate.

Glabella tapering, rounded in front, does not extend to the border; glabellar furrows weak. Brim fairly long; border well-defined. Palpebral lobes medium-sized, situated about at the middle of the cheeks. Ocular ridges oblique. Anterior branches of the facial suture diverging forwards. Genal angles prolonged into spines. Hypostoma of the same type as in *Olenus*.

Thorax of 12 segments in the genotype. Axis prominent, slightly conical. Pleura geniculate, furrowed, terminating in short spines.

Pygidium of moderate size, well segmented, with a fairly broad flat border and dentate margin.

R e m a r k s. — In general aspect *Nericia* recalls the associated *Andrarina costata*, the differences being mainly the following. In *Nericia* the glabella is somewhat more conical and rounded in front instead of subrectangular, the ocular ridges are oblique instead of almost transverse, the fulcrum is situated closer to the dorsal furrows, and in the pygidium the axis and border are relatively broader and the margin dentate instead of entire. The forms may be generically distinct, but closely related.

Nericia should also be compared with *Marjumi* WALCOTT, whose genotype, *M. typa* WALCOTT (1916 b), was recorded from the late Middle Cambrian of Utah, U. S. A. In cephalon and thorax the genera seem to agree except that *Nericia* has less tapering glabella and 12 thoracic segments, whereas the number is 14 in *Marjumi* (in the respective genotypes). As regards the pygidium the differences are conspicuous, particularly in the well-defined border distinctive of the Swedish genus being absent in the American. Both genera have marginal spines (stout in *M. typa* and short in *M. newfoundlandensis* LOCHMAN, 1938).

Only two species to be described, both from the zone of *Lejopyge laevigata*, are so far referable to *Nericia*.²

Nericia quinquedentata sp. n. — Pl. 4, figs. 5—9.

D i a g n o s i s. — See that of the genus.

¹ Latinized form of Närke.

² The pygidium which Angelin (1854, pl. 33, fig. 11) tentatively combined with the cranium of *Corynexochus spinulosus* has been sought in vain (cf. Lake, 1934, p. 181, and Grönwall, 1902, p. 139), and the present writer has never found in the Andrarum limestone any specimen like Angelin's figure. It compares fairly well with that of *Nericia* and may belong to a species of this genus, whose cranium has not been discovered.

Description. — Glabella inconsiderably more than half as long as the cranium, conical, rounded in front; one or two pairs of very weak lateral furrows sometimes discernible in certain light. Dorsal furrows deepening into a pair of pits at the anterior corners of the glabella, shallow at the middle line. Occipital furrow shallow, fading out at the dorsal furrows; occipital ring equal in sagittal length throughout, with a very faint median tubercle, often imperceptible on specimens retaining the test. Brim about one-third as long as the glabella, flat to very slightly convex (never concave), smooth or with faint close-set ridges perpendicular to the marginal furrow. Border well-defined, in sagittal length subequal to the brim, flat to gently arched, moderately upturned; anterior margin strongly convex. Fixed cheeks almost flat, across the palpebral lobes somewhat narrower than the glabella in front. Palpebral lobes moderate, slightly upturned. Ocular ridges usually definite, on specimens retaining the test sometimes almost effaced, oblique. Posterior limb subequal in width to the occipital ring. Free cheeks about as broad as the fixed cheeks, with faint anastomosing ridges radiating from the aperture of the eye, terminating in a stout spine a little shorter than the cheek proper and forming an obtuse angle with the posterior margin. Anterior branches of the facial suture running from the eyes forwards—outwards directly to the border, then curving forwards and strongly inwards, reaching the margin about half-way between the corners of the cranium and the middle line; posterior branches running almost straight backwards—outwards.

Thorax of twelve segments. Axis prominent, tapering continuously, its width being in the anterior segments subequal to, and at the rear narrower than, the pleura; axial rings smooth. Pleura geniculate, with fulcrum situated more closely to the dorsal furrows than to the tips, deeply furrowed, terminating in short spines.

Pygidium fully twice as broad as long. Axis prominent, conical, at the rear sloping abruptly to the border, with five or six smooth rings (inclusive of the end-lobe), the furrow between the fifth and sixth rings faint to effaced. Pleural lobes gently arched, with three pairs of well-defined ribs displaying faint interpleural grooves. Border well-defined, flat, increasing in breadth to the sides, with five pairs of small marginal spines, which are somewhat upturned (usually broken).

Size. — The holotype, a dorsal shield somewhat below middle size, is 30 mm long (cranium 11.4, thorax 14, and pygidium 4.6 mm) and 19 mm broad across the thorax. The largest cranium found is 27.5 mm long, indicating a total length of 70 mm.

Remarks. — In addition to the specimens illustrated a great many detached parts of the dorsal shield and hypostomata have been found at the type locality.

Horizon and Localities. — *Paradoxides forchhammeri* beds; as most slabs have yielded no other species than *Lejopyge laevigata*, in many of them common, the species may be confined to the zone of the latter. — Närke: Ullavi (type locality) and Gymninge.

Nericia septemdentata sp. n. — Pl. 4, figs. 10—12 (13?).

D i a g n o s i s. — Distinct from the genotype by having a larger pygidium with seven instead of five pairs of marginal spines and relatively narrower axis.

R e m a r k s. — Only the fragments illustrated have been found. The imperfect cranidium, fig. 10, agrees with that of the genotype except that the brim is concave and twice as long as the border. The free cheek, fig. 11, which may belong here, wants the test and displays a very broad and faintly striated doublure; it cannot be decided whether the genal angle is truncate or prolonged into a spine. An associated large hypostoma, fig. 13, has possibly a pair of posterior wings, and in such a case it is not referable to this species.

The pygidium is semicircular in outline. Axis prominent, conical, at the rear strongly tapering and sloping abruptly to the border, with at least six discernible segments. Pleural lobes arched, with four pairs of flat-topped ribs separated by deep pleural furrows and marked with faint interpleural ridges. Border flat, equal in breadth throughout, with seven pairs of short marginal spines that are slightly upturned. Test smooth, under a strong lens minutely punctate.

S i z e. — Cranidium 21 mm long; holotype pygidium 20 mm long and 41 mm broad. (Provided that the ratio of length of pygidium and dorsal shield in *septemdentata* is about the same as in the genotype, the former attained a total length of at least 110 mm.)

H o r i z o n a n d L o c a l i t y. — Zone of *Lejopyge laevigata*, upper part. Gudhem, Västergötland. Extremely rare.

Conocoryphidae ANGELIN, 1854.¹

Ptychopariinae MATTHEW, 1887.

Conocephalina BRÖGGER, 1886.

Genotype: *Conocephalites ornatus* BRÖGGER, 1878.

Most of the species referred to this genus are so imperfectly known that their generic reference must so far be more or less uncertain. The forms earlier included in the genus from North America (Walcott, 1912 and 1914) and eastern Asia (Walcott, 1913; Sun, 1924 and 1935) have subsequently been placed under several other genera. Thus, members of *Conocephalina* in a restricted sense, seem to be known only from the Middle and Upper Cambrian in the Acado-Baltic Province (Scandinavia, England and Wales).²

For the present the taxonomic position of *Conocephalina*, of which no complete specimen has been found, cannot be definitely settled. It is here placed under Ptychopariinae, but its resemblance in the cephalon to *Anomocare* ANGELIN may indicate that it belongs in Anomocaridae POULSEN (1927), which according to Poulsen probably arose from the Ptychopariidae.³

¹ As regards the reason for substituting the family name Conocoryphidae for Ptychopariidae cf. R. & E. Richter, 1941 b, pp. 50, 51.

² Cf. Lake, 1931, pp. 127—129; Kobayashi, 1935, pp. 234, 235; Resser, 1942, pp. 13, 23, 29, 46.

³ Kiaer (1916) regarded *Anomocare* as having descended from the same stock as *Ellipsocephalus*. In fact there is in the cephalon a striking resemblance between the adult *A. laeve* and the meraspid forms of *E. polytomus* (Westergård, 1936).

Conocephalina suecica (WALLERIUS, 1895). — Pl. 3, figs. 1—4, (5?), 6.

1895. *Conocephalites suecicus* WALLERIUS, Zonen med *Agnostus laevigatus*, p. 50, text-fig. 4, pl., figs. 4 a, b. (Description and indifferent figs. of the cranidium and a sketch of the free cheek. Zone of *Lejopyge laevigata*, upper part. Djupadalen and Gudhem, Västergötland.)
 1930. *Conocephalites suecicus* WALLERIUS, G. F. F., vol. 52, p. 60, text-fig. 9. (Pygidium illustrated. Gudhem, Västergötland.)

Description. — Wallerius's detailed description (in Latin and Swedish) of the cranidium may be supplemented as to the following features: a third pair of very faint glabellar furrows is usually perceptible in specimens of different sizes and the occipital ring bears a small median node, better defined in young than in full-grown specimens. The glabella is shorter and the brim longer in young than in adult specimens. The free cheek is fairly broad, with weak anastomosing ridges radiating from the eye; genal spine considerably longer than the cheek proper, coarse and straight in its proximal and slender and curving inwards in its distal portion, forming an angle of about 130° with the posterior margin.

An associated thoracic segment, fig. 5, possibly belongs to this species; another form, which should be taken into account, is like this one except that it wants the axial node.

Pygidium almost three-fourths as long as broad, evenly rounded in outline. Axis strongly convex, occupying anteriorly about two-fifths of the total breadth, with four smooth rings separated by shallow furrows, rapidly narrowing behind the fourth ring to a conical ridge sloping to the margin. Pleural lobes gently arched; first pair of pleural furrows well-defined, second pair faint, third pair sometimes perceptible; first and second pairs of interpleural grooves (or ridges) faint to obsolete. Border fairly broad, almost flat, indistinctly set off from the pleural platform.

Ornament. — The test of the cranidium is smooth to the naked eye but under a strong lens it proves to be granulate, the granules being very fine and close-set. Quite the same ornament is to be found also on the pygidium, which therefore may confidently be referred to this species.

Size. — Largest cranidium found 13.5 mm and largest pygidium 6 mm long.

Remarks. — The material of this form is scanty, there having been found but a few more or less defective cranidia, free cheeks, and pygidia.

In the cranidium *C. suecica* differs from the genotype (from the zone of *Paradoxides rugulosus*) in having somewhat shorter and anteriorly more tapering glabella and a longer brim. The pygidium of the former is narrower, the axis broader, and the margin entire instead of dentate.

Horizon and Localities. — Zone of *Lejopyge laevigata*, upper part. Västergötland: Gudhem; Torbjörntorp; Djupadalen (type locality). Rare.

? *Solenopleuridae* ANGELIN, 1854.

Acrocephalites WALLERIUS, 1895.

Genotype: *Calymene stenometopa* ANGELIN, 1851.

In *Acrocephalites* Walcott (1916 a) included a great number of North American forms which Resser (1935) removed into various other genera. In the

restricted sense given the genus by the latter writer there remain, in addition to the genotype and its subspecies *agnostorum* and *olenorum* to be described, but *A. vigilans* WALCOTT & RESSER (1924) from Novaya Zemlya (and, possibly, *A. ? rarus* WESTERGÅRD, 1922), the genus thus being so far confined to the late Middle and Upper Cambrian in the Acado-Baltic Province.

The family reference of this genus is uncertain. Kobayashi (1935) placed it in his new subfamily Dokimocephalinae of Solenopleuridae.

Acrocephalites stenometopus (ANGELIN, 1851). — Pl. 2, figs. 9—13.

1851. *Calymene stenometopa* ANGELIN, Pal. Suec., fasc. I, p. 24, pl. 19, fig. 4. (Indifferent diagnosis and restored, partly inadequate fig. of cephalon. Regio Olenorum. Gudhem (type locality), Västergötland; [Södra] Möckleby, Öland.)
1854. *Solenopleura? stenometopa* ANGELIN, Pal. Scand., fasc. II, p. 28, pl. 19, fig. 4. (Same diagnosis and fig. as in fasc. I.)
1895. *Acrocephalites stenometopus* (ANGELIN), Wallerius, Zonen med *Agnostus laevigatus*, p. 53, text-fig. 5, pl., figs. 5 a—c. (Species assigned as the type of the new genus *Acrocephalites*. Description and schematic figs. of cranidium and free cheek. Zone of *Lejopyge laevigata*, upper part. Gudhem and Djupadalen, Västergötland.)
1916. *Acrocephalites stenometopus* (ANGELIN), Walcott, Cambr. Geol. and Paleont., vol. 3, no. 3, pp. 174, 181, pl. 24, figs. 1, 1 a, b. (Genus and species discussed; figs. of cranidium and free cheek from the type locality.)
1922. *Acrocephalites stenometopus* (ANGELIN), partim, Westergård, S. G. U., ser. Ca, no. 18, pp. 123, 195, pl. 1, fig. 20. (Only the cranidium from the Exporrecta conglomerate at Köpings klint, Öland; not figs. 21 a—c.)
1930. *Acrocephalites stenometopus* (ANGELIN), Wallerius, G. F. F., vol. 52, p. 59, text-fig. 8. (Comments on species; fig. of cranidium from the type locality.)

Description. — Cranidium strongly convex transversely and longitudinally, usually faintly keeled; anterior outline angulate, projecting into a short blunt median cusp. Dorsal furrows deep, broadening backwards. Glabella occupying between a half and three-fifths of the length of the cranidium, tapering forwards, gently rounded to almost truncate in front, with three pairs of oblique furrows, the first (posterior) pair of which is sometimes furcate and the third pair weak and often obsolete. Occipital furrow well defined, deeper at the sides than at the middle; occipital ring widening to the axial line and bearing a strong spine directed obliquely upwards. Brim raised into a pronounced boss which occupies the whole area between the glabella and border and is bounded to the sides by broad and shallow depressions. Border convex, sometimes slightly swollen at the axial line; marginal furrow relatively narrow and shallow at the axial line (in specimens retaining the test), broadening and deepening to the sides. Fixed cheeks more than half as wide as the glabella, swollen, but lower than the latter. Palpebral lobes moderate, semicircular, slightly upturned, situated at the middle of the cheek. Ocular ridges imperceptible or weak. Free cheeks subequal in breadth to the fixed cheeks, gently arched; border well-defined, convex; genal spine stout, about half as long as the cheek proper, at the base bent slightly outwards and then curving slightly inwards. Anterior branches of the facial suture almost perpendicular to the border (in a dorsal view converging forwards due to the anterior angles being turned strongly downwards); posterior branches running backwards-outwards and cutting the posterior margin at a distance from the dorsal furrows a little shorter than the width of the occipital ring.

Associated hypostoma tentatively included in this species greatly convex; lateral and posterior borders narrow, thread-like; surface of the middle body shagreened rather than finely granulate.

Detached thoracic segments have a strongly convex axis with a median tubercle. Pleuron geniculate with fulcrum about at the middle, deeply furrowed, terminating in a short spine.

Pygidium small, length somewhat less than half the breadth; posterior outline evenly rounded, entire. Axis strongly convex, occupies about one-third the total breadth, divided by a fairly deep furrow into one ring and a large end-lobe sloping abruptly to the margin. Pleural lobes gently arched, with two pairs of pleural furrows; interpleural grooves effaced; border flat, moderately broad at the sides, interrupted at the middle by the axis.

Test thick; surface of carapace granulate, smooth in the furrows.

Size. — The largest cranium is 10 mm long (anterior cusp and occipital spine excluded) and the largest pygidium 1.9 mm long and 4.1 mm broad.

Remarks. — The above description is based on a number of topotypes of different sizes.

Of Angelin's specimens there has been found but an imperfect 7 mm long cranium (No. Ar. 248 in the collections of the Paleozool. Dept. of the Swedish Mus. of Nat. Hist.) from the type locality, Gudhem, which thus is the lectotype.

No specimen displaying a posterior pair of furcate furrows with the angular points turned inwards as described and illustrated by Wallerius has been observed.

Horizon and Localities. — Zone of *Lejopyge laevigata* (confined to its upper portion in Västergötland). — Scania: Andrarum (in a thin stratum about 0.3 m above the Andrarum limestone). — Västergötland: Gudhem, Torbjörntorp, Djupadalen, and Ödegården, all in the Falbygden area. — Närke: Ullavi.

In the Exporrecta conglomerate at Köpings klint, 2 km E of Borgholm, Öland.

Fairly infrequent in the Falbygden area, otherwise rare.

Acrocephalites stenometopus agnostorum subsp. n. — Pl. 2, figs. 14 a, b.

1922. *Acrocephalites stenometopus* (ANGELIN), partim, Westergård, S. G. U., ser. Ca, no. 18, pp. 123, 195, pl. 1, figs. 21 a—c; not fig. 20. (A cranium from the *Agnostus pisiformis* zone. Klövsjö, Jämtland.)

Diagnosis. — Distinct from *stenometopus* by less strongly arched cranium, somewhat lower boss on the brim, and strictly truncate glabella.

Remarks. — Two cranidia are present which agree except that the ocular ridges are absent in the one and faintly developed in the other, an insignificant variability also found in the species. In the subspecies the brim (the space between the glabella and the border) tends to become a little longer in proportion to the glabella than it is in the species. Thus, in nine well-preserved specimens of *stenometopus* — six from Gudhem and neighbouring local-

ities and three from Andrarum (these latter in shale, but little flattened) — the ratio of length of glabella and brim is $1:0.32$ ($0.30-0.34$), whereas it is $1:0.35$ in both the specimens of *stenometopus agnostorum* and $1:0.44$ in *stenometopus olenorum* to be described. In this feature and still more in the criteria mentioned in the diagnosis *stenometopus agnostorum* is intermediate between *stenometopus* and *stenometopus olenorum*.

Size. — The subgenotype, the cranidium illustrated by the writer in 1922, is 12 mm long (the spines omitted) and 15 mm broad.

Horizon and Locality. — Zone of *Agnostus pisiiformis*. Klövsjö, southern Jämtland. (The specimen illustrated in this paper is possibly the one recorded by Angelin from S. Möckleby, Öland, and identified by him as *stenometopus*; it occurs in a small stinkstone slab otherwise yielding but *A. pisiiformis*.)

Acrocephalites stenometopus olenorum subsp. n. — Pl. 2, fig. 15.

Diagnosis. — Cranidium and boss on the brim of considerably lower convexity, glabella shorter and quite square in front, brim longer, and palpebral lobes apparently smaller than in *stenometopus*.

Remarks. — Only the specimen illustrated is present; it is damaged and somewhat flattened owing to tectonic action. The most reliable characteristic will be the length of the brim relative to that of the glabella (see above). The form differs so markedly from *stenometopus* and *stenometopus agnostorum* that it may deserve specific rank. However, some of the differences have been increased, to some extent at least, by the mode of preservation; furthermore, it may be noted that a specimen in an erratic boulder of stinkstone rich in *Olenus truncatus* recorded by Kummerow (1927) from Stienitz-See, E of Berlin, Germany, and identified by him as *A. stenometopus*, has a defined boss on the brim (personal communication by Mr. Kummerow). For these reasons it seems for the present advisable to give this form but subspecific rank.

The three forms under consideration obviously constitute a straight line of evolution.

Size. — The cranidium illustrated is about 12 mm long.

Horizon and Locality. — Zone of *Olenus*. Boulder at Skansholm, on the western shore of Lake Mälaren, Southern Lapland.

Family undetermined.

Ullaspis gen. n.¹

Genotype and only known species: *U. conifrons* nov.

Diagnosis. — Carapace of low convexity, ovate; test smooth. Glabella conical, not extending to the border, with defined lateral furrows. Eyes small, situated fairly close to the anterior corners of the glabella. Anterior branches of the facial suture diverging slightly forwards. Genal angles prolonged into spines. Number of thoracic segments unknown (10 + x).

¹ Ull is taken from the Scandinavian mythology and enters into the name of the type locality, Ullavi = sacrificial grove sacred to Ull; *ἀσπίς* = shield.

This species does not seem to be referable to any genus hitherto described; for the present its taxonomic position may be left unsettled. It is apparently allied to the Olenidae.

Ullaspis conifrons sp. n. — Pl. 4, figs. 14—17.

Diagnosis. — See that of the genus.

Description. — Glabella strongly tapering, about half as broad in front as at the rear, truncate; three pairs of discontinuous glabellar furrows, first (posterior) pair well impressed and oblique, third pair shallow, short, and almost transverse. Dorsal furrows deepening into a pair of strongly marked pits at the anterior corners of the glabella, shallow in front of the latter. Occipital furrow deep at the sides, shallow and curving slightly forwards at the middle; occipital ring smooth or with a very weak node. Brim flat. Border well-defined, somewhat upturned, in sagittal length subequal to, or slightly shorter than, the brim. Palpebral lobes small, located opposite to the anterior pair of glabellar furrows and at a distance from the glabella equal to half the glabellar breadth in front. Ocular ridges weak to imperceptible, almost transverse. Fixed cheek sloping from the palpebral lobe to the dorsal furrow. Posterior limb about as wide as the occipital ring. Free cheek fairly broad, with faint anastomosing ridges radiating from the aperture of the eye; border well-defined, gently convex. Genal spine stout, much shorter than the cheek proper, directed slightly outwards, forming an obtuse angle with the posterior margin. Anterior pair of branches of the facial suture diverging slightly forwards (in dorsal view subparallel), reaching the anterior margin a short distance within the corners of the cranidium; posterior pair slightly sinuous.

Axis of the thorax moderately arched, tapering continuously, in the anterior segments about as wide as the pleuron, in the posterior narrower; axial rings smooth. Pleura with fulcrum about at the middle, in their inner part sloping slightly to the axis, terminating in very short spines.

But a poor fragment of an associated pygidium has been found. Axis of low convexity, annulate, occupying about one-third the total breadth at the anterior margin. Pleural lobes apparently smooth and fairly flat. Posterior and marginal portions not preserved.

Size. — The cranidium of the holotype, fig. 14, is 6.0 mm long and 12.4 mm broad; the largest cranidium measures 8.3 mm in length.

Horizon and Locality. — The specimens (ten cranidia, five free cheeks, and fragments of thorax and pygidium) were collected from some stinkstone (orsten) blocks in a filled up quarry near Ullavi, Närke. As *Lejopyge laevigata* (not infrequent) and a single specimen of *Agnostus pater* are the only associated species found, the blocks may originate from the *laevigata* zone (apparently from another stratum than that yielding *Nericia*).

Toxotis WALLERIUS, 1895.

Genotype: *T. pusilla* WALLERIUS.

Toxotis pusilla WALLERIUS, 1895. — Pl. 3, figs. 17—21.

Toxotis pusilla WALLERIUS, partim, Zonen med *Agnostus laevigatus*, p. 59, pl., fig. 7 a. (Only the »cephalon» [cranidium] described and illustrated. Zone of *Lejopyge laevigata*. Gudhem, Västergötland.)

Remarks. — A great many specimens of the cranidium, the only part of this form so far known, have been collected. This material as well as that collected by Wallerius, which the present writer has examined, manifest that the original figure is in one essential feature erroneous; the lateral bosses on the brim do not extend as tapering marginal ridges to the postero-lateral corners, and as the cheeks are clearly bounded by the facial sutures the shield cannot be interpreted as the cephalon as claimed by Wallerius. The shield regarded by Wallerius as the pygidium of *T. pusilla* is a transitory pygidium of the associated *Proceratopyge conifrons*, q. v.

The glabella rises high above the cheeks, and the exterior portions of the brim and of the posterior limbs slant downwards. The occipital ring bears a very long spine at the base directed upwards but rapidly curving backwards (usually broken and indicated by a scar). A narrow and weak anterior border is sometimes discernible. A few specimens display a pair of very faint transverse ocular ridges (fig. 18). A pair of small bosses on the cheeks at the base of the glabella are sometimes distinct but usually weak or even absent. The test is finely punctate on the brim, otherwise apparently smooth and compact. The average length of the cranidium, the occipital spine not counted, is but 1—1.5 mm and does not exceed 2.0 mm.

On account of its small size and as the members of the associated fauna are by no means dwarfed, it might be reasonable to regard *T. pusilla* as an immature form. If this be true, it is readily found that only *Acrocephalites stenometopus* can be taken into account as the adult form. However, the smallest cranidium of the latter, 2.5 mm long and but 0.5 mm longer than the largest specimen of *T. pusilla*, does not differ essentially from full-grown specimens and is consequently quite distinct from *T. pusilla*. Thus, the idea that these forms may represent different stages of growth of one species must be abandoned.

Wallerius compared *T. pusilla* with *Ptychoparia?* *linnarssoni* WALCOTT, 1884, from the late Middle Cambrian of Nevada, a form which Walcott in 1916 placed in *Alokistocare* LORENZ and Resser in 1935 assigned as the type of his genus *Eldoradia*. In the shape of the brim *Eldoradia* resembles *Toxotis* but differs in some features, the glabella being conical, the dorsal furrows well defined, and the occipital ring wanting the spine. Only on the presumption that very young specimens display a closer resemblance to *Toxotis* than does the adult may these forms be closely related.

No other form resembling *Toxotis* is known to the present writer.

Horizon and Localities. — Zone of *Lejopyge laevigata*, upper part. Gudhem, Torbjörntorp, Djupadalen, and Ödegården, all in the Falbygden area of Västergötland. Fairly infrequent.

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in addition to those cited in the present writer's memoir of 1946.

Abbreviations: S. G. U. = Sveriges Geologiska Undersökning.

G. F. F. = Geologiska Föreningens i Stockholm Förhandlingar.

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Explanation of Plates.

If nothing is mentioned regarding the rock, the specimen is preserved in limestone.

If no other statement is made, the specimens belong to the Geological Survey of Sweden.

Abbreviations:

RM. = Paleozoological Department of the Swedish Museum of Natural History, Stockholm.

G.-M. I. Lund = Geological-Mineralogical Institution of the University of Lund.

Plate 1.

Burlingia laevis WESTERGÅRD. — Page 3.

- Fig. 1. Complete specimen, external mould (impression in shale); holotype. Copy from ser. C, no. 394, pl. 12, fig. 9.
Zone of *Paradoxides pinus*. Borgholm, Öland.

Schmalenseeia acutangula sp. n. — Page 4.

- Figs. 2—4. Two fairly complete dorsal shields and a thorax with attached pygidium; fig. 2 is the holotype. Gislövshammar (boulder 118), Scania.
Figs. 5—6. Two cranidia, the latter one of the largest specimens found. Brantevik (boulder 1), Scania.
Zone of *Tomagnostus fissus* and *Ptychagnostus atavus*.

Proceratopyge conifrons WALLERIUS. — Page 5.

- Fig. 7. The youngest cranidium found, at an early stage of the meraspid period, 0.7 mm long.
Fig. 8. Cranidium of a slightly more advanced specimen, 0.95 mm long.
Fig. 9. Cranidium, 1.5 mm long, differing from the adult but in having narrower glabella with almost imperceptible furrows.
Figs. 10, 11. Two cranidia of the adult, the larger with defined ocular ridges.
Fig. 12. Free cheek.
Figs. 13, 14. Two transitory pygidia, 1.1 mm long (exclusive of the spines), with four not liberated thoracic segments. Fig. 13, which has both marginal spines broken, is one of Wallerius's specimens of *Toxotis pusilla*.
Fig. 15. Transitory pygidium, 1.0 mm long, with three not liberated thoracic segments.
Fig. 16. Pygidium of the adult.
Zone of *Lejopyge laevigata* in the Falbygden area, Västergötland; figs. 7, 9—13, 15, and 16 from Gudhem, 8 and 14 from Djupadalen. — Fig. 13. G.-M. I., Lund.

Proceratopyge magnicauda sp. n. — Page 6.

- Fig. 17. Almost complete carapace in shale, holotype. Copy from Westergård, 1947, pl. 2, fig. 11. — RM. No. Ar. 9798.
Fig. 18. Incomplete thorax with attached pygidium.
Zone of *Lejopyge laevigata*. Andrarum, Scania.

Figs. 2—4, 11, 13 photographed by C. Larsson.

Figs. 5—10, 12, 14—18 photographed and retouched by J. W. Englund.

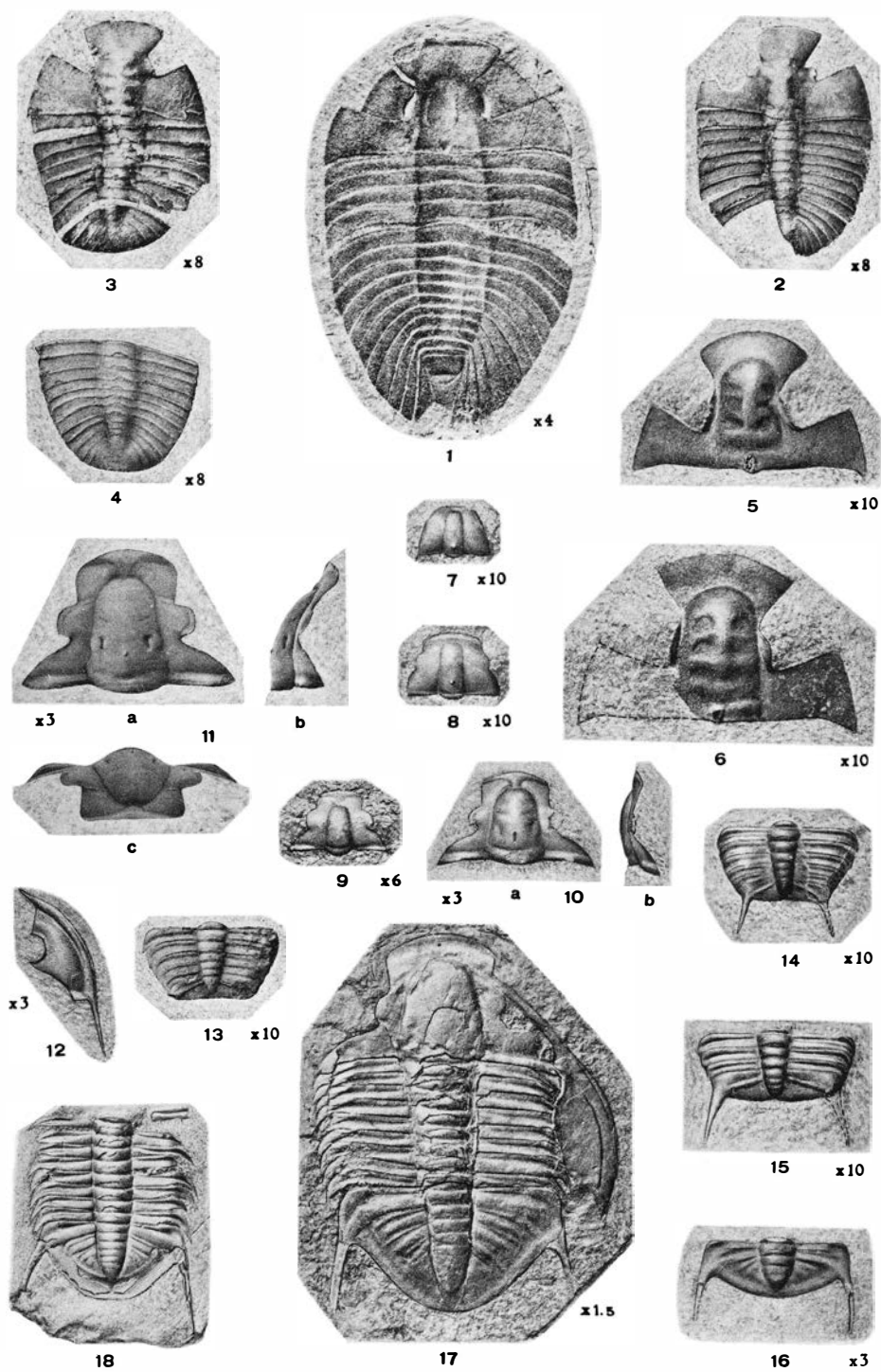


Plate 2.

Dorypyge aenigma (LINNARSSON). — Page 7.

Figs. 1—5. Two imperfect cranidia, free cheek (cast of impression), incomplete thoracic segment, and fragment of pygidium. In a greenish gray, slightly glauconitic, impure limestone sometimes replacing the *Exporrecta* conglomerate. Mösseberg, Västergötland. — RM. Nos. Ar. 10639—10641.

Figs. 6, 7. Cranidium of young specimen and associated hypostoma. In limestone like that in which the preceding specimens occur. Djupadalen, Västergötland.

Figs. 8 a, b. Pygidium; a, almost wanting the test; b, cast of the right portion of the counterpart of a. In a slab of black stinkstone (orsten) rich in *Oligomys exporrecta*. — Djupadalen, Västergötland.

Paradoxides forchhammeri beds (zone of *Solenopleura brachymetopa*).

Acrocephalites stenometopus (ANGELIN). — Page 19.

Figs. 9—12. Cranidium, free cheek, and two pygidia. — Gudhem, Västergötland.

Fig. 13. Cranidium. — Djupadalen, Västergötland.

Zone of *Lejopyge laevigata*, upper part.

Acrocephalites stenometopus agnostorum subsp. n. — Page 20.

Figs. 14 a, b. Cranidium. Zone of *Agnostus pisiformis*. Locality unknown. — RM. No. Ar. 1952.

Acrocephalites stenometopus olenorum subsp. n. — Page 21.

Fig. 15. Damaged cranidium. Stinkstone (orsten) boulder abundant in fragments of *Olenus*. Skansholm, parish of Vilhelmina, Southern Lapland.

Figs. 1—8, 10—13 photographed and retouched by J. W. Englund.

Figs. 9, 14, 15 photographed by C. Larsson.

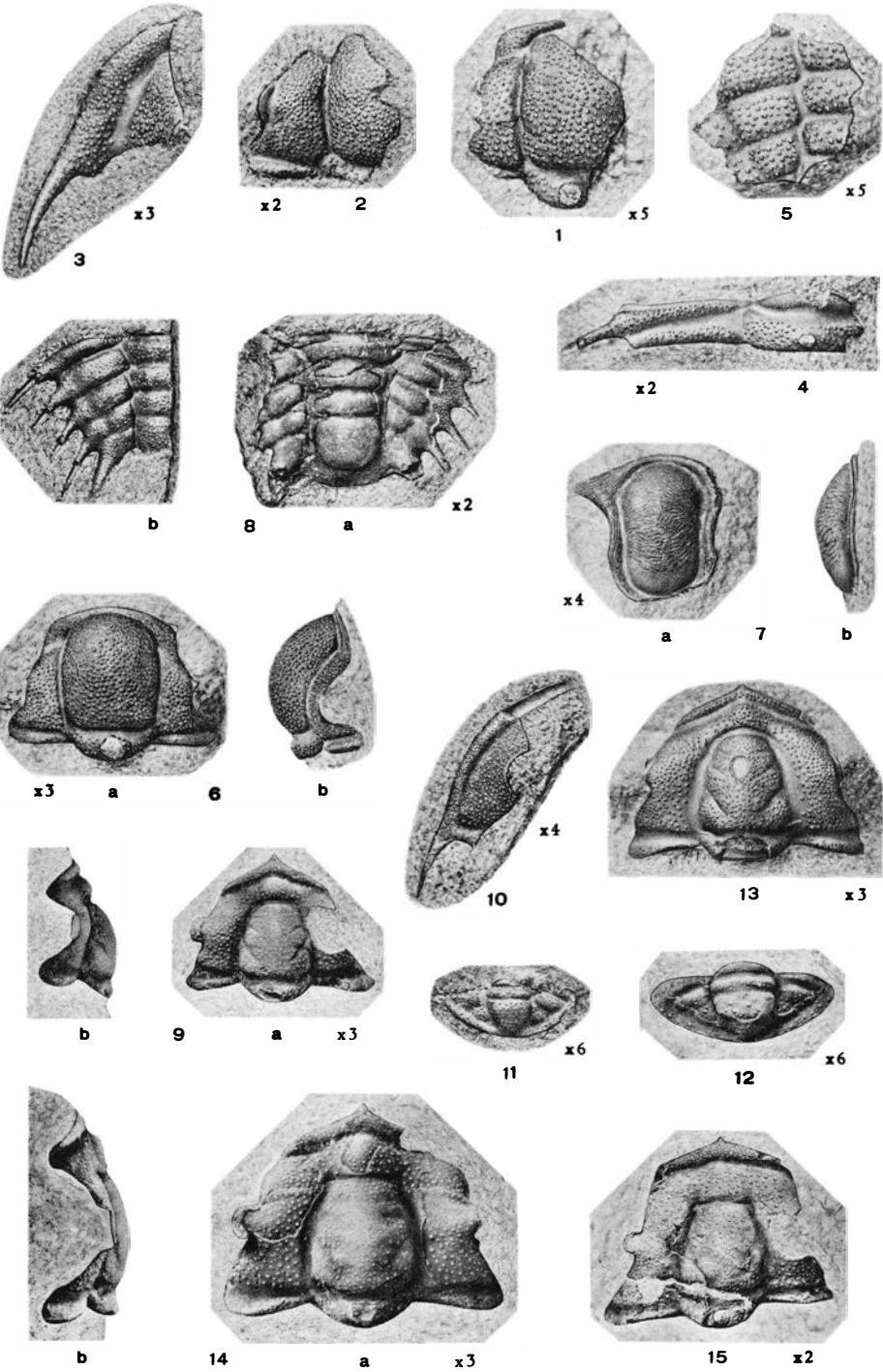


Plate 3.

Conocephalina suecica (WALLERIUS). — Page 18.

- Fig. 1. New figure of the holotype cranium. Djupadalen, Västergötland. — G.-M. I. Lund.
 Figs. 2, 3. Two cranidia of different sizes. Gudhem, Västergötland.
 Fig. 4. Imperfect free cheek. Djupadalen, Västergötland.
 Fig. 5. Imperfect thoracic segment (of this species?) associated with figs. 2 and 3.
 Fig. 6. Pygidium. Blinningsberg, near Falköping, Västergötland.
 Zone of *Lejopyge laevigata*, upper part.

Corynexochus spinulosus ANGELIN. — Page 10.

- Figs. 7—9. Two cranidia of different sizes, and associated pygidium. Zone of *Solenopleura brachymetopa* (Andrarum limestone). Andrarum, Scania.

Corynexochus sp. — Page 11.

- Fig. 10. Pygidium, in shale, 0.3 m above the Andrarum limestone. Andrarum, Scania.
 Fig. 11. Cranium, in shale. Boring at Andrarum (Westergård, 1944 a; level 45.8 m), Scania.
 Zone of *Lejopyge laevigata*.

Dolichometopus suecicus ANGELIN. — Page 11.

- Figs. 12—14. Three cranidia; the two larger, in nat. size, belonging to Angelin's specimens. No. 14 is a new figure of the lectotype illustrated by Matthew in 1897. — RM. Nos. Ar. 11456, 1958 c, and 1958 b.
 Figs. 15—16. Two pygidia, the smaller exfoliated and the larger retaining the test. — RM. Nos. Ar. 11455 a and b.
 Zone of *Solenopleura brachymetopa* (Andrarum limestone). Andrarum, Scania.

Toxotis pusilla WALLERIUS. — Page 23.

- Fig. 17. Cranium, one of Wallerius's specimens; lectotype. Gudhem, Västergötland. — G.-M. I. Lund.
 Figs. 18—20. Three cranidia; No. 18 with faintly indicated ocular ridges; No. 20 the largest specimen found. Djupadalen, Västergötland.
 Fig. 21. Cranium. Torbjörntorp, Västergötland.
 Zone of *Lejopyge laevigata*, upper part.

Andrarina costata (ANGELIN). — Page 14.

- Figs. 22, 23. Cranium and pygidium; new figs. of the specimens illustrated by Angelin, impressions in limestone photographed in reverse light. No. 23 is the lectotype. Collected by J. W. Dalman in 1827. Zone of *Lejopyge laevigata*. Hönsäter, Kinnekulle, Västergötland. — RM. No. Ar. 285 a.

Figs. 1, 2 b, 7, 10, 13, 14, 22, 23 photographed by C. Larsson.

Figs. 2 a, 3—6, 8, 9, 11, 12, 15—21 photographed and retouched by J. W. Englund.

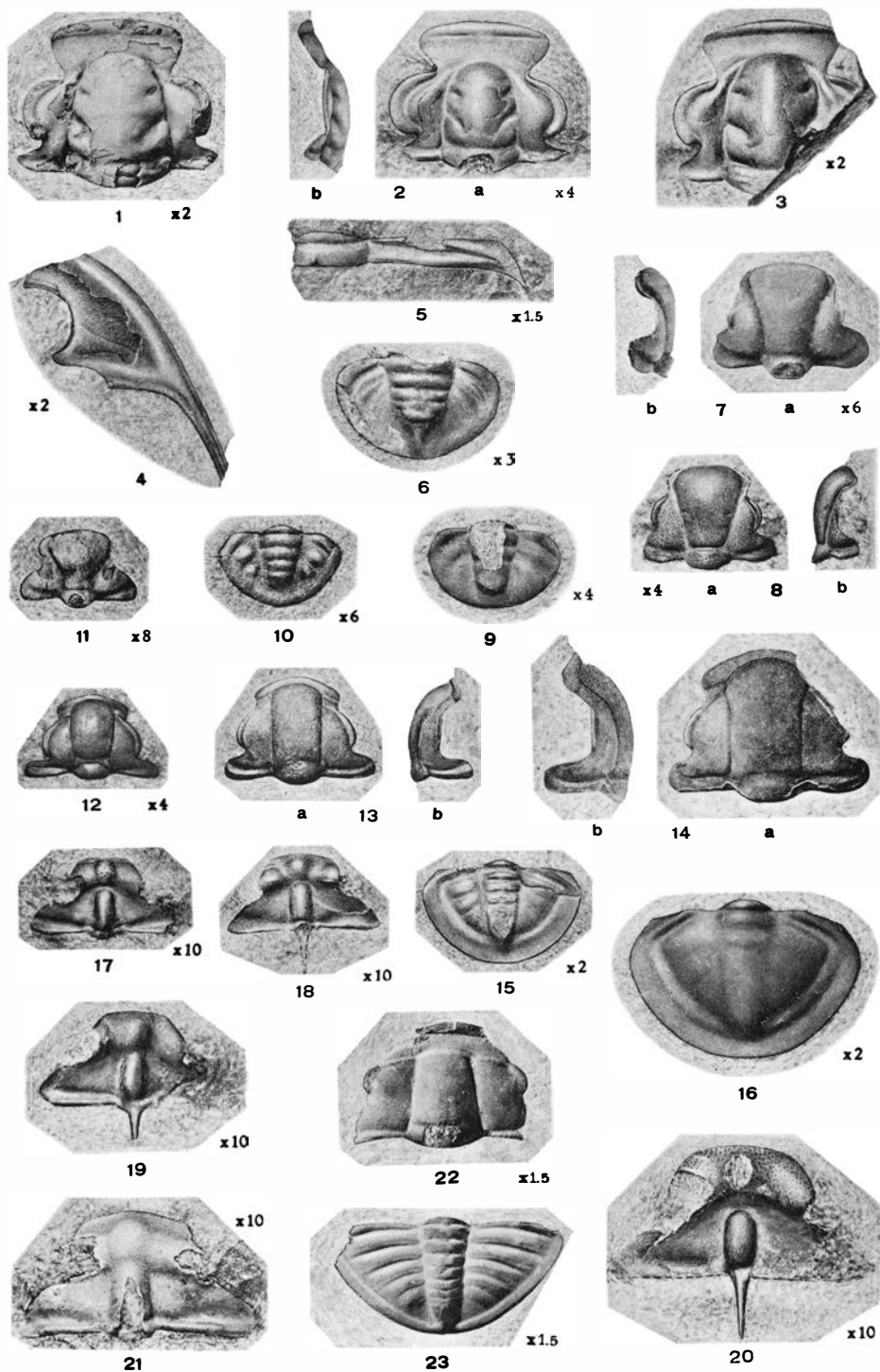


Plate 4.

Andrarina costata (ANGELIN). — Page 14.

Figs. 1—4. Cranidium, free cheek, pygidium, and hypostoma. Zone of *Lejopyge laevigata*, lower part (small stinkstone lens 0.7—0.9 m above the Exporta conglomerate). Djupadalen, Västergötland.

Nericia quinquedentata gen. n. et sp. n. — Page 15.

Fig. 5. Dorsal shield wanting the free cheeks. Holotype.

Figs. 6—9. Cranidium, cephalon, pygidium, and hypostoma. *Paradoxides forchhammeri* beds, probably zone of *Lejopyge laevigata*. Ullavi, Närke.
Collected and presented to the Geological Survey by Mr. Torsten Tjernvik.

Nericia septemdentata gen. n. et sp. n. — Page 17.

Fig. 10. Imperfect cranidium. Nat. size.

Fig. 11. Associated free cheek wanting the test and displaying the broad striated doublure, tentatively referred to this species. Nat. size.

Fig. 12. Pygidium, impression in limestone photographed in reverse light. Holotype. Nat. size.

Fig. 13. Hypostoma, possibly this species.

Zone of *Lejopyge laevigata*, upper part. Gudhem, Västergötland.

Ullaspis conifrons gen. n. et sp. n. — Page 22.

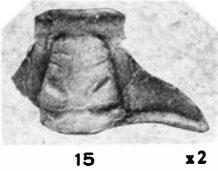
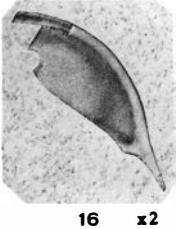
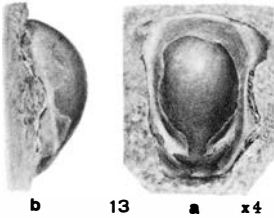
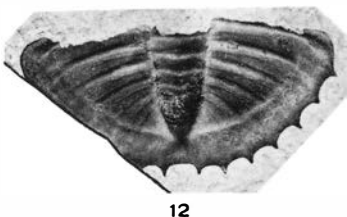
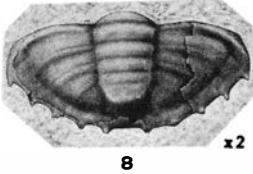
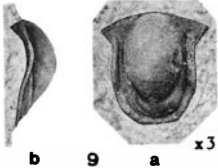
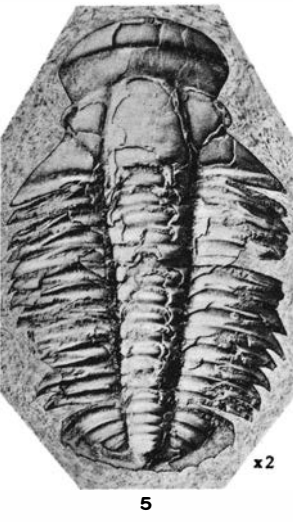
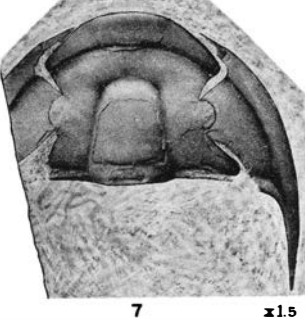
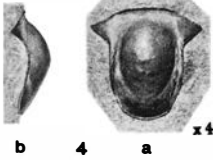
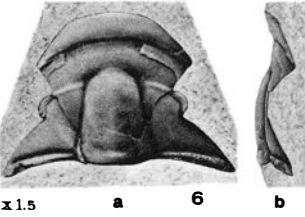
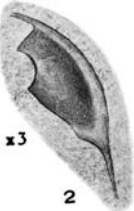
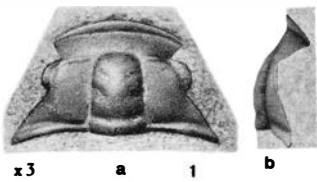
Fig. 14. Cranidium with two attached thoracic segments. Holotype.

Figs. 15—17. Imperfect cranidium, free cheek, and incomplete dorsal shield. *Paradoxides forchhammeri* beds, probably zone of *Lejopyge laevigata*. Ullavi, Närke.

Collected and presented to the Geological Survey by Mr. Torsten Tjernvik.

Figs. 1—4, 13 photographed and retouched by J. W. Englund.

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