A thesis entitled

EARLY PROETID TRILOBITES FROM NORTHERN EUROPE

Submitted for the degree of

DOCTOR OF PHILOSOPHY

in the

FACULTY OF SCIENCE of the

UNIVERSITY OF LEICESTER

by

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Volume 1. Text.

June
1971

S Y N O P S I S

All known Lower Palaeozoic proetid trilobites from northern Europe have been examined, and those from the Ordovician of the British Isles and Scandinavia, and those from the Silurian of the British Isles and Bohemia have been described in detail. Closely related species from other areas have been figured for comparison. Unfortunately time has not permitted the detailed description of many of the Silurian forms from Scandinavia, but all type material has been examined and photographed, and it is intended to decsribe this material at a later date.

113 species are investigated, 36 of which are new, distributed among 23 genera, 8 of which are new. With the description and revision of many Lower Palaeozoic proetid genera and species it is now possible to propose a provisional phylogeny, and attempt to seek the origins of many important Devonian groups. From this study it appears as if at least two main lines of proetid trilobites extend at least as far back as the early Ashgill, and probably considerably earlier, so that eventually it may be necessary to split the proetids into perhaps two seperate families within the Proetacea. The origin of the Proetidae remains an unsolved question, and they may have their roots in the Hystricurinae. Since the major part of this thesis was written, Mr. R. Fortey has sent me photographs of a proetid of Arenig age from western Ireland. The cranidia on these photographs are close to Decoroproetus, and show that this genus, the root stock of a large number of later groups, has its origins in the earliest Ordovician.

Of morphological features, the most useful characters for classification are found in the pygidium. The rostral plate is nearly always trapezoidal, with the connective sutures converging backwards, but on one genus the connective sutures diverge backwards.

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Robert M. Owens. PhD thesis, 1971.

EARLY PROETID TRILOBITES FROM NORTHERN EUROPE.

A B S T R A C T

All known Lower Palaeozoic proetid trilobites from northern Europe have been examined, and those from the Ordovician of the British Isles and Scandinavia and those from the Silurian of the British Isles and Bohemia are described in detail. Closely related species from other areas are figured for comparison. Members of 23 proetid genera, 8 of which are new, are described and figured. 113 species have been investigated, 36 of which are new.

The Lower Palaeozoic proetids have hitherto been poorly understood and neglected, and in this thesis they are comprehensively treated as a group for the first time. With their description and figuring, it is now possible to propose a provisional phylogeny for the earlier Proetidae, and to attempt to seek the origins of many important Devonian genera. Of morphological features, the most useful characters for classification are found in the pygidium. Cephalic characters tend to be less reliable. The rostral plate is always subtriangular or trapezoidal in outline, and in all except one case the connective sutures converge backwards. The preannulus has been found to be restricted to the subfamilies Proetinae and Cornuproetinae.

From this study it appears as if at least two main lines of proetid trilobites extend well back into the Ordovician, and there may well be a case in the future for recognising two distinct families. The origin of the Proetidae remains problematical, but they could have their origins in Cambro-Ordovician Hystricurine trilobites, some of which, like the proetids, have a trapezoidal rostral plate.

INTRODUCTION

The trilobite family Proetidae Salter 1864 ranges from the early Ordovician to the late Permian, and is world wide in its distribution. The Proetidae become an abundant and important part of Devonian and later trilobite faunas, and most of the post Devonian forms belong to them. In the Ordovician and Silurian, Proetidae occur in relatively small numbers, and these early members of the family have hitherto remained poorly understood. Perhaps this is partially due to the fact that much of the major work on Proetidae has been carried out in Central Europe (Germany and Czechoslovakia) where they are not found before the later Silurian. Since Barrande's (1852) monumental work, which embraced Silurian and Lower Devonian Proetidae, Novak (1890), R. and E. Richter (1909-1956), Přibyl (1946 onwards), Erben (1951 onwards), Haas (1968 onwards), G. Alberti (1962 onwards), G. and R. Hahn (1963 onwards) and Osmolska (1957 onwards) have made substantial contributions to our knowledge of the Upper Palaeozoic Proetidae, largely from central Europe and Morocco. Lower Palaeozoic Proetidae have received sporadic treatment in Europe and elsewhere, and have often been 'lumped' in convenient genera to which they do not really belong. The result is that Lower Palaeozoic Proetidae are poorly understood, both in their distribution in space and time, and in their relationships to one another and with later forms.

The object of this research project has been to systematically treat the early Proetidae as a group, incorporating redescription and refiguring of old species, description and figuring of new species, and hypotheses on distribution and phylogenetic relationships. The geographical scope of this thesis has been broadly confined to northern Europe (including Britain, Scandinavia, Poland, Czechoslovakia and Northern Germany), but comparisons are made with Russian, North American and Australian species. It was decided to treat the species by geological occurrence (i.e. Ordovician or Silurian) over three major areas (Britain, Scandinavia and central Bohemia), and the chapters are arranged in a roughly chronological order, with all the Ordovician species covered in the first three. Unfortunately time has not permitted a detailed treatment of all of the Silurian Proetidae of Scandinavia, but collections have been examined and most old types refigured, within the scope of the British or Bohemian chapters. Scharyia, an interesting problematical genus, not a proetid, but often associated with them, is treated in a short chapter at the end, as important information on its morphology and phylogeny has been discovered. All the systematic chapters (1-7) are to be published as independent papers. Phylogenetic conclusions are included at the end, and relationships with later Proetidae and with other trilobite Families are discussed.

Material upon which this study is based has largely originated from museum collections, and these have been supplemented by personal collecting and by specimens provided by numerous individuals. Many specimens have required lengthy and careful preparation, which has largely been done with a Vibrotool supplied with a fine needle. An air abrasive machine has proved useful for fine details and a soft matrix. All the photographs, with rare exceptions, were taken by the author, using the Leitz Aristophot camera. In addition, a few were taken with the scanning electron microscope, an instrument which has proved valuable for small specimens and fine surface details. In the Appendix a number of Stereoscan photographs are given to indicate the potential of this machine for photographing fine surface details. For normal photography, the specimens were whitened with a fine dusting of ammonium chloride sublimate. Some were previously blackened with a dilute 'opaque' to give an even matt surface texture. For the Stereoscan photographs, specimens were coated with an extremely fine film of silver.

Acknowledgements

I have had the good fortune to be able to undertake my research work on a 'European' basis, and have had the opportunity to visit universities and museums in Britain, Germany, Norway, Sweden and Czechoslovakia. Most of the time has been spent at the University of Leicester, the Palaeontological Institute of the University of Bonn and the Palaeontological Museum in Oslo.

At Leicester, my supervisor, Dr. J.H.McD. Whitaker has offered continual help and guidance, has provided specimens and literature, and has shown me field localities in the Welsh Borders. Professor P.C. Sylvester-Bradley has offered considerable help in discussion and in reading through certain parts of this thesis, particularly during the last year.

At Bonn, I was fortunate to work under theinspired guidance of Professor Dr. H.K. Erben and Dr. W. Haas, and I have benefited much from their considerable knowledge of the Proetidae, and of various techniques of preparation and illustration.

At Oslo, it was a particular pleasure to be able to work with a former Leicester student, Dr. D.L. Bruton, who made a similar European study on the Odontopleuridae from 1962-1965, and who was thus well aquainted with the various problems involved. Professor G. Henningsmoen also offered much valuable help while at Oslo, including valuable assistance in his capacity as Editor of the Norsk Geologisk Tidsskrift to which I am submitting part of my work for publication. Dr. Bruton and Professor Henningsmoen kindly invited me to join an Oslo University field excursion to Vastergotland, Narke and Siljan in Sweden in September 1969, where, under the leadership of Dr. T. Tjernvik and Dr. V. Jaanusson I gained first hand knowledge of a classic area.

During visits to various institutions, the following have offered many helpful comments in discussion, either on Proetidae or related stratigraphical problems: Professor H.B. Whittington (Cambridge), Dr. C.P. Hughes (Cambridge), Dr. J.K. Ingham (Glasgow), Dr. W.T. Dean (formerly B.M.(N.H.), now Geological Survey of Canada), Mr. S.F. Morris (B.M.(N.H.)), Dr. A.W.A. Rushton (I.G.S.), Dr. V. Jaanusson (Naturhistoriska Riksumseet, Stockholm) and Mr. L. Karis (S.G.U.). In correspondence, Dr. K.S.W. Campbell (Canberra), Dr. A. Přibyl (Prague), Dr. G.K.B. Alberti (Hamburg) and Professor P.J. Lespérance (Montreal) have offered helpful comments.

I should like to thank the following for enabling me to study or loan valuable museum specimens in their charge: Dr. W.T. Dean and Mr. S.F. Morris (British Museum, Natural History), Dr. A.W.A. Rushton (Institute of Geological Sciences, Geological Survey Museum), Dr. C.L. Forbes (Sedgwick Museum, Cambridge), Mr. H.P. Powell and Mr J.M. Edmonds (University Museum, Oxford), Dr. J.K. Ingham (Hunterian Museum, Glasgow), Dr. I. Strachan (Birmingham University Museum), Mr. G.E. Wilmott (Yorkshire Museum, York), Dr. M.G. Bassett (National Museum of Wales, Cardiff), Dr. A. Lord (Hull University), Dr. M. Muir (Imperial College), Dr. C.E. O'Riordan (National Museum of Ireland, Dublin), Dr. Zazvorka (National Museum, Prague), Dr. V. Jaanusson (Naturhistoriska Riksmuseet, Stockholm), Mr. L. Karis (Museum of Swedish Geological Survey, Stockholm), Dr. E. Wickander (Stockholm University), Dr. B. Neuman (Uppsala), Dr. J. Bergstrom (Lund) and Dr. D.L. Bruton (Oslo).

The following have kindly made specimens of Proetidae available from their own collections: Dr. R.B. Rickards, Dr. P.D. Lane, Mr. J. Penn, Miss J. Vinnicombe, Mr. M.D. Jones, Mr. D. Palmer, Professor C. Holland, Dr. J. Vanek, Mr. J. Wattison and Mr. J.F. Bockelie. Professor P.J. Lesperance has sent casts of Proetidae from the Whitehead formation of Quebec, Canada and Professor C. Poulsen has sent casts of Greenland specimens.

During the first year of research, my father arranged for funds to be made available. I am much indebted to him for this, and without such funds, it would have been impossible to embark on this research project. This money was supplemented by a small grant from the Charles Henry Foyle Trust, Birmingham, which is gratefully acknowledged. While at Bonn (1968-1969) I was fortunateto hold a scholarship awarded by the Rheinisch-Friedrichs-Wilhelms Universitat, Bonn, and for my last year of research (1969-1970) I was supported by a Research Scholarship awarded by the University of Leicester. I am deeply grateful for both these scholarships, and to Professor Dr. H.K. Erben and Professor P.C. Sylvester-Bradley, through whose efforts they were gained.

Mr. G.L.C. McTurk has offered much assistance with photography, and has taken the stereoscan photographs, and Mr. R.J. King and Mr. R.G. Clements taught me various casting techniques.

I wish to extend my sincere thanks to all who have offered assistance and encouragement, in whatever fashion, helping to make this a most enjoyable and rewarding period of my life.

Taxonomic value of different exoskeletal parts and morphological features of Proetidae

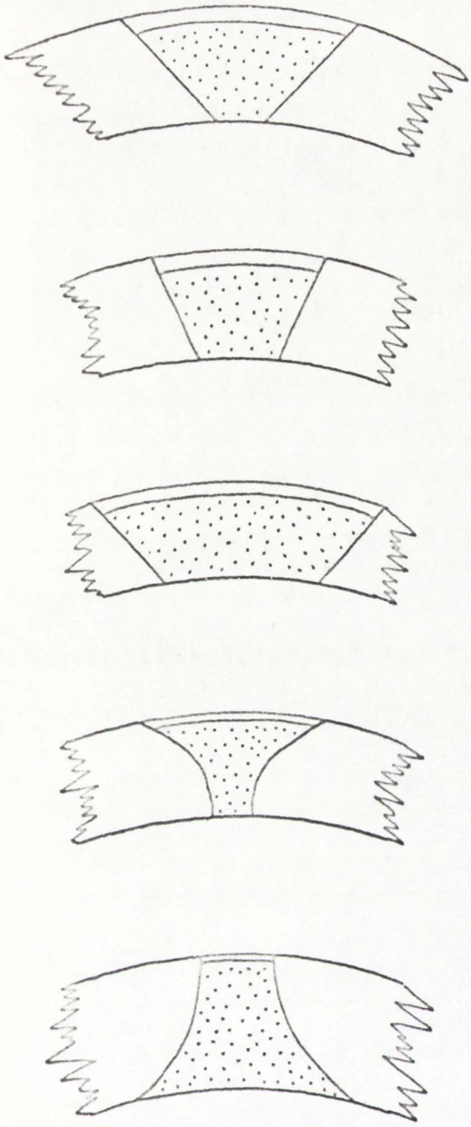
Modern trilobite taxonomy places emphasis on a combination of exoskeletal characters rather than on any single character, and such a practice is essential when dealing with proetids, as morphologically similar cranidia may, for example possess quite different pygidia. If one exoskeletal part must be singled out as being particularly important in proetid classification, it is the pygidium, where the structure of the pleural ribs is a feature of at least generic importance. In the following paragraphs, various parts of the exoskeleton are considered in turn.

(i) THE CRANIDIUM

The glabellar outline is generally of a rather standardised type - i.e. parallel sided to distinctly forwardly tapering, with a bluntly pointed, bluntly or well rounded frontal lobe. Lateral glabellar furrows are usually shallow, but in some genera 1p is deep and defines prominent basal glabellar lobes (e.g. *Warburgella* and *Cyphoproetus*). The occipital ring is variable in form, but three generalised types may be recognised: (a) width constant (sag. and exsag.), no lateral occipital lobes; (b) as (a), but with lateral occipital lobes; and (c) laterally narrowing (generally without lateral occipital lobes). The form of the occipital ring is usually constant at a generic level. The pre-glabellar field may or may not be present, and its presence or absence is important at a generic level. At a greater taxonomic rank it is sometimes important, and while some subfamilies always have it, it is never entirely absent at subfamily level. The profile of the pre-glabellar field is quite important, and ranges from straight to sigmoidal or convex. The palpebral lobe is generally close to the glabella, and backwardly placed, but may be situated some distance out and be anteriorly placed. Generally the eye is of maximum size when the palpebral lobe is backwardly placed and close to the glabella and reduced in the other positions. The variation in size and position of the palpebral lobe can vary within a genus, and is thus a feature which cannot generally be used in a generic diagnosis. The same applies with the structure and path of the facial suture, which is intimately connected with the palpebral lobe.

(ii) THE EYE

No blind proetids are known from the Lower Palaeozoic, but eye reduction is a common feature, and is reflected in the size and position of the palpebral lobe (see above) as well as the size of the eye.



Proetus(Pr.) concinnus (Pl.34 fig.8)

Cyphoproetus nasiger (Pl.31 fig.1)

Astroproetus reedi (Pl.23 figs.21-2)

Stenoblepharum warburgae (Pl.14 E)

Rutellum malvernense (Pl.32 fig.13)

Fig.1. Schematised diagrams showing a range of proetid rostral plates.

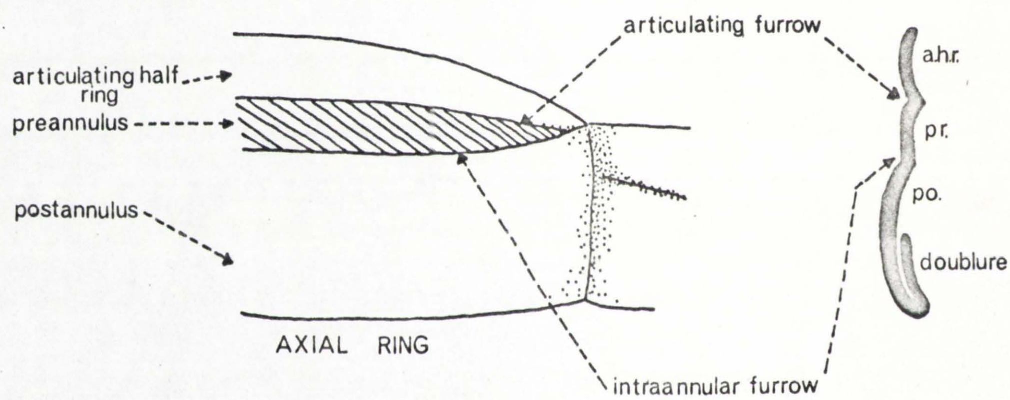


Fig. 2. Structure of the preannulus

Occasionally small eyes are a generic feature (e.g. Paraproetus) but this is not always the case - one species of Kallholnia has small eyes, while another has large ones. It is always possible that a large-eyed Paraproetus will one day come to light. The eye socle is usually present, but may be inconspicuous. In some genera (e.g. Stenoblepharum) nearly all species have the lower margin defined by a deep furrow, but in others (e.g. Decoroproetus) the presence or absence of this furrow is much more variable. The distinctness of the lower marginal furrow is quite a useful specific character, but must be used with some reservation when dealing with higher taxa.

(iii) THE GENAL SPINE

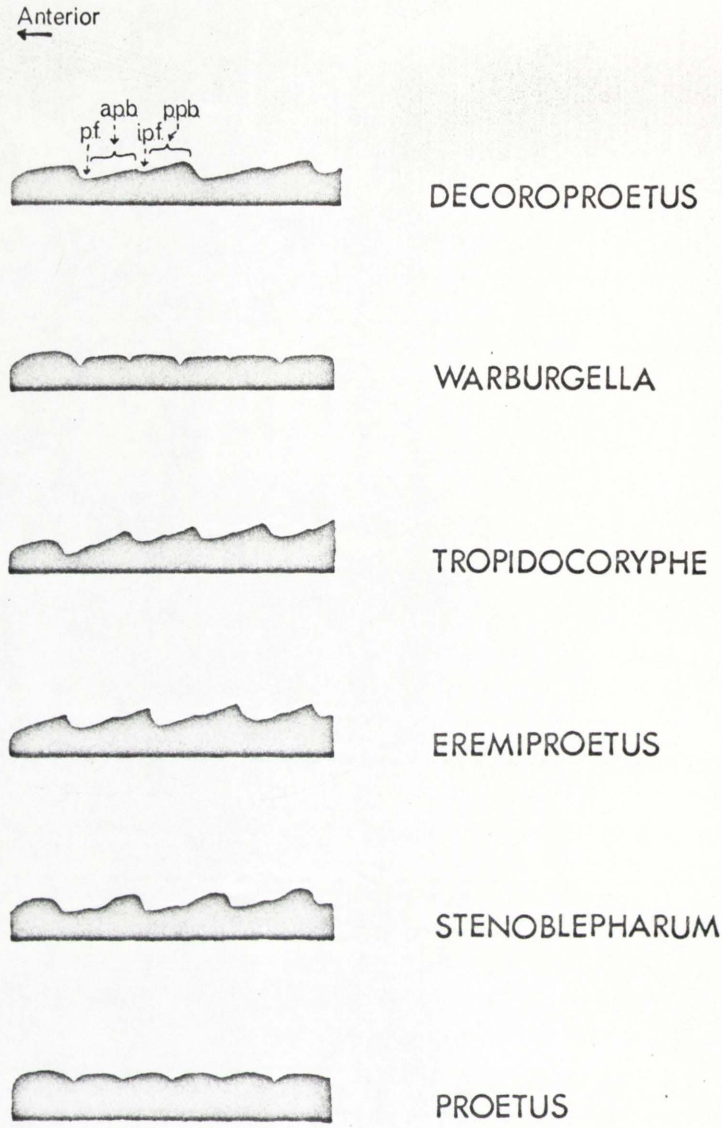
The genal spine is present on the vast majority of Lower Palaeozoic proetids, but is occasionally absent (e.g. P. latifrons (M'Coy), P. granulatus (Lindstrom)). The presence or absence of the genal spine is presently used as a specific character, but may eventually be of use at a subgeneric level to separate spine-bearing species of Proetus from those without spines.

(iv) VENTRAL CEPHALIC FEATURES

Unfortunately, too few hypostomes are known to be able to assess their real taxonomic importance, but the hypostome certainly seems to be of generic significance. As Whittington and Campbell (1967, p. 456) have suggested, the hypostome does not seem to have been suturally linked with the rest of the cephalon. Although several specimens are known where the hypostome is present, it is never actually attached, and rather random orientation bears out their suggestion that the hypostome was moveable and attached to the cephalon by uncalcified integument and muscles. In nearly all proetid genera, the rostral plate is trapezoidal or triangular with the connective sutures converging backwards. One genus, Rutellum, is contrary to this general rule, as its connective sutures diverge backwards. The shape of the rostral plate, from available evidence is apparently of generic significance, at least in some cases. An indication of variety of proetid rostral plates is given in Fig. 1.

(v) THE THORAX

The thorax usually consists of 10 segments, but sometimes only has 8 or 9. While the number is usually stable within the limits of a genus, this is not always the case - species of Astroproetus have 9 or 10, and in Warburgella the range is from 8 to 10. A particularly important feature on the thorax of some proetids is the preannulus. As far as I am aware, the preannulus is restricted to proetids. The general form



apb. – anterior pleural band
ppb. – posterior " "
pf. – pleural furrow
ipf. – interpleural "

Fig.3. Lateral profiles of some proetid pygidial pleural ribs

is shown in Fig. 2. The preannulus is found on all species of <u>Proetus</u> at least some species of <u>Dechenella</u> and <u>Cyphoproetus</u> and on the type species of <u>Corunproetus</u>. The phylogenetic significance of this feature is discussed elsewhere (see Chapter 8), and its taxonomic importance is at least of generic rank.

(vi) THE PYGIDIUM

The important taxonomic features here are the pleural ribs (see Fig. 3), and Erben (1966, p. 179) has already shown how they differ in some proetids. The principal variable features are the relative depths, directions and relationships of the pleural and interpleural furrows. These in turn effect the nature of the anterior and posterior pleural bands. The structure of the pygidial pleural ribs is not only of generic significance, but can also be used at the level of subfamilies. The presence or absence of a distinct pygidial border is often only of specific significance, but sometimes all members of a genus (e.g. <u>Dechenella</u>), or even all members of a subfamily (e.g. Dechenellinae) possess a distinct border.

(vii) SURFACE SCULPTURE

The type of surface sculpture found on proetids includes granules, continuous or discontinuous striations and pits, and sometimes the exoskeleton is smooth. These various sculptural elements may occur on their own, or in combination with others, and may cover the entire exoskeleton or be localised. Sculpture has normally been ignored at all levels of proetid taxonomy. All proetids have prominent, parallel terrace lines on the cephalic and pygidial doublures, a feature which immediately distinguishes pygidia from rather similar phacopid pygidia when internal moulds are available. Otarionids also bear terrace lines, but their pygidia are not easy to confuse with those of proetids.

Surface sculpture is almost universally a useful specific character in proetids (except in smooth forms), and can be used in a specific diagnosis as long as information is available on the external surface. It is also applicable at higher taxonomic levels in some cases - nearly all species of <u>Decoroproetus</u>, for example, have a striated surface sculpture. Striations are absent from nearly all members of the Proetinae, and from all members of the Dechenellinae, and so sculpture is of some significance even at the subfamily level. An important feature falling under the general heading of surface sculpture is the tropidium. This feature consists of one or more raised ridges running parallel with the cephalic border on the field of the free cheek and on the preglabellar field. Nearly all proetids

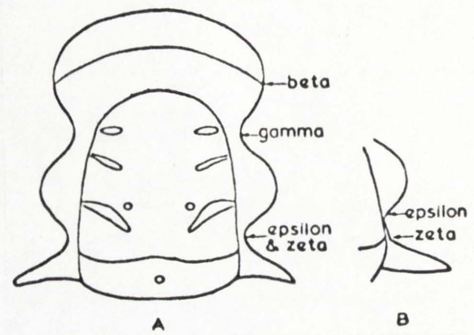


Fig.4. Generalised proetid cranidium showing the different points on the facial suture indicated by the Greek litteration.

A. Epsilon and zeta as one angle.

B. Epsilon and zeta as separate angles.

bearing the tropidium are presently included in the subfamily Tropidocoryphinae, with Warburgella as a notable exception. The tropidium is used as a subfamilial character in the Tropidocoryphinae, and is a generic one in Warburgella. The feature seems to be almost confined to the Proetidae, but seems to be present on the remopleuridid Paryfenus.

Terminology

Most of the terms used are those defined by Harrington et al. in Moore (1959, pp. O 117-O 126). The following additional terminology is useful when describing proetids:

Eye socle, defined by Shaw and Ormiston (1964, p. 1002) is used for that curb like ridge which supports the visual surface of the eye.

Greek litteration, introduced by R. and E. Richter (1949, p. 69) to define points on the course of the facial suture is found useful, and the terms beta, gamma, epsilon and zeta are employed herein (see Fig. 4).

Preglabellar ridge is introduced for a short, transversely elongated ridge which lies on the anterior part of the preglabellar field, close to the anterior margin. When the tropidium is present, the preglabellar ridge lies between it and the anterior border furrow.

Orientation and Measurement

For the making of measurements, and also in the photographs, the cranidium is orientated so that the palpebral lobe is horizontal, and the pygidium so that the axial furrow is horizontal.

All measurements are in millimeters. Those taken are shown in Fig. 5.

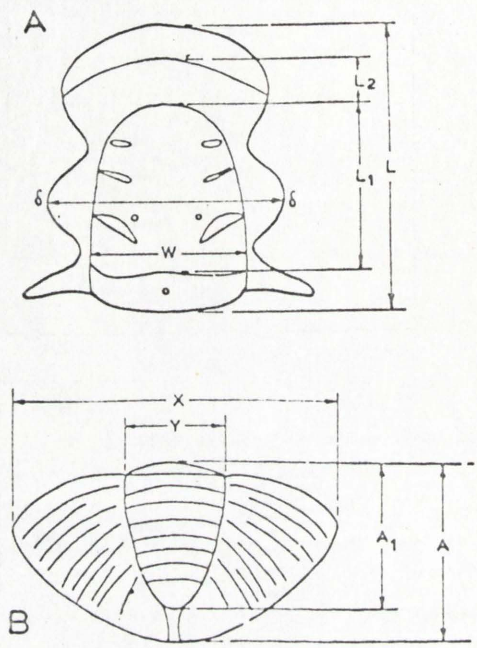


Fig.5. A. Cranidial measurements.

L = total sagittal length of cranidium.

L_1 = sagittal length of the glabella.

L_2 = sagittal length of the preglabellar field (except in Analocaspis ursina, where L_2 is the sagittal length of the entire preglabellar area).

W = transverse width of the glabella at its widest point.

S-5 = transverse palpebral width of the cranidium.

B. Pygidial measurements.

A = sagittal length of pygidium.

A_1 = sagittal length of pygidial axis.

X = greatest transverse width of pygidium.

Y = transverse anterior width of pygidial axis.

Abbreviations

In the text and in the plate explanations the following abbreviations apply to museums and institutions where specimens are housed:

BM(NH)	British Museum (Natural History)
BU	Birmingham University Museum
GSM	Institute of Geological Sciences, Geological Survey Museum
HM	Hunterian Museum, Glasgow
HU	Hull University (HUR = Rickards collection, HUD = Ingham collection)
IC	Imperial College, London (Murchison Museum)
LCM	Leicester City Museum
LO	Museum of Palaeontological Institute, Lund
LU	Leicester University
NMI	National Museum of Ireland, Dublin
NMP	National Museum, Prague
NMW	National Museum of Wales, Cardiff
OUM	Oxford University Museum
PMO	Paleontologisk Museum, Oslo
RM	Naturhistoriska Riksmuseet, Stockholm
SMC	Sedgwick Museum, Cambridge
SGU	Museum of Swedish Geological Survey, Stockholm
SU	Stockholm University
TCD	Trinity College, Dublin
UM	Museum of Palaeontological Institute, Uppsala
YM	Yorkshire Museum, York

Link Paragraph 1

Chapters 1-3 embrace all the Ordovician Proetidae from the British Isles, Norway and Sweden. It has been convenient to treat these species in geographical regions, as in each different series of facies prevail. The Middle Ordovician proetids of the Oslo region have been isolated so as to form part of the monographic series dealing with the palaeontology and stratigraphy of the Oslo region. In each chapter, an attempt is made to compare species over the entire region, as well as further afield (e.g. eastern North America) where similar faunas occur. The following genera from the subfamily Proetidellinae are treated: *Decoroproetus*, *Stenoblepharum* and *Astroproetus*; from the Eremiproetinae: *Eremiproetus*; and from the Proetinae: *Proetus*, *Ascetopeltis* and *Paraproetus*. *Cyphoproetus*, *Isbergia*, *Kallholnia*, *Xenocybe*, *Rorringtonia* and *Analocaspis* are classified incertae sedis.

Standard British Graptolite Succession		Shelly Succession of Shropshire and N. England	Upper Part of Middle Ordovician Succession of Oslo District	Proetid Trilobites with Known Stratigraphic Distribution	Districts of the Oslo Region: Oslo-Asker	Ringerike	Hadeland	Neshamar
CARADOC	*Dicranograptus clingani*	ONNIAN	4bδ Upper Chasmops Limestone	*Decoroproetus solenotus*	+	+	•	•
		ACTONIAN		*Decoroproetus* sp. A.	•	+	•	•
				Decoroproetus furubergensis	•	•	+	•
	Climacograptus wilsoni	MARSHBROOKIAN	4bγ Upper Chasmops Shale	*Decoroproetus furubergensis*	•	+	+	+
		LONGVILLIAN: UPPER						
		LONGVILLIAN: LOWER	4bβ Lower Chasmops Limestone		•	•	•	•
	Climacograptus peltifer	SOUDLEYAN	4bα Lower Chasmops Shale	*Anatocaspis ursina*	+	•	•	•
		HARNAGIAN		*Decoroproetus gyratus*	+	•	•	•

Table I Known distribution of Proetid trilobites in the Middle Ordovician of the Oslo District. Correlation of Shelly succession after Dean 1960.

CHAPTER 1

THE MIDDLE ORDOVICIAN OF THE OSLO REGION, NORWAY

23. The Trilobite Family PROETIDAE

ABSTRACT

Proetid trilobites from the Middle Ordovician of Norway are described and figured for the first time. From the fragmentary but well-preserved material it has been possible to distinguish four species of Decoroproetus, D. furubergensis sp. nov., D. gyratus sp. nov., D. solenotus sp. nov. and D. sp. A. These species can be compared with ones occurring in the Girvan area of the British Isles and in North America. A new genus, Analocaspis gen. nov. (type species Analocaspis ursina sp. nov.) is erected for a proetid-like species from the Lower Chasmops Shale. It has not been found outside the Oslo region.

INTRODUCTION

Proetid trilobites only occur at horizons within the Chasmops Series of the Middle Ordovician in the Oslo region (see Table), the species Decoroproetus furubergensis sp. nov. being the most widespread, occurring in the Upper Chasmops Shale and its northern equivalent, the Cyclocrinus Shale. This species is present in beds of probable Upper Chasmops Limestone age. The other Decoroproetus species are less common, and have not been found at so many localities, The supposed proetid Analocaspis ursina gen. et sp. nov. is known only from the type locality.

The term 'Middle Ordovician' is accepted herein in the sense of Stormer, i.e. from the base of the Didymograptus bifidus zone ($4a\alpha_1$) to the top of the Upper Chasmops Limestone ($4b\delta$).

SYSTEMATIC DESCRIPTIONS

Family PROETIDAE Salter, 1864

Subfamily PROETIDELLINAE Hupe, 1953

Genus DECOROPROETUS Přibyl, 1946

Synonyms: Proetidella Bancroft, 1949, Ogmocnemis Kielan, 1960, Warburgaspis Přibyl, 1946.

Type species: Proetus decorus Barrande, 1846

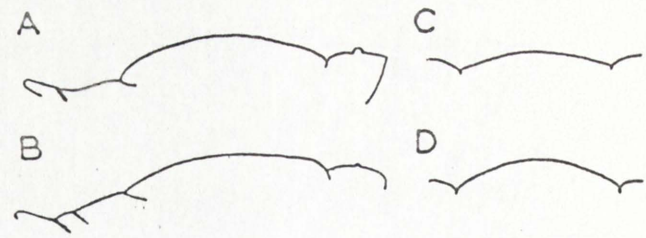


Fig.1.1. Lateral and longitudinal profiles of the cranidia of Decoroproetus furubergensis (A and C) and D. solenotus (B and D).

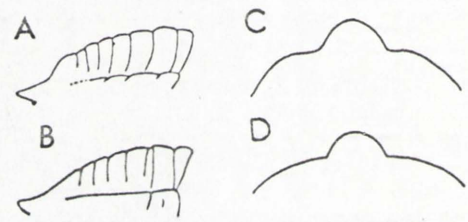


Fig.1.2. Lateral and longitudinal profiles of the pygidia of Decoroproetus furubergensis (A and C) and D. solenotus (B and D).

Decoroproetus furubergensis sp. nov.

Plate 1, A-K, Plate 2, E, G-M, Plate 3, L.

DERIVATION OF THE NAME

From the type locality, Furuberget, Nes-Hamar district.

HOLOTYPE

A cranidium (PMO 8700), Pl. 1, B, E, Pl. 3, L.

MATERIAL

Besides the type, 12 cranidia, 7 free cheeks and 9 pygidia.

TYPE STRATUM AND TYPE LOCALITY

Cyclocrinus Shale (4bγ), Furuberget, Nes-Hamar district, Oslo region.

OCCURRENCE

Upper Chasmops Shale (4bγ) and probably Upper Chasmops Limestone (4bδ), Ringerike, Hadeland and Nes-Hamar districts, Oslo region, Norway.

DIAGNOSIS

Glabella with three pairs of distinct lateral glabellar furrows interrupting the glabellar sculpture; a well developed eye socle, without a deep furrow at its base; pygidial axis with six rings; no postaxial ridge; sculpture of fine, raised, discontinuous ridges on parts of the cranidium, free cheeks and on the axial region of the pygidium.

DESCRIPTION

The cranidium has the sagittal length slightly greater than the palpebral width. The glabella is of approximately equal length and breadth, narrowing forwards weakly with the frontal lobe bluntly rounded. The glabella is defined by distinct conjoined axial and preglabellar furrows, and is weakly constricted at 2p. The glabella is moderately convex in both lateral and longitudinal profiles, and the frontal lobe curves down fairly rapidly to the preglabellar furrow in lateral profile (see Fig. 1.1, A, C). Three pairs of glabellar furrows are present, represented by smooth areas in the glabellar sculpture. 1p is situated opposite the anterior end of the palpebral lobe, directed inwards and backwards at about 45° to an exsagittal line. The furrow widens at mid length, but narrows to a point distally. It does not reach the occipital furrow, and extends about half way towards the sagittal line. Associated with 1p is a small auxiliary impression. 2p is situated opposite gamma, and is directed backwards at about 30° to an exsagittal line, extending a little further inwards than 1p. 3p is situated near the anterolateral corners of the glabella, represented by a small ovate area, isolated from the axial furrow and no larger than the auxiliary impression (see Pl. 3, L).

The occipital furrow is rather deep, shallowing at the lateral ends, with a steep anterior slope and a shallow posterior slope. It is arched forwards weakly sagittally and at either end. The occipital ring is fairly wide (sag.), about one quarter of the sagittal length of the glabella. It narrows somewhat laterally, where the posterior margin bends forwards quite strongly. In lateral profile the occipital ring is moderately convex, and in longitudinal profile it bends down steeply at either end, with the posterior edge bending down more steeply than the anterior edge. A small median occipital tubercle is present.

The preglabellar field is rather long (sag), about one third the sagittal length of the glabella. In lateral profile it is convex immediately in front of the preglabellar furrow, and then slopes down in a weakly concave curve to the anterior border furrow. The latter is poorly defined, indicated merely by the change in slope between the preglabellar field and the anterior border, which is weakly convex and upturned.

The anterior branches of the facial sutures are moderately divergent, with beta a wide, rounded angle. An exsagittal line drawn backwards from beta falls on the outer part of the palpebral lobe. The posterior branches of the facial sutures have epsilon and zeta as independent angles, this stretch of the suture running more or less parallel with the axial furrow. From zeta the posterior branches diverge rapidly outwards to cut the posterior margin about half way between the lateral end of the occipital ring and the lateral margin.

The palpebral lobe is rather large, about half the sagittal length of the glabella. It is backwardly placed and is semi-elliptical in outline. In longitudinal profile it rises up steeply from the axial furrow, and is flattened distally. It is not elevated as high as the sagittal region of the glabella (see Fig. 1.1, C). The eye is prominent, reniform, and mounted on a distinct eye socle. The lower margin of the eye socle is not demarcated by a distinct furrow but by an abrupt change in slope. The lower margin of the eye socle diverges from the upper margin at both anterior and posterior ends.

The field of the free cheek slopes down fairly steeply from the eye region, the inner part being weakly convex. The lateral border furrow is broad and shallow, with the lateral border slightly upturned and weakly convex. The posterior border furrow is narrower and more steep sided than the lateral, with the posterior border quite strongly upturned. The genal spine is fairly long and rather narrow. Fusing near the base of the genal spine, the lateral and posterior border furrows continue on to it as the median furrow, which quickly shallows posteriorly and is hardly perceptible distally.

The cephalon has a sculpture of short, fine, discontinuous ridges, which form a "broken thumbprint" pattern on the glabella. The ridges are arched forwards on the occipital ring. They are also present on the posterior part of the preglabellar field, and on the inner part of the anterior border of the holotype. On smaller specimens the latter area is smooth. While discontinuous ridges are found on the inner part of the free cheek, the outer part and the lateral border region are smooth. On the palpebral lobe the discontinuous ridges run forwards and outwards. On the anterior and lateral borders, and on the inner part of the genal spine there are two or three strong, subparallel, raised striae.

The pygidium is of subparabolic outline, without a border, and about twice as wide as long on larger specimens, but proportionately longer in smaller specimens (cf. Pl. 2, G and Pl. 2, J). Anteriorly the axis occupies about one third of the total pygidial width, tapering gradually backwards to the bluntly rounded posterior end, not reaching the posterior margin. There is no postaxial ridge. The axis consists of six rings and a short end piece. In lateral view the axis slopes gently backwards, sloping down steeply at the posterior end where it forms a continuous concave curve with the postaxial area (see Fig. 1.2, A and Pl. 1, G). The pleural areas have four or five pairs of ribs, which curve gently backwards. Each rib consists of an anterior and posterior pleural band of approximately equal width, and widens distally. The pleural furrow is strong, deepening distally with a steep anterior slope and a shallower posterior slope. The interpleural furrow is rather weak, evident along its entire length and deepening distally. The pleural and interpleural furrows turn backwards quite sharply distally, and the first three or four pairs reach the pygidial margin.

The pygidial axis has a sculpture of forwardly arched, discontinuous ridges. Sometimes these occur on the most anterior pleural band (e.g. Pl. 2, J). The pleural areas are otherwise almost devoid of sculpture, apart from occasional short striae. At the margin there are two or three fine, continuous ridges, which run subparallel to it.

DIMENSIONS

Cranidia

Specimen Number	L	L_1	L_2	W	$\delta-\delta$
Holotype					
PMO 8700	9.9	5.4	2.5	5.6	?8.0
PMO 68283		1.9	?0.5	2.0	2.9
PMO 68504		3.2	0.9	3.1	4.6
PMO 70442	?3.1	1.8	0.5	2.0	?3.0
PMO 70460		2.7		2.7	4.0
PMO 20649	4.1	2.3	0.7	2.4	3.5
PMO 8816	2.8	1.6	0.5	1.6	?2.2
PMO 8817	3.6	2.1	0.4	2.1	3.0
PMO 8818	3.3	1.8	0.6	1.7	?2.7

Pygidia

Specimen Number	A	A_1	X	Y
PMO 8692	3.5	2.7	?6.8	2.0
PMO 8694	3.7	2.9	?7.0	2.0
PMO 20694	4.5	3.6	9.0	3.0
PMO 70447	3.0	2.4	5.5.	2.0
PMO 68281	2.5	2.1	4.8	1.6

DISCUSSION

Decoroproetus furubergensis is one of the more abundant Middle Ordivician proetids in the Oslo region. The small differences exhibited between different specimens (cf. Pl. 1, A and E) are taken to be minor intraspecific variations (e.g. glabellar outline, presence or absence of small sculptural elements, degree of convexity of border etc). Most of the material comes from the Upper Chasmops Shale or its equivalents, but one cranidium and two free cheeks (Pl. 1, D, H) are from beds of probable Upper Chasmops Limestone age.

From the Middle Ordovician outside Norway, Decoroproetus furubergensis may be compared with Decoroproetus jamesoni (Reed, 1914, Pl. 4, Fig. 8) from the Balclatchie Mudstones of the Girvan area, and with three species of Proetidella recently described by Ross (1967, Pl. 2, Figs. 8-18), from the Lexington Limestone of Kentucky. Both these species and D. furubergensis share similar glabellar shapes and pygidial proportions, the latter being proportionately shorter than in Decoroproetus fearnsidesi (Bancroft) (see Dean, 1963, Pl. 45, Fig. 3). The sculpture of discontinuous ridges of D. furubergensis is in contrast to that of D. fearnsidesi andmany other species of Decoroproetus, where the ridges are continuous and cover the entire exoskeleton.

The length-breadth proportions of the pygidium, the number of axial rings (six) and the lack of the postaxial ridge in D. furubergensis invite comparison with species of Cornuproetus (Lepidoproetus) Erben 1952, especially C. (L) regulus Haas, 1968 from the Lower Devonian of north-western Turkey (see Haas 1968, Pl. 27, Figs. 15-22 and Text Fig. 9, p. 83). C.(L) regulus has an overall similar appearance to D. furubergensis but has a number of small differences, notably the wider (sag.), occipital ring, the broader cephalic border, the smaller number of pygidial axial rings (four) and the pygidial pleural ribs bending backwards less strongly. There is a great age difference between the two species, so that the similarity between them may be purely fortuitous. Conversely it may be due to a true phylogenetic relationship, but evidence from the intervening Upper Ordovician and Silurian is needed before this can be demonstrated with any certainty.

Decoroproetus gyratus sp. nov.
Pl. 2, A, B, D, Pl. 3, M.

DERIVATION OF THE NAME

From the Latin gyratus, turned around, referring to the arrangement of striae on the preglabellar field.

HOLOTYPE

A cranidium (PMO 8702), Pl. 2, A, Pl. 3, M.

MATERIAL

Besides the type, one cranidium (PMO 63296), Pl. 2, B, D.

TYPE STRATUM AND TYPE LOCALITY

Lower Chasmops Shale (4bα), shore section below the parking place to Fornebu Airport, Baerum, Oslo.

OCCURRENCE

Lower Chasmops Shale, the type locality and Bygdøy, Oslo-Asker region.

DIAGNOSIS

Glabella with faint, non impressed lateral furrows. Preglabellar field almost straight in lateral profile. Sculpture of dense, continuous striae, those on the anterior part of the preglabellar field arranged in a transversely elongated concentric pattern.

DESCRIPTION

The cranidium has the sagittal length considerably greater than the palpebral width. The glabella is a little longer than broad in the holotype, narrowing forwards weakly to the bluntly rounded frontal lobe. The glabella is slightly constricted in front of the palpebral lobe, and in lateral profile slopes down gently from posterior to anterior in a weakly convex curve. In longitudinal profile it is quite strongly convex. Two pairs of lateral glabellar furrows are present on the holotype, interrupting the striated sculpture (see Pl. 3, M). On the other cranidium (PMO 63296) the furrows are not discernible. 1p is a little anterior to the centre of the palpebral lobe, and is directed backwards at an angle of 45° to an exsagittal line. The furrow widens at mid length and tapers distally to a point, not reaching the occipital furrow and extending about one third of the way inwards towards the sagittal line. 2p is situated opposite the anterior end of the palpebral lobe, and is directed inwards and slightly backwards. It widens a little distally and extends about half way towards the sagittal line.

The occipital furrow is deep, running transversely for most of its length, but bending forwards at either end. The occipital ring is a little shorter (sag.) than the preglabellar field, and it is about the same width as the glabella (trans.). It narrows only very slightly laterally, and lacks the lateral occipital lobes. A small, distinct median tubercle is present. In lateral profile the occipital ring is very weakly convex, rising up gently from the occipital furrow, and in longitudinal profile it bends down steeply at either end.

The preglabellar field is long (sag.), between one quarter and one third the length of the glabella. It slopes down steeply in lateral profile, following the same contour as the frontal lobe of the glabella, and is almost straight (see Pl. 2, B). The anterior border furrow is ill defined, represented by a change in slope between the downsloping preglabellar field and the wide, weakly convex anterior border.

The anterior branches of the facial sutures are strongly divergent with beta forming a wide curve. An exsagittal line drawn backwards from beta falls on the outer part of the palpebral lobe. Gamma is close to the axial furrow, near the constriction of the glabella. The posterior branches of the facial sutures have epsilon and zeta as apparently one angle, close to the lateral end of the occipital ring. From here the posterior branches diverge strongly outwards. The palpebral lobe is large, approaching half the length of the glabella, backwardly placed and crescentic in outline. In longitudinal profile it rises up quite steeply from the axial furrow, but soon flattens out. The palpebral lobe is considerably below the height of the sagittal region of the glabella.

The entire cranidium has a sculpture of dense, continuous raised striae, arranged in a Bertillon pattern. On the preglabellar field they are not so dense, and are arranged in a transversally elongated concentric pattern (see Pl. 2, A).

DIMENSIONS

Specimen Number	L	L_1	L_2	W	$\delta-\delta$
Holotype PMO 8702	7.1	4.5	1.3	3.7	?5.0
PMO 63296	6.5	3.5	1.3	?3.2	

DISCUSSION

The two cranidia upon which this species is based are distinctive in the arrangement of the striae on the anterior part of the preglabellar field. The two specimens differ from one another in the distinctness of the lateral glabellar furrows, and on the holotype they are clearly indicated, while on the other specimen they are hardly discernible.

In its glabellar shape, D. gyratus is similar to 'Proetidella sp. B' of Tripp (1967, Pl. 2, Figs. 15-16) from the Middle Ordovician Upper Stinchar Limestone of the Girvan district. The Girvan specimens are too badly preserved to ascertain whether they are conspecific with the Norwegian one.

Decoroproetus solenotus sp. nov.

Pl. 2, K and Pl. 3, A-K.

DERIVATION OF THE NAME

From the Greek solenotos, channelled, alluding to the shallow depression running parallel to the anterior border.

HOLOTYPE

A cranidium (PMO 70437), Pl. 3, B, C, K.

MATERIAL

Besides the type, 3 cranidia, 3 free cheeks and 2 pygidia.

TYPE STRATUM AND TYPE LOCALITY

Upper Chasmops Limestone(4bδ), 1.7 meters below the top, N. Raudskjaer, Asker.

OCCURRENCE

Upper Chasmops Limestone (4bδ), Oslo-Asker and Ringerike districts.

DIAGNOSIS

Cephalon with a shallow depression running subparallel to the border; preglabellar field almost straight in lateral profile; eye socle well developed, with a distinct furrow at its lower margin; sculpture of very fine, discontinuous striae and minute granules.

DESCRIPTION

The cranidium is rather strongly vaulted, with the palpebral width approximately two thirds of the sagittal length. The glabella is defined by shallow, conjoined axial and preglabellar furrows, and is marginally longer than it is wide. From its widest point, at the posterolateral angles the glabella narrows very gradually forwards and is slightly constricted laterally. In longitudinal profile it is moderately convex (see Fig. 1.1, D), and in lateral profile it slopes down gently from anterior to posterior, and is weakly convex (see Fig. 1.1, B and Pl. 3, B). Three pairs of lateral glabellar furrows are present, their positions marked by smooth areas in the glabellar sculpture (see Pl. 3, J, K). 1p and 2p are weakly impressed. 1p is situated more or less opposite the centre of the palpebral lobe, and is directed backwards at about 45° to an exsagittal line. It is widest proximally and narrows rapidly distally, not reaching the occipital furrow and extending about half way towards the sagittal line. Associated with 1p is a small, inconspicuous auxiliary impression. 2p is situated opposite gamma and is narrower and rather shorter than 1p, and is directed inwards and slightly backwards. It is weakly curved with the convex side facing backwards. 3p is inconspicuous, situated a short distance in front of 2p, near the anterolateral corner of the glabella and isolated from the axial furrows, and directed inwards and noticeably forwards.

The occipital furrow is rather deep, arched forwards weakly sagittally and more strongly laterally. In lateral profile it has a deep anterior slope and a shallow posterior slope. The occipital ring is fairly wide (sag.), narrowing markedly laterally, without lateral lobes. Transversely it is a little wider than the glabella. In lateral profile it is very weakly convex, and slopes up noticeably backwards. In longitudinal profile it plunges down steeply at either end. A small, distinct, median tubercle is present.

The preglabellar field is long (sag.), between half and one third the length of the glabella. It slopes down rather steeply from the preglabellar furrow to the anterior border furrow, and its lateral profile is straight and follows more or less the same line as the glabellar profile (see Fig. 1.1, B and Pl. 3, B). The anterior border furrow is wide and shallow, with the anterior border weakly convex and slightly upturned. Running a little way inside the anterior border, and parallel with it, is a shallow depression, indicated by a dark band on the preglabellar field (Pl. 3, A, C, D and G).

The anterior branches of the facial sutures are strongly divergent, with gamma close to the glabella. Beta is a rather wide, open curve. The posterior branches of the facial sutures have epsilon and zeta as one angle, close to the axial furrow. From this point they diverge strongly outwards to cut the posterior margin close to the base of the genal spine.

The palpebral lobe is backwardly placed, close to the glabella and about half its length, and is subcrescentic in outline. In longitudinal profile it rises up at an angle of $35-40^{\circ}$ (seeFig. 1.1, D), gradually flattening distally. The eye is reniform, rather large and mounted on a distinct eye socle, whose base is demarcated by a distinct furrow, which diverges markedly at either end from the upper margin of the eye socle.

From the eye the field of the free cheek slopes down quite rapidly to the lateral border furrow. The latter, like the anterior border furrow, is shallow and rather wide. Outside it lies the rather wide, upturned lateral border. The depression on the preglabellar field continues onto the free cheek, converging with the lateral border near the base of the genal spine (see Pl. 3, F, H). The posterior border furrow has a steep anterior slope and this terminates at the base of the genal spine. The posterior border is rather narrow, and upturned. The genal spine is broad based and tapers rapidly backwards, and bears a wide median groove, produced by the merging of the lateral and posterior border furrows.

The cranidium has a sculpture of very fine, short raised striae, which are arched forwards sagittally on the glabella and occipital ring. They are almost reduced to granules on parts of the glabella and the preglabellar field. The regions of the anterior, lateral and posterior border furrows are almost smooth. On the cephalic border the sculpture is markedly granular. Distinct raised striae occur on the margins of the cephalon, running parallel with it.

The thorax is unknown, but two early holaspid pygidia belonging to this species possess one attached thoracic segment. This lacks the preannulus, and the pleuron has a deep, distinct pleural furrow. The distal end of the pleuron is turned backwards and is bluntly pointed.

The early holaspid pygidium is of subparabolic outline, without a border. The axis is about one third of the width (trans.) of the pygidium anteriorly. It tapers backwards quite rapidly and terminates in a bluntly pointed end, which does not reach the posterior margin. A short postaxial ridge is present. The axis consists of five rings and a short end piece. In lateral profile the axis slopes down moderately rapidly towards the posterior (see Fig. 1.2, B), and each axial ring is weakly convex. The pleural areas have four pairs of ribs, with strong pleural and weak interpleural furrows, which turn strongly backwards distally. The pleural furrows deepen considerably distally, and possess a deep anterior slope and a rather shallow posterior slope. The interpleural furrows are narrow and shallow and are only immediately evident distally, although they can be traced inwards almost to the axial furrow.

DIMENSIONS

Cranidia

Specimen Number	L	L_1	L_2	W	$\delta-\delta$
Holotype PMO 70437	3.6	2.0	0.8	1.8	2.3
PMO 70497	7.5	4.0	1.5	3.5	?4.8
PMO 70495	6.0	3.4	1.2	2.9	4.0
RM Ar 37442	4.3	2.5	0;9	2.4	2.8

Pygidia

Specimen Number	A	A_1	X	X_1
PMO 8695	1.0	0.7	1.7	0.5
PMO 8696	0.9	0.7	?1.8	0.5

DISCUSSION

The profile of the preglabellar field and glabella is close to that of *Decoroproetus matutinus* (Ruedemann) from the Middle Ordovician of New York state. In most other species of *Decoroproetus* the preglabellar field is concave or sigmoidal in profile. The only information available on the pygidium of *D. solenotus* is from two early holaspid specimens. These have a small number of axial rings (five) and a distinct postaxial ridge. They resemble the transitory and early holaspid pygidia of *Denemarkia frontalis* (see Erben 1966, Pl. 19, Figs. 1-4) and the pygidium of *Phaseolops sepositus* (see Whittington 1963, Pl. 5, Figs. 1-6). In all three a range of common pygidial features is evident; the backwardly turned pleural ribs, the deep pleural furrows and the small number of axial rings. Other parts of the exoskeleton do not correspond so well, but the glabellar outline and the strongly divergent anterior branches of the facial sutures are features shared by all three species. *Phaseolops sepositus* and *Denemarkia frontalis* show far greater similarities to one another than does either of them to *Decoroproetus solenotus*. The similarity of the pygidial and other features might suggest some relationship, but the age difference between the three species is great (*P. sepositus*, Llanvirn, *D. solenotus*, Caradoc and *D. frontalis*, Lower Devonian) and makes any relationship highly unlikely. The resemblance of *Phaseolops sepositus* to undoubted proetids supports Whittington's (1963, p. 40) contention that it is one.

Decoroproetus sp. A.

Pl. 2, C, F.

MATERIAL

One cranidium (PMO 61018c), on the same piece of rock as *Prognaspis stoermeri* Nikolaisen (figd. Nikolaisen, 1965, Pl. 2, Fig. 4).

HORIZON AND LOCALITY

Upper Chasmops Limestone(4bδ_2), subzone of *Tretaspis kiaeri*, western side of Frognøy Island, Lake Tyrifjorden, Ringerike.

DESCRIPTION

The cranidium has the palpebral width about three-quarters of the sagittal length. The glabella is slightly longer (sag.) than it is wide (trans.) and is defined by narrow, distinct, conjoined axial and preglabellar furrows. It is widest at the posterolateral corners, and tapers gradually forwards to the anterolateral corners, with a bluntly angular frontal lobe. The glabella is slightly constricted opposite gamma, and is moderately convex in lateral and longitudinal profiles. Three pairs of lateral glabellar furrows are present, which are weakly impressed on the glabellar surface and interrupt the striated sculpture. 1p is situated opposite the centre of the palpebral lobe and is directed towards the back at about 45° to an exsagittal line. The proximal part is wide, while the distal part is rather narrow, and the whole furrow extends about two thirds of the way towards the sagittal line. 2p is situated opposite the anterior part of the palpebral lobe, and is about the same width as the distal part of 1p, and is directed backwards a little less strongly than 1p. 2p is about the same length as the proximal part of 1p. 3p is situated just behind the anterolateral corner of the glabella, is about the same length as 2p and is directed slightly forwards. There is an inconspicuous auxiliary impression associated with 1p, situated between the proximal part of 1p and the sagittal line.

The occipital furrow is rather narrow, and is deeper than the axial and preglabellar furrows. It widens slightly about half way between the sagittal line and the lateral end. The occipital furrow runs transversely for most of its length, and curves forwards slightly at either end. It does not run into the axial furrow due to the fusion of the posterolateral corner of the glabella with the anterolateral corner of the occipital ring. The occipital ring is apparently of about the same width (sag.) as the preglabellar field, and is a little wider (trans.) than the glabella. It apparently maintains more or less the same width along its length (sag. and exsag.), and narrows slightly at the extreme lateral ends. There are no lateral occipital lobes, but there is a small, distinct median tubercle.

The preglabellar field is short (sag.), about one sixth the sagittal length of the glabella. The anterior border furrow is wide and shallow, its position being indicated by the change in slope between the downsloping preglabellar field and the upturned, weakly convex anterior border, which is about four fifths the length (sag.) of the preglabellar field.

The anterior branches of the facial sutures are quite strongly divergent, with gamma close to the axial furrow. Beta forms a wide curve, and an exsagittal line drawn backwards from it falls on the outer margin of the palpebral lobe. The posterior branches of the facial sutures have epsilon close to the axial furrow at the lateral end of the occipital ring. They diverge strongly on the posterior border, and presumably cut the posterior margin close to the base of the genal spine.

The palpebral lobe is rather narrow, crescentic in outline, nearly half the sagittal length of the glabella and backwardly placed. It bends up strongly from the axial furrow and flattens out distally, and is not elevated to the height of the sagittal region of the glabella.

The cranidium has a sculpture of fine, raised striae, arranged in a Bertillon pattern on the glabella and occipital ring. On the preglabellar field they run transversely, on the anterior border inwards and slightly forwards and on the palpebral lobe, forwards and outwards. The striae are interspersed with rows of fine granules on parts of the cranidium, particularly on the lateral parts of the glabella.

DIMENSIONS

Specimen Number	L	L_1	L_2	W	$\delta-\delta$
PMO 61018c	?3.6	2.4	0.4	2.2	2.7

DISCUSSION

This single cranidium is the youngest proetid known from the Middle Ordovician of the Oslo region, and does not particularly resemble the other species described herein. It differs from them principally in the short preglabellar field and in its glabellar outline. These features are comparable with species from elsewhere, particularly *Stenoblepharum kullsbergense* (Warburg 1925) (see Pl. 16, A, G-I) from the Middle Ordovician Kullsberg Limestone and *Decoroproetus* aff. *subornatus* (Cooper and Kindle) (see Pl. 22, Figs. 15, 25), from the Lower Ashgill of the British Isles. The former species differs from *D.* sp. A in having the occipital ring markedly narrowing laterally, and the latter in having a more bluntly rounded frontal lobe of the glabella.

Subfamily UNCERTAIN

Genus ANALOCASPIS gen. nov.

Type species: *Analocaspis ursina* gen. et sp. nov.

DERIVATION OF THE NAME

From the Greek an, no, alox, a furrow and aspis, a shield, from the absence of a clearly marked anterior border furrow. Gender: feminine.

DIAGNOSIS

Cephalic border rather wide, weakly convex and poorly defined; glabella of trapezoidal outline, with three pairs of deeply impressed lateral furrows; preglabellar field extremely short (sag.); eye small, forwardly placed; anterior and posterior branches of facial suture both divergent, the posterior delimiting a small triangulate posterior portion of the fixed cheek; thorax of at least nine segments; pygidium of subparabolic outline, without a border; axis of six rings, pleural areas with four or five pairs of ribs, which extend almost to the margin.

DISCUSSION

The taxonomic position of Analocaspis is uncertain in relation to other proetids. The deep glabellar furrows and the sagittally widened occipital ring can be compared with other supposed proetids, such as "?Phaseolops sp. ind." (Whittington, 1965, Pl. 19, Figs. 1-5) from the Middle Ordovician Table Head Formation of Newfoundland, but which like Analocaspis is hard to place. The interesting genus Rorringtonia (type species R. flabelliforme, Whittard 1966, Pl. 50, Figs. 8-9) which may be a proetid bears some resemblance to Analocaspis, but differs in several features, notably the narrow anterior border, the parallel anterior branches of the facial sutures, the larger number of rings (ten) on the pygidial axis and the larger number of pygidial pleural ribs (nine).

Apart from the proetids, the only other group to which Analocaspis shows any resemblance is the calymenids. Several features of Analocaspis are found in the calymenids, notably the small, forwardly placed eyes and the deep lateral glabellar furrows. However, the strongly divergent anterior branches of the facial sutures, the convex anterior border, the number of thoracic segments and the type of pygidium are all proetid rather than calymenid, and thus the similarities to proetids far outweigh those to calymenids. For these reasons Analocaspis is considered to be a proetid, but because of its distinct morphology it is not assigned to any established proetid subfamily.

Analocaspis ursina gen. et sp. nov.

Pl. 4, A-H.

DERIVATION OF THE NAME

From the Latin ursina, pertaining to bears, alluding to the name of the type locality, Bjornsvikveien ('Bears' Bay Road').

HOLOTYPE

An almost complete specimen (PMO 8701), Pl. 4, B.

TYPE STRATUM AND TYPE LOCALITY

Lower Chasmops Shale (4bα), Bjornsvikveien, close to the syenite dyke, near Drammensveien, Baerum, Oslo-Asker district.

OCCURRENCE

Only known from the type locality.

DIAGNOSIS

Anterior border furrow almost obsolete; lateral border furrow more clearly defined, but very shallow; palpebral lobe small, upturned; posterior branch of the facial suture weakly outwardly convex.

DESCRIPTION

The cephalon is rather weakly vaulted, more or less semicircular in outline with a poorly defined border. The glabella has a trapezoidal outline and is weakly convex in lateral and longitudinal profiles. It is defined by the deep, conjoined axial and preglabellar furrows, and tapers forwards quite rapidly from its widest point, just behind the 1p furrows. Anteriorly it is bluntly truncated. At its widest (trans.) the glabella occupies about one third of the total cephalic width. Three pairs of deep lateral glabellar furrows are present. 1p is situated opposite epsilon. It is almost obsolete proximally, but deepens rapidly inwards and is bent backwards at an angle of between 45° and 50° from an exsagittal line. Posteriorly it shallows and runs into the occipital furrow, thereby partially isolating triangulate 1p lobes, which are about one third of the glabellar length. 2p is situated opposite the anterior part of the palpebral lobe, is shorter and shallower than 1p, and is bent backwards at a similar angle. 3p is situated a short distance in front of 2p, and is shorter and shallower than the other furrows, running almost straight inwards.

The occipital furrow is about the same depth as the axial and preglabellar furrows, and is arched gently forwards sagittally. In longitudinal profile it slopes downwards from the sagittal region to the lateral extremities, and in lateral profile it is weakly convex.

The preglabellar field is extremely short (sag.). The anterior border furrow is very poorly defined, and is invisible on some specimens (cf. Pl. 4, D and Pl. 4, H). The anterior border is rather wide, and is weakly convex in lateral profile.

The anterior branches of the facial sutures are strongly divergent. On the holotype and certain other specimens (e.g. Pl. 4, B, D), beta is a rounded curve, while on other specimens (e.g. Pl. 4, C, G), beta is markedly angular. This difference is probably the result of deformation. The posterior branches of the facial sutures run outwards and backwards from the palpebral lobes, to cut the posterior margin just inside the inner margin of the genal spine, producing a small triangulate posterior portion of the fixed cheek.

The palpebral lobe is well forwards, more or less opposite the 2p furrow. It is situated a little way out from the axial furrow, and is rather small and upturned. The eye is small and reniform, The free cheek is weakly convex in profile, sloping down gently from the eye to the weak, shallow, lateral border furrow. The lateral border is rather wide and weakly convex. The inner part of the posterior border furrow is of comparable depth to the axial furrow, but it rapidly widens and shallows laterally, so that outside the facial suture it is about the same depth as the lateral border furrow. The genal spine is short, broad based and flattened, without a median furrow.

The thorax has at least nine segments, but on the only near complete specimen available (the holotype) it is disarticulated between the sixth and seventh segments. The thoracic axis is weakly convex in longitudinal profile. Anteriorly it is about the same width as the pleural areas, but posteriorly it is rather wider. The axis narrows gently backwards so that the last ring is about three fifths as wide (trans.) as the first. The pleurae run almost straight outwards from the axial furrow, and curve gently backwards distally. Each pleuron has a rather deep, distinct, pleural furrow, which runs almost to the distal extremity. The distal end of the pleuron is pointed.

The pygidium is of subparabolic outline, without a border. Anteriorly the axis is just over one quarter of the pygidial width, and tapers quite rapidly backwards, terminating bluntly and not reaching the posterior margin. It consists of six rings and a short terminal piece. There is no postaxial ridge. The pleural areas have four to five pairs of ribs which bear narrow interpleural furrows and wider, deeper pleural furrows, both of which reach close to the pygidial margin. The pleural furrows divide each pleural rib into an anterior and posterior band of more or less equal width and convexity. The pygidial doublure is rather narrow and dorsally concave. As far as can be seen, the entire exoskeleton is smooth.

DIMENSIONS

Total length (sag.) of holotype (PMO 8701) - 8.1 mm.
Greatest width (trans.) of cephalon of holotype - c. 7.0 mm.
Length of thorax (sag.) of holotype - 2.9 mm.

Cranidia

Specimen Number	L	L_1	L_2	W	$\delta - \delta$
Holotype PMO 8701	3.5	2.1	0.9	2.6	3.6
PMO 70449	?6.1	3.5	1.9	?4.0	4.0
PMO 70450	5.0	2.5	1.3	3.3	4.0
PMO 70451	5.5	3.1	1.5	3.8	4.1
PMO 70453	?5.5	3.3	?1.0	3.8	4.0
PMO 70454	7.8	4.5	2.4	4.5	4.7

Pygidia

Specimen Number	A	A_1	X	Y
Holotype PMO 8701	1.8	1.3	4.0	1.2
PMO	3.7	2.9	?7.0	2.5

DISCUSSION

Analocaspis ursina is the only known species of *Analocaspis*, and has only been found at the type locality, from where about a dozen specimens have been recovered. All are rather poorly preserved internal moulds, which have suffered some distortion. One specimen (PMO 70454) is proportionately longer and narrower than the other specimens, but these differences are probably due to distortion.

	Proetus ainae	Ascetopeltis bockeliei	Ascetopeltis lepta	Ascetopeltis sp. A	Ascetopeltis? sp. B	Decoroproetus asellus	Decoroproetus brevifrons	Decoroproetus evexus	Decoroproetus furubergensis	Decoroproetus modestus	Decoroproetus papyraceus	Decoroproetus remotus	Decoroproetus sp. B	Decoroproetus sp. C	Decoroproetus?scanicus	Stenolblepharum warburgae	Stenoblepharum norvegicum	Stenoblepharum kullsbergense	Stenonlepharum pentagonoides	Eremiproetus agellus	Parvigena parvigena	Parvigena striata	Xenocybe micrommata	Isbergia parvula	Isbergia planifrons	Kallholnia dapsilis	Kallholnia sp. A
Oslo Region		+	+	+		+		+									+			+			+		+		
Västergötland							+						+														
Östergötland		+																									
Skåne															+												
Öland									+																		+
Dalarna	+	+			+					+	+	+		+		+	+	+	+	+	+	+		+	+	+	
Tretaspis Series-Stage 5a		+	+	+				+									+			+			+		+		
Tretaspis Series-Stage 4cα						+																					
Boda Limestone	+									+		+				+	+		+	+	+	+		+	+	+	
Boda Lst.-off reef facies		+			+																	+					
Jonstorp Formation		+					+						+														
Jerrestad Mudstone															+												
Fjäcka Shale											+																
Kullsberg Limestone														+				+									
Macrourus Limestone									+																		+

Fig. 2.1. Stratigrpahical and geographical distribution of Ordovician Proetidae in Scandinavia.

C H A P T E R 2

MIDDLE AND UPPER ORDOVICIAN PROETIDAE FROM SCANDINAVIA

ABSTRACT

Twenty-eight proetid species are investigated from the Ordovician of Scandinavia. They are distributed among nine genera; Proetus, Decoroproetus, Isbergia, Eremiproetus, Stenoblepharum, Kallholnia, Parvigena, Ascetopeltis and Xenocybe, of which the last five are new. The following new species are defined: Ascetopeltis bockeliei sp. nov., A. lepta sp. nov., Decoroproetus evexus sp. nov., Stenoblepharum norvegicum sp. nov., Eremiproetus agellus sp. nov., Parvigena striata sp. nov. and Xenocybe micrommata sp. nov. Many species are specialised reef dwellers, with their occurrence limited to the Dalarna reef limestones. Non-reef species can be compared with others occurring in Poland, Estonia and the British Isles.

INTRODUCTION

Scandinavian localities, particularly the Dalarna reef limestones, have proved to be some of the richest sources of Ordovician proetid trilobites, and the material is often abundant and well preserved. Over the past 150 years about a dozen proetid species have been described from Scandinavia in the works of Esmark (1833), Angelin (1854), Linnarsson (1869), Tornquist (1884), Olin (1906), Warburg (1925) and Størmer (1940). The majority of these originate from the Dalarna reef limestones, and were described in Warburg's monumental work. While her descriptions have stood the test of time, it has been necessary to refigure all her material, which was illustrated as drawings, which, while excellent for the time, are inadequate by modern standards. Warburg did not describe all the material available to her, andher descriptions can often be amplified from information from extra material.

RELATIONSHIP OF THE SPECIES

The Scandinavian Ordovician proetids can conveniently be divided into three groups for the purpose of comparison with other regions.

(i) Non reef Middle Ordovician
(ii) Non-reef Upper Ordovician
(iii) Middle and Upper Ordovician reefs.

(i) The Middle Ordovician Non-Reef Facies

Five proetid species are described from the Middle Ordovician of the Oslo Region in Chapter 1, and one of these has been found in the Macrourus Limestone erratics of Oland. This species (D. furubergensis), accompanied by a species of Kallholnia, are the only proetids from the non-reef Middle Ordovician of Sweden. The absence of proetids from other areas may be more apparent than real.

(ii) The Upper Ordovician Non-Reef Facies

In Scandinavia this is essentially a shale sequence, in which impure limestones are sometimes locally developed. In this facies of the Upper Ordovician, Decoroproetus is dominant, represented by D. papyraceus (Tornquist), D. asellus (Esmark) and D. brevifrons (Angelin). These species can be compared with ones occurring in the Holy Cross Mountains in Poland and in the British Isles. Ascetopeltis bockeliei sp. nov. occurs in small numbers in the Red Jonstorp formation, and in the reef-flank deposits of the Boda Limestone. Parvigena striata is also recorded from the reef-flank deposits of the Boda Limestone. The latter is more commonly found in the true reef, and the former is common in the reef-like Palaeoporella facies of the Oslo Region.

(iii) The Middle and Upper Ordovician Reef Facies

In the late Viruan Kullsberg Limestone, only one proetid is common - Stenoblepharum kullsbergense (Warburg). By contrast, the Harjuan Boda Limestone is rich in both proetid genera and species, of which the commonest areStenoblepharum warburgae (Pribyl) and Kallholnia dapsilis sp. nov. The latter occurs in vast numbers at one locality, but has not been recorded elsewhere. Species similar to those in the Boda Limestone occur in the reef-like Palaeoporella facies of the Tretaspis series (Stage 5a) of the Oslo region, and in the Kildare Limestone in Eire. The Palaeoporella facies of Norway contains forms rare or absent from the Boda Limestone, such as Ascetopeltis bockeliei and Xenocybe micrommata sp. nov., but is not as rich in species or in individuals as the Boda Limestone. The fauna of the Kildare Limestone of Eire is being described by Deah, and contains Stenoblepharum and Isbergia species.

STRATIGRAPHY

The stratigraphical terminology for Scandinavia recently proposed by Jaanusson (1960, 1960a, 1963, 1963n, 1964) is employed herein, and the terms Virnan and Harjuan are used for Middle and Upper Ordovician respectively. Ingham and Wright (1970) have recently revised the British Ashgill Series, including in it the Pusgillian stage. This has brought the Ashgill to have approximately the same meaning as the Harjuan. Ingham (personal communication, 1970) considers Stage 5a in Norway to be of approximately equivalent age to the Upper Drummuck Group at Girvan, which belongs to the late Rawtheyan Stage of the Ashgill. The Red Jonstorp formation is also about the same age. On proetid evidence, the Boda Limestone, whose age is debatable, would seem to be approximately contemporaneous with Stage 5a and the Upper Drummuck Group. The Fjacka Shale is correlatable with the Pusgillian Stage, at least in part. The simplified correlation of British and Scandinavian successions (see Fig. 2.1) is based on one author's interpretation of the information available to him.

SYSTEMATIC DESCRIPTIONS

Family PROETIDAE Salter 1864

Subfamily PROETINAE Salter 1864

Genus PROETUS Steininger 1831

Type Species: Calymene concinna Dalman 1827

Proetus ainae Warburg 1925

Plate 5, A-I, K, L

1925 Proetus Ainae n. sp.: Warburg, p. 178, Pl. 5, Figs. 26-31

1964 Paraproetus ainae (Warburg): Pribyl, p. 44

LECTOTYPE

A cranidium (Stockholm University Collection), figd. Warburg 1925, Pl. 5, Fig. 26, and refigured herein as Pl. 5, F.

MATERIAL

Many detatched exoskeletal parts, mostly internal moulds.

TYPE STRATUM AND TYPE LOCALITY

Harjuan, Boda Limestone, Lissberg.

OCCURRENCE

Only known from the type locality.

DIAGNOSIS

Glabella broadly coniform, longer (sag.) or as long as wide (Trans), weakly convex in lateral and longitudinal profiles, but steeply declined at its perimeter to the axial and preglabellar furrows; three pairs of non-impressed lateral glabellar furrows, all backwardly inclined, with 1p and 2p long; short (sag.) preglabellar field developed; eye rather small, on narrow, poorly defined eye socle; anterior branches of facial sutures weakly divergent, posterior branches with epsilon and zeta separated; field of free cheek pitted; genal spine short; occipital ring with lateral lobes; pygidium without border; broad axis with 7-8 axial rings clearly defined; pleural areas with 5 pairs of ribs.

DESCRIPTION

See Warburg, p. 178.

DISCUSSION

Of Warburg's original material, it has unfortunately been impossible to trace the hypotome (Warburg, Pl. 5, Fig. 28) which she supposed to belong to this species. Warburg (p. 180) stated that *P. ainae* has affinities with species from the Silurian of Gotland and Estonia but did not name them. *P. ainae* does not particularly resemble *P. berwynensis* from the Upper Ordovician of North Wales (see Chapter 2, Plate 19, Figs. 1-2), the only other species of *Proetus* so far described from the Ordovician. The latter has a larger eye, (apparently) no lateral occipital lobes and fewer pygidial pleural ribs and axial rings. A free cheek from the Upper Ordovician Kildare Limestone of Eire (see Pl. 5, J) is quite close to that of *P. ainae*, and may come from a closely related, hitherto undescribed species. It differs in having a larger eye, more divergent anterior branch of the facial suture and in having epsilon and zeta as one angle. The closest Silurian species to *P. ainae* are *P. conspersus* (Angelin) and *P. signatus* Lindstrom. How these are related to *P. ainae* remains uncertain.

Genus *ASCETOPELTIS* gen. nov.

Type Species: *Ascetopeltis bockeliei* gen. et sp. nov.

DERIVATION OF NAME

From Greek *asketos*, curiously wrought, ornamented, and *pelte*, a small shield, alluding to the surface sculpture of the type species. Gender, feminine.

DIAGNOSIS

Preglabellar field, when present, is very short (sag.); palpebral lobe large to rather small; occipital ring may or may not narrow abaxially; small, ill defined lateral occipital lobes present; anterior branches of facial sutures divergent; panderian notch present on cephalic doublure at base of genal spine; rostral plate trapezoidal, with connective sutures converging backwards; thorax of ten segments, preannulus present; pygidium broadly triangulate, without border; axis with 4-5 rings, separated by very shallow interannular furrows; pleural areas with 3-4 pleural ribs, with pleural and interpleural furrows of about the same depth; sulpture striate, often interspersed with sporadic granules, or smooth.

Species: Ascetopeltis bockeliei sp. nov., A. lepta sp. nov., A. barkingensis sp. nov., A. sp. A, A.? sp. B, A.? kertelensis (Schmidt) and at least one additional species from Estonia.

OCCURRENCE

Ordovician, Harjuan, Tretaspis Series, Stage 5a, Oslo, Norway; Boda Limestone (off-reef facies) and Red Joustorp Formation, Siljan district and Ostergotland, Sweden; Porkuni Stage, Estonia; Ashgill, N.W. Yorkshire, England.

DISCUSSION

Ascetopeltis is an early member of the Proetinae, closely related to Proetus (Proetus) and to Paraproetus. The latter differs in having very small, forwardly placed eyes, having pointed anterolateral corners of the occipital ring, often confluent with the posterolateral corners of the glabella, in lacking the panderian notch on the cephalic doublure, in lacking the preannulus and in having deeper axial interannular furrows on the pygidium, and in having the pygidial pleural furrows much stronger than the interpleural furrows. The pygidial construction of Paraproetus is almost intermediate between Ascetopeltis and Decoroproetus.

The principal differences between Ascetopeltis and Proetus (Proetus) are the shape of the pygidium and the striated surface sculpture of the former. Important shared features of Ascetopeltis and Proetus (Proetus) include the cephalic panderian notch, the preannulus and incurved marginal pygidial terrace lines. Species of Proetus are already present in the later Ordovician, and some pre-date the earliest known Ascetopeltis. Ascetopeltis does not, therefore, seem to be the direct ancestor of Proetus, but may be its descendant. The origins of Ascetopeltis, Proetus and Paraproetus are uncertain. Perhaps they lie in Decoroproetus, or with the early Cornuproetinae, or possibly in Cyphoproetus.

Ascetopeltis bockeliei sp. nov.

Plate 5, M-O, Plate 6, A-J, Plate 7, H, J-L.

HOLOTYPE

A complete partially exfoliated exoskeleton (PMO 8808) with counterpart (PMO 8807), Plate 6, A, G, J.

MATERIAL

Several cranidia, free cheeks and pygidia.

TYPE STRATUM AND TYPE LOCALITY

Harjuan, Tretaspis series, Stage 5a, Holmenskjaeret, Holmen, Oslo-Asker district, Norway.

OCCURRENCE

Harjuan, Tretaspis series, Stage 5a, Oslo-Asker district, Norway, Red Jonstorp formation, Ostergotland and Siljan, Sweden, Boda Limestone (off-reef facies), Siljan, Sweden.

DERIVATION OF NAME

After Mr J.F. Bockelie (Oslo) who collected much of the material upon which this species is based.

DIAGNOSIS

Preglabellar field absent; anterior border rather wide. Occipital ring narrows rapidly abaxially, with small, ill-defined lateral lobes; sculpture of dense, incised striations.

DESCRIPTION

Cephalon semicircular in outline, with a moderately wide, convex border. The glabella is demarkated by distinct, conjoined axial and preglabellar furrows, and is as wide or a little wider than long. It is widest near the posterior part of thepalpebral lobe and from here it narrows forwards to the well-rounded anterior lobe, and is slightly constricted near the anterior end of the palpebral lobe. The glabella is gently convex in lateral and longitudinal profiles. Three pairs of lateral glabellar furrows are present, hardly impressed into the glabellar surface and are represented by smooth areas on the striated glabellar surface, although some striations cross the anterior two pairs. 1p is far more distinct than 2p and 3p and is situated opposite the anterior part of thepalpebral lobe. The posterior edge is directed backwards at about 45° and the anterior edge runs almost straight inwards, beforebending strongly backwards about half way along its length, so that 1p is widest at mid-length. Distally it narrows to a point and does not reach the occipital furrow. 2p is situated nearly opposite gamma, is directed backwards at about 45° and widens slightly inwards. 3p is represented by an inconspicuous ovate area a short distance in front of 2p, is directed forwards and is isolated from the axial furrow.

The occipital furrow is deep and is flexed forwards at the extreme lateral ends. The anterior slope is nearly vertical and the posterior slope is inclined at about 45^{O}. The occipital ring is wide (sag), and narrows markedly laterally. In lateral profile it is inclined at 45^{o} from the occipital furrow and flattens off posteriorly. At its greatest width (trans), the occipital ring is marginally wider than the glabella. A small median tubercle and small, rather ill-defined, ovate lateral lobes are present.

The anterior branches of the facial sutures diverge quite strongly, with beta forming a rounded curve. The palpebral lobe is crescentic, posteriorly placed and rises up quite steeply from the axial furrow, flattening off distally. A narrow line runs parallel with the outer edge, interrupting the striations. The eye is large and reniform, supported by an indistinct eye socle. The posterior branches of the facial sutureforms an open adaxially convex curve at epsilon, where it runs close to the axial furrow, before diverging strongly on the posterior border.

The anterior border furrow is distinct and runs into the preglabellar furrow at the anterior lobe of the glabella. The anterior border is weakly convex and somewhat flattened sagitally, where it widens very slightly.

The free cheek slopes down quite steeply from the eye lobe, and is gently convex in profile. The lateral border is convex, and the posterior border is also convex, but is slightly narrower than the anterior and lateral borders. The genal corner is produced into a rather short genal spine, which has a short median groove at the anterior end. The cephalic doublure is ventrally convex, and bears a distinct panderian notch near the base of the genal spine (see Pl. 6, B).

The thorax consists of ten segments, with the axis narrowing gently backwards. The annulus is gently convex in lateral profile and is rather narrow (sag). The preannulus is about two thirds the width of the annulus, and does not reach the axial furrow. The articulating half ring is wider than the annulus (sag). The doublure of the annulus is dorsally convex, and bears strong transverse terrace lines. The pleuron has a deep pleural furrow, which extends about three-quarters of the way towards the distal end. The fulcrum is situated about half way along the pleuron. The posterolateral end of the pleuron is pointed.

The pygidium is subtriangular in outline, without a border. The axis occupies about one third of the total pygidial width at its anterior end, and tapers backwards gradually and is bluntly rounded posteriorly, not reaching the posterior border. It is strongly arched in longitudinal profile. Five axial rings are present, of which the first is narrower and elevated above the remainder. In lateral profile each ring rises up gently from anterior to posterior, and they are separated by very shallow interannular furrows. The articulating furrow is rather deep. On all except the first ring there is a small rounded impression near the posterolateral angle, which interrupts the striations. There is no postaxial ridge. The axis is separated from the pleural areas by a shallow axial furrow, which represents an abrupt change of slope. On the pleural area three pairs of ribs can be clearly distinguished, with a fourth pair weakly indicated. The pleural and interpleural furrows are of more or less the same strength, with the exception of the first pair of pleural furrows, which are much deeper and narrower than the remainder. The anterior pleural band is a little wider than the posterior, and both are of equal convexity and height. The pygidial doublure is of comparable width to the cephalic doublure, and is similarly ventrally convex and ornamented with strong, parallel terrace lines.

The entire exoskeleton is covered with fine striations, which have a "dip and scarp" structure, with the "dip" slope inclined towards the anterior. On the glabella the striations are arched gently forwards in a Bertillon pattern. They are similarly arched forwards on the thoracic and pygidial axes. On the cheeks and pleural areas of the thorax they run transversely and slightly forwards, and on the palpebral lobes run strongly forwards and slightly outwards from the axial furrow. On the pygidial pleural areas the striations run forwards and slightly outwards before arching round and curving backwards near the pygidial margin, where they run into the inturning marginal terrace lines. On some parts of the exoskeleton, notably the posterior part of the glabella and the occipital ring and pygidial axis, the striations are interspersed with sporadic granules.

DISCUSSION

Ascetopeltis bockeliei is quite frequent in Stage 5a in the Oslo region, and occurs less commonly in the Red Jonstorp Formation and in the off-reef facies of the Boda Limestone in central Sweden.

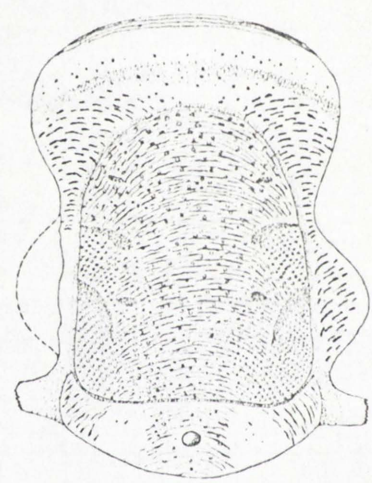


Fig. 2.2 Ascetopeltis lepta. Holotype cranidium.

Comparable specimens occur in the Porkuni stage of Estonia (see Pl. 7, B, C, E and Pl. 8, A-G). One cephalon, with one free cheek preserved (Pl. 8, C, E-G) shares similar proportions to A. bockeliei, but as it is an internal mould, the surface sculpture cannot be compared. Another cranidium (Pl. 8, A, B, D) has the external surface preserved, which is striated, but differs from A. bockeliei in the shape of the glabella and in having a smaller palpebral lobe. A pygidium (Pl. 7, B, C, E) has the external surface devoid of striations, and bears a short anterior projection on the articulating facet of the pygidium (see Pl. 7, E). One or moreof these Estonian specimens may belong to Schmidt's (1894, p. 56, Pl. 4, fig. 37) species Proetus kertelensis, which occurs in the Porkuni stage. His figure shows that the species is quite similar to A. bockeliei, and therefore probably belongs to Ascetopeltis, but I have been unable to see the original specimen.

Ascetopeltis lepta sp. nov.
Pl. 7, D, F, G, I, Text Fig. 2.2.

HOLOTYPE

A cranidium (PMO 70498)

MATERIAL

One additional cranidium

TYPE STRATUM AND TYPE LOCALITY

Harjuan, Tretaspis Series, Stage 5a, Holmenskjaeret, Holmen, Asker, Norway.

OCCURRENCE

Only at the type locality.

DERIVATION OF NAME

From the Greek, leptos, slender, from the slender glabella.

DIAGNOSIS

Glabella elongated, not constricted laterally. Short (sag) preglabellar field present. Sculpture of fine striations, interspersed by small granules.

DESCRIPTION

The cranidium is well vaulted, with the palpebral width about three-quarters of the sagittal length. The glabella is elongated, almost parallel-sided with a well-rounded frontal lobe. Its width (trans) is about three-quarters of its sagittal length. The glabella is defined by moderately deep, conjoined axial and preglabellar furrows. In lateral and longitudinal profiles it is quite strongly convex, both forming even curves. Three pairs of glabellar furrows are present, which interrupt the glabellar sculpture. 1p is situated opposite the middle of thepalpebral lobe, and is directed backwards at about 45° to an exsagittal line. It narrows distally and dies out before reaching the occipital ring. On the holotype there is a short anterior branch running inwards and slightly forwards, joined to the 1p furrow on the left hand side, but isolated from it on the right hand side. On the one additional specimen, the anterior branch is isolated from the rest of 1p, on both sides. 2p is situated opposite the anterior end of the palpebral lobe, and is directed backwards at an angle of 60° to an exsagittal line, widening distally and extending inwards nearly as far as the anterior branch of 1p. 3p is situated a short distance in front of 2p, and does not reach as far inwards and is isolated from the axial furrow.

The occipital furrow is rather deep, with the anterior and posterior slopes steeply inclined from it. It is flexed forwards very slightly at either end, but the median portion runs more or less transversely. The occipital ring is wide (sag.) and is gently convex in lateral profile, and narrows distinctly laterally, due to the strong forward curving of the posterior margin. In longitudinal profile it slopes down steeply from the sagittal region to the lateral extremities. There is a small, distinct median tubercle.

Preglabellar field very short (sag.), a little narrower than the anterior border. Thelateral parts of the preglabellar field are quite strongly convex, while the sagittal part is almost flat. The anterior border furrow is shallow, and from it the weakly convex anterior border is inclined at a shallow angle. The latter is not quite as wide (sag.) as the sagittal part of the occipital ring.

The anterior branches of the facial sutures form an even, outwardly convex curve, with an exsagittal line from beta falling on the outer part of the palpebral lobe. The posterior branches have epsilon and zeta as one angle, situated close to the axial furrow, and from it the posterior branches diverge strongly on the posterior border.

The palpebral lobe is of moderate size, about two-fifths of the sagittal length of the glabella. It is situated posteriorly, and is crescentic in outline, and rises up steeply from the axial furrow, flattening distally.

The whole cranidium is ornamented with striae arranged in a Bertillon pattern, which are interspersed with small granules, and on the lateral part of the preglabellar field the striae have degenerated into rows of granules. On the inner part of the anterior border the granules are rather sparse, and the outer part of the anterior border bears strong, subparallel terrace lines.

The remainder of the exoskeleton is unknown.

DISCUSSION

A. lepta differs from A. bockeliei principally in possessing the preglabellar field and in the shape of the glabella. It differs from A. sp. A in possessing a large number of granules in the sculpture and in having the occipital ring narrowed laterally. A. lepta differs from the British species A. barkingensis, in its glabellar shape and in having the occipital ring narrowing laterally. It is conceivable that A. lepta and A. bockeliei are sexual dimorphs, as both occur at the same horizon and locality.

Ascetopeltis sp. A
Plate 7, A.

MATERIAL

One cranidium (PMO 8858)

HORIZON AND LOCALITY

Harjuan, Tretaspis series, Stage 5a, Halmenskjaeret, Holmen, Asker, Norway.

DESCRIPTION

The cranidium is marginally longer (sag.) than it is wide (trans.) across the palpebral lobes. The glabella is as long (sag.) as it is wide (trans.) and is defined by narrow, impressed conjoined axial and preglabellar furrows. From the posterolateral corners it broadens to a position more or less opposite the centre of the palpebral lobe. From this position until gamma, the side of the glabella is weakly bowed inwards, and from gamma to the anterolateral corner narrows quite rapidly. The frontal lobe is bluntly rounded. In lateral profile, the posterior part of the glabella is gently inclined towards the anterior, but in front of gamma the frontal lobe curves down strongly to the preglabellar furrow in a strongly convex curve. In longitudinal profile the glabella is moderately convex. Three pairs of lateral glabellar furrows are present. The abaxial end of lp is situated near the posterior end of the lateral constriction of the glabella. Adaxially lp widens, then narrows again, and is thus more or less lozenge shaped. It is directed backwards at about 45° to an exsagittal line, and is indicated by a smooth area interrupting the striated sculpture. About two-thirds of the way from the abaxial end of lp and the sagittal line is an ovate, darkened area, the auxiliary impression. This does not interrupt the striated sculpture. 2p is situated opposite gamma. Its abaxial end is narrow, does not interrupt the glabellar sculpture and is hardly apparent. Adaxially it broadens, and interrupts the glabellar sculpture, extending about three-quarters of the way towards the sagittal line. It runs nearly straight inwards. 3p is a short distance in front of 2p, and has a similar length and direction. It does not interrupt the glabellar sculpture, and is represented by a darker area on the surface of the glabella.

The occipital furrow is narrow and rather deep, with fairly steep anterior and posterior slopes. The median portion is arched weakly forwards, and abaxially each end turns slightly forwards. The occipital ring is about one-third as long again as the preglabellar area (sag.) and is a little wider (trans.) than the glabella. The lateral margins describe a strongly abaxially convex curve. In longitudinal profile the occipital ring is strongly convex, with the posterior margin more convex than the anterior. In lateral profile the occipital ring, at least in its lateral portions, is almost flat. Sagittally it is elevated higher than the glabella. On the anterior part of the occipital ring, opposite the position where the occipital furrow begins to run forwards abaxially, there is a slight depression, which is devoid of the striated sculpture. This defines very poorly defined occipital lobes.

The preglabellar field is short (sag.), of approximately the same width as the anterior border. In lateral profile it is weakly convex. The anterior border furrow is shallow but sharply defined. The anterior border is rather narrow, upturned and weakly convex. The lateral parts of the preglabellar area are, like the preglabellar field, convex in lateral profile. Gamma is close to the axial furrow, at the anterior end of the lateral constriction of the glabella. From here the anterior branches of the facial sutures diverge strongly, with gamma-beta describing a rather strong, abaxially convex curve. The posterior branch has epsilon and zeta as a single curve, close to the axial furrow at the anterolateral corner of the occipital ring. The posterior branches diverge strongly on the posterior margin.

The palpebral lobe is a little over half the sagittal length of the glabella, and is subparabolic in outline, showing a negative skew towards the posterior. It is backwardly placed and in lateral profile is weakly convex and is not elevated to the height of the glabella.

The entire cranidium has a sculpture of distinct striations, arranged in a Bertillon pattern on the glabella and occipital ring. These striae have a shallow anterior slope, and a deep, incised posterior slope. On the preglabellar area they run in a more or less transverse direction. On the inner part of the palpebral lobe they run strongly forwards and slightly outwards, while on the outer part they branch and turn strongly outwards, running almost transversely on the middle and posterior part of the occipital lobe.

DISCUSSION

Only one cranidium of this species has been found, and its morphological features indicate assignment to Ascetopeltis. The short preglabellar field and non-narrowed occipital ring are similar to A. barkingensis, but the latter has a differently shaped glabella, a smaller palpebral lobe, and finer striations. Ascetopeltis sp. A is remarkably similar in cranidial shape, proportions and sculpture to Corunproetus (Sculptoproetus) maghrebus Alberti, 1967 (see Alberti, 1969, Pl. 13, figs. 6-8, partic fig. 6a) from the high Lower Devonian of Morocco. Because of the wide stratigraphical separation, these similarities are taken to be the result of homeomorphy.

Ascetopeltis? sp. B

Plate 8, H, J, K.

1925 Proetus sp. ind. c. Warburg 1925, p. 182, Pl. 5, Fig. 64.

1925 Proetus sp. ind. e Warburg, 1925, p. 183, Pl. 5, Fig. 37.

MATERIAL

Two pygidia.

HORIZON AND LOCALITIES

Harjuan, Boda Limestone, Ostbjorka and Klittberg, Lake Siljan district, Sweden.

DISCUSSION

Two pygidia, described by Warburg as Proetus sp. ind. c. and Proetus sp. ind. e are not dissimilar to species of Ascetopeltis, although the pleural and interpleural furrows are distinctly deeper than in any of these. Although the outline of the two pygidia is a little different, there is a size difference (Plate 8, K is the smaller), and the overall rib pattern and shape of the axis are comparable. Until more material is forthcoming, these specimens are considered as one species, referred with doubt to Ascetopeltis.

Subfamily PROETIDELLINAE Hupe 1953

Genus DECOROPROETUS Pribyl, 1946

Synonyms: Proetidella Bancroft, 1949, Ogmocnemis Kielan, 1960, Warburgaspis Pribyl, 1946

Type Species: Proetus decorus Barrande 1846

Decoroproetus asellus (Esmark, 1833)

Plate 8, N

1833 Trilobites asellus Esmark, Plate 7, Fig. 5.

1940 Proetus asellus (Esmark): Størmer, p. 122, Text Fig. 2, Plate 1, Fig. 1.

1960 Ogmocnemis asellus (Esmark): Kielan, p. 71

1963 Proetus asellus (Esmark): Dean, p. 245

HOLOTYPE

An incomplete exoskeleton, of which most of the pygidium is missing, preserved in pyrrhotite (PMO 56442), figd. Esmark, Pl. 7, Fig. 5 Størmer, Pl. 1, Fig. 1, and refigured herein as Pl. 8, N. The only specimen known.

TYPE STRATUM AND TYPE LOCALITY

Harjuan, Tretaspis Series, Stage 4c , Trosviken, Brevik, Norway.

DIAGNOSIS

Glabella as long as wide, with sides weakly abaxially convex. Preglabellar field about a quarter of the sagittal length of the glabella; lower margin of eye socle defined by deep, distinct furrow; cephalic border rather narrow, brim-like; thoracic axis narrow, tapering gently backwards.

DESCRIPTION

The cephalon is semi-elliptical in outline, with a narrow, brim-like border. The glabella is as long as wide, with the sides very weakly convex abaxially and bluntly rounded frontal margin. It is subquadrate in outline and defined by narrow, shallow conjoined axial and preglabellar furrows. At the posterior end it is about a third of the total cephalic width (trans.). It is weakly convex in lateral and longitudinal profiles. There are apparently no lateral glabellar furrows.

The occipital furrow is narrow, and deeper than the axial furrow and more or less transverse, curved gently forwards at either end. The occipital ring is poorly preserved, but apparently maintains the same width (sag. and exsag.) and lacks lateral lobes. It is distinctly wider (sag.) than the anterior border. The preglabellar field is about a quarter of the sagittal length of the glabella, very weakly convex in lateral profile and gently declined towards the anterior. The anterior border furrow is narrow and distinct, and the anterior border is narrow, convex and about half the width (sag.) of the preglabellar field.

The anterior branches of the facial sutures are quite strongly divergent, with beta an acute, outwardly convex angle. An exsagittal line drawn backwards from beta falls on the outer edge of the eye lobe, and gamma is close to the axial furrow. The posterior branches seem to have epsilon and beta as a single angle, from which they diverge weakly backwards to the posterior border furrow, and then more strongly on the posterior border. They cut the posterior margin about a third of the way from the axial furrow to the lateral margin.

The eye is badly preserved, but seems to be a little under half the sagittal length of the glabella, and crescentic in outline. Its posterior end is about a sixth of the way forwards from the posterior end of the glabella. The palpebral lobe is not preserved. The eye socle has a clearly defined lower margin, which diverges from the upper margin at either end. The eye socle is about three-quarters of the length of the glabella.

The field of the free cheek is broad and weakly convex. The lateral border furrow and lateral border are similar to the anterior, with the lateral border widening very slightly towards the base of the genal spine. The posterior border furrow is similar to the anterior and lateral. The posterior border is about as wide as the occipital ring, perhaps widening a little abaxially. It is gently inclined towards the posterior. The genal spine is rather narrow based and bears a narrow, shallow median groove, which is the backward continuation of the lateral border furrow. The length of the genal spine is unknown. The cephalic doublure, seen where the right hand genal spine has been damaged, bears fine, parallel terrace lines, and is weakly ventrally convex.

The thorax consists of 10 segments. The axis tapers very gently backwards, and is distinctly convex in longitudinal profile. The axial furrow is distinct, but non incised. Each axial ring seems to be arched gently forwards abaxially. Along the whole thorax, the pleurae are as wide, or wider than the axis. Each pleura runs more or less transversely, and curves gently backwards abaxially. The pleural furrow is distinct, and reaches close to the abaxial extremity. It runs more or less parallel with the margin of the pleura, and has a steep anterior, and a shallow posterior slope. The anterior pleural band is narrower than the posterior. Thelatter is gently inclined towards the posterior, while the former curves down steeply to the axial furrow. The posterolateral corner of the pleura is angular.

Only the anterior part of the left hand side of the pygidium is preserved, and shows parts of three distinct pleural furrows. There are traces of an original striated sculpture on the exoskeleton.

DISCUSSION

Decoroproetus asellus is exceedingly similar to *D. modestus* (cf. Pl. 8, N and Pl. 10, K), and it is only in small details that these species differ - the shape of the glabella and the length of the preglabellar field. Unfortunately, only a single, poorly preserved specimen of *D. asellus* is available, so there is no information on variation. For the present *D. asellus* and *D. modestus* are retained as independent species, but further material of the former may well show them to be conspecific.

Dean (1963, p. 245) was misled by a misprint on Størmer's (1940, Pl. 1, Fig. 1) plate explanation which read 4a rather than 4c , and consequently stated that *D. asellus* came from beds of probable Llanvirn age, assuming this species to be considerably earlier than it really is.

Decoroproetus brevifrons (Angelin, 1854)

Pl. 8, I, L, M, Plate 9, D.

1854 *Forbesia? brevifrons* Angelin, p. 63, Pl. 33, Fig. 18.

1869 *Proetus brevifrons* (Angelin): Linnarsson, Pl. 2, Fig. 29

1960 *Ogmocnemis brevifrons* (Angelin): Kielan, p. 28

MATERIAL

3 cranidia, 1 imperfect cephalon, and 1 cephalon with ~~2~~9 attached thoracic segments.

OCCURRENCE

Harjuan, Jonstorp Formation, Ålleberg and Mösseberg, Bestorp, Västergötland.

DIAGNOSIS

Glabella tapering rapidly forwards, often distinctly constricted laterally; preglabellar field short (sag.); anterior border rather narrow; eye small, backwardly placed; lateral border broadens backwards towards broad based genal spine.

DESCRIPTION

The cephalon is semioval in outline, with the border widening and flattening towards the base of the genal spine. The cranidium has the palpebral width less than the sagittal length. The glabella is as wide, or wider than long, defined by distinct, shallow conjoined axial and preglabellar furrows. It is broadest at the posterolateral corners, and tapers quite strongly forwards to the well or bluntly rounded frontal lobe. It is often constricted laterally. In lateral and longitudinal profiles the glabella is weakly convex. One specimen (Plate 8, M) shows 2 pairs of faint lateral glabellar furrows inclined backwards at about 70° to an exsagittal line. 1p seems to be forked adaxially. The occipital furrow is deeper than the axial and preglabellar furrows, and the median portion runs more or less transversely, with the abaxial ends turned forwards. The occipital ring is rather narrow (sag.) and maintains the same width along its length (trans.), and is wider (trans.) than the glabella. In lateral profile the occipital ring is weakly convex, and gently inclined towards the posterior. There do not seem to be any lateral occipital lobes.

The preglabellar field is short (sag.), varying from being as wide (sag.) as the anterior border to about twice as wide. In lateral profile it is weakly sigmoidal. The anterior border is rather narrow, weakly convex and upturned, separated from the preglabellar field by the shallow, ill-defined anterior border furrow. The anterior branches of the facial sutures are moderately divergent, describing an abaxially convex curve which turns sharply inwards at beta. The posterior branches apparently have epsilon and zeta as one angle, from which each turns strongly outwards onto the posterior border to cut the posterior margin about half way between the lateral end of the occipital ring and the lateral margin.

The palpebral lobe is rather small, between one quarter and one third the length of the glabella, and is semioval in outline. The distal part is nearly flat, not elevated quite as high as the sagittal part of the glabella. Adaxially the palpebral lobe is declined steeply to the axial furrow. The eye is small, backwardly placed and about two fifths the sagittal length of the glabella. There seems to be an indistinct eye socle.

The field of the free cheek is broad and weakly convex. The lateral border furrow is of similar depth to the anterior, while the posterior border furrow is distinctly deeper and narrower. Both lateral and posterior borders widen towards the genal spine, the former being weakly convex and the latter weakly convex and inclined towards the posterior. The genal spine is flattened and broad based, extending backwards as far as the posterior end of the thorax. It is divided longitudinally by the median furrow into a wider (trans.) inner band and a narrower (trans.) outer band. The median furrow of the genal spine is as deep as the lateral border furrow, and is slightly abaxially offset from it at the base of the genal spine. It dies out before reaching the end of the genal spine.

The cephalic doublure is as wide as the border, and is strongly ventrally convex and bears fine, parallel terrace lines.

The thorax has 10 segments. Longitudinally the axis is moderately convex, and it tapers gently towards the posterior. The axis is about the same width (trans.) as the pleurae. The annulus is somewhat wider than the articulating half ring, and the two are separated by a deep articulating furrow which curves slightly forwards sagittally. The pleural furrow is distinct on the pleura, dying out close to the abaxial end and dividing it into a wider (exsag.) posterior pleural band and a narrower (exsag.) anterior pleural band. The fulcrum is close to the adaxial end of the pleura on the first thoracic segment, but on the more posterior ones it is closer to the abaxial end. The abaxial end of the pleura is declined and curved backwards, and the posterolateral corner is pointed. On the specimen where the thorax is preserved (Plate 8, I), the doublure of one of the pleurae is seen, which shows fine terrace lines running in an exsagittal direction.

A pygidium, possibly belonging to this species, is preserved as an incomplete external mould, one of the same slab as the cranidium figured as Plate 8, M. The outline is apparently subparabolic. The axis is distinctly conical, weakly convex in lateral profile, and consists of fine well defined rings and a short end piece. Three, perhaps four, pairs of pleural ribs are present, curving gently backwards. The pleural furrows are fairly distinct, but no inter-pleural furrows are apparent. The doublure is moderately wide, with strong, subparallel terrace lines. The external surface of the exoskeleton seems to be smooth.

DISCUSSION

On describing this species, Angelin (1854, Pl. 33, Fig. 18) figured a cranidium and a pygidium from Ålleberg. In the collections of the Naturhistoriska Riksunnseet, Stockholm, two cranidia are labelled as Angelin's original. One of these (see Pl. 9, A) is considered not to belong to D. brevifrons, and is possibly conspecific with D. sp. A (see below). The other specimen (Pl. 8, M) has the external mould of part of a pygidium on the back of the same slab, which may be the original of Angelin's Fig. 18a. Dr. V. Jaanusson (personal communication) is doubtful if the specimen really is Angelin's original, and for this reason, no type specimen for D. brevifrons is designated. Of the material of D. brevifrons, one specimen (the 'original' of Angelin) is probably from the Oglunda Limestone, while the remainder are from Red Jonstorp Shale. There is some variation in glabellar outline and length of the preglabellar field, but from the present evidence, it is considered that only one species is represented.

The species showing closest resemblance to D. brevifrons is D. piriceps (Ingham), from the Cautleyan of the Cautley district, Yorkshire, recently described and figured by Ingham (1970, Pl. 4, Figs. 20-26, 28, 30-32) as Astroproetus? piriceps. This species and D brevifrons share the rather short (sag.) preglabellar field, the rapidly tapering, laterally constricted glabella and probably the smooth exoskeleton.

Decoroproetus evexus sp. nov.

Plate 9, E-J

HOLOTYPE

A cranidium (PMO 70439), Figd. Pl. 9, G.

MATERIAL

3 cranidia, 4 free cheeks, 3 pygidia.

TYPE STRATUM AND TYPE LOCALITY

Harjuan, Tretaspis Series, Stage 5a, Øvre Nes bathing place, Asker, Norway.

OCCURRENCE

Stage 5a, at the type locality and at New Terasse 10, 2nd limestone hump, c. 15-20 m. SE of house, Nesbru, Asker, Norway.

DERIVATION OF THE NAME

From Latin evexus, rounded at the top - alluding to the rounded frontal margin of the glabella.

DIAGNOSIS

Glabella as wide, or wider than long, with 2 pairs of lateral furrows interrupting the glabellar sculpture, 1p may be forked adaxially; preglabellar field short (sag.) about an eighth of the sagittal length of the glabella. Anterior border furrow weak; poorly defined lateral occipital lobes present; eye socle with weak lower marginal furrow diverging from the upper at the anterior end; pygidium parabolic, with strongly convex (longitudinally) axis composed of 7 well defined rings. Pleural areas with 6 pairs of distinct ribs and the anterior pleural band of a 7th. Sculpture of fine, raised striations.

DESCRIPTION

The cranidium is rather weakly vaulted, with the sagittal length and palpebral width almost equal. The glabella is suboval in outline, defined by narrow, conjoined axial and preglabellar furrows. It is as wide, or rather wider than long. From the rounded posterolateral corners the glabella expands forwards quite rapidly as far as the centre of the palpebral lobes, and then tapers forwards rapidly to the well rounded frontal lobe. In lateral and longitudinal profiles it is rather weakly convex, the convexity being greater in the former. Two pairs of lateral glabellar furrows are seen on the holotype, interrupting the glabellar sculpture and non-incised. 1p has its anterior (abaxial) end between two fifths and a half of the way up the glabella from the posterior. It is directed backwards at about 45° to an exsagittal line and extends to within a short distance in front of the occipital furrow, and is adaxially and anteriorly weakly convex. 1p forks at the adaxial end on the holotype, and the short anterior branch of the fork runs almost transversely, and extends about threequarters of the distance towards the sagittal line from the axial furrow. 2p is opposite gamma and is directed to an exsagittal line inwards at 70°, and extends about the same distance adaxially as 1p.

The occipital furrow is deep, with a vertical anterior slope, and a rather less steep posterior slope. The median portion runs more or less transversely, and abaxially it curves weakly backwards before turning weakly forwards. The occipital ring is about seven eighths the width (sag.) of the preglabellar area, and does not narrow abaxially. Transversely it is as wide as the glabella. In lateral profile the anterior two thirds is declined towards the occipital furrow, while the posterior third flattens off. There is a distinct median tubercle, and three fifths of the way abaxially along the anterior margin is a slight depression running into the occipital ring, which partially defines an indistinct lateral occipital lobe.

The preglabellar field is short (sag.), about an eighth of the sagittal length of the glabella and as wide (sag.) as the anterior border. It is almost straight and gently declined towards the weak, indistinct anterior border furrow. The anterior border is weakly convex and upturned. The anterior branches of the facial sutures are divergent with gamma-beta nearly straight. Beta is an abaxially rounded acute angle, and an exsagittal line drawn backwards from it falls on the palpebral lobe. Gamma is a short distance out from the axial furrow. The posterior branches have epsilon and zeta as independent angles, with epsilon-zeta running parallel to the axial furrow. Epsilon is a little anterior to the posterolateral corner of the glabella, while zeta is about half way along the lateral end of the occipital ring. The posterior branches diverge strongly on the posterior border.

The palpebral lobe is crescentic and about half the length of the glabella. It is inclined at a shallow angle from the axial furrow and flattens abaxially, and is backwardly placed. The eye is not preserved on any specimen, but the eye socle has a shallow lower marginal furrow which diverges from the upper at the anterior end.

The field of the free cheek is rather narrow, and is gently convex. The lateral border furrow is shallow, and the lateral border is broad and weakly convex. The posterior border furrow is deep and incised, with steep anterior and posterior slopes. The posterior border is narrower than the lateral and is inclined towards the posterior. The genal spine is broad based and tapers quite rapidly backwards. The median groove is shallow, and is offset abaxially from the lateral border furrow. The cephalic doublure is strongly ventrally convex and bears strong, parallel terrace lines.

The pygidium is of subparabolic outline, without a border, and has a length-breadth ratio of 3:5. The anterior margin runs gently backwards abaxially, and turns strongly backwards at the anterior margin of the articulating facet. Anteriorly the axis is between a third and a quarter of the pygidial width (trans.), and is strongly longitudinally convex. It tapers backwards quite rapidly to the bluntly rounded posterior end, where there is an indistinct postaxial ridge. Seven clearly defined axial rings are present, which curve gently backwards abaxially. The first is elevated higher than the remainder and is shorter (sag.) and more strongly convex, separated from the second by a deep furrow. The other rings are weakly convex in lateral profile, and the second and third have steep posterior margins. The axial rings (excepting the first) gradually decrease in length from anterior to posterior, and the interannular furrows become shallower. The axis curves down gently towards the posterior in lateral profile, with the extreme posterior end steeply declined and forming a continuous, gently concave curve with the postaxial area.

The pleural areas are gently convex, with six pairs of backwardly curving ribs and the anterior pleural band of a seventh. The pleural ribs widen abaxially. The pleural furrows are deep, with a steep anterior slope and shallow posterior slope, and shallow abaxially where they die out before reaching the pygidial margin. The inter-pleural furrows are shallow, becoming more apparent distally, and only the first three pairs are distinct. Adaxially they bend backwards less strongly than the pleural furrows, but abaxially they are bent through a wide angle and the abaxial end bends backwards more strongly than the pleural. In lateral profile the anterior pleural bends are steeply inclined towards the posterior and curve strongly downwards to the pleural furrow. The posterior pleural band is gently inclined from the pleural to the inter-pleural furrow. The posterior edge of the anterior pleural band is elevated above the posterior edge of the posterior pleural band. The anterior and posterior pleural bands are of approximately equal width (exsag.).

The whole cephalon and pygidium are covered with fine, raised striations, forwardly arched on the glabella, occipital ring and pygidial axis, transverse on the preglabellar area and pygidial pleural fields, forwardly and outwardly directed on the palpebral lobe and lateral border, backwardly and outwardly directed on the field of the free cheek. On the cephalic margin there are two or three prominent parallel terrace lines.

DISCUSSION

Decoroproetus evexus sp. nov. does not particularly resemble any other Ordovician species, but the wide, flattened cephalic border invites comparison with Decoroproetus scrobiculatus (see Pl. 25, Figs. 1, 11) and D. sp. K (Pl. 26, Fig. 18), both Silurian species.

In the material of D. evexus from Nesbru there is a small cranidium (Pl. 9, H) which is probably an early growth stage of D. evexus, and has a narrower, more elongated glabella than larger specimens (Pl. 9, F, G). From this small cranidium through Pl. (, F to Pl. 9, G a relative broadening of the glabella can be seen, which is in relation to size. More material is required to test this numerically.

Decoroproetus furubergensis Owens
Plate 10, A-H.

TYPE DATA

See chapter 1.

SWEDISH MATERIAL

8 cranidia, 1 free cheek, 10 pygidia.

OCCURRENCE IN SWEDEN

Viruan, Macrourus Limestone, erratic blocks from Eriksöre, Kråketorp and Hulterstad, Öland.

DISCUSSION

The identification of specimens from Öland as Decoroproetus furubergensis extends the geographical range of this species to Sweden. The pygidia from Öland show slight differences to the Norwegian ones - they are proportionately longer and the interannular furrows are shallower (cf. Pl. 1, G, J and Pl. 10, C, D), but are otherwise similar. As the Öland cranidia are identical to the type of D. furubergensis (cf. Pl. 1, E and Pl. 10, A) there is no reason to suspect that a separate species is present in Öland. One of the Öland cranidia (Pl. 10, F) shows poorly isolated lateral occipital lobes, and on the posterior margin of the glabella opposite their inner ends are small depressions running a short distance forwards. The cranidium is otherwise like theothers, and whether this feature is of any significance must await more material.

DECOROPROETUS MODESTUS (Törnquist, 1884)

Pl. 10, K, L.

1884 Proetus modestus sp. nov. Törnquist, p. 46, Pl. 2, Fig. 1-3.

1907 Dicellocephalus? leptaenarum sp. nov., Wiman, p. 5, Pl. 2, Figs. 1-3.

1925 Proetus modestus Törnquist: Warburg, p. 167, Pl. 5, Figs. 15, 16, 18.

1946 Proetus (Warburgaspis) modestus Törnquist: Pribyl, p. 5.

1960 Proetus modestus Törnquist; Kielan, p. 69

HOLOTYPE

A nearly complete specimen (S.G.U. Coll.), figured Törnquist 1884, Pl. 2, Fig. 3, Warburg 1925, Pl. 5, Fig. 16 and refigured herein as Pl. 10, K.

MATERIAL

Several partially complete specimens, and isolated cranidia, free cheeks, thoracic segments and pygidia.

TYPE STRATUM AND TYPE LOCALITY

Harjuan, Boda Limestone, Kallholn.

OCCURRENCE

Boda Limestone, Kallholn, Osmundsberget, Boda, Unskarsheden, Lissberg, Östbjörka.

DIAGNOSIS

Glabella parallel-sided, non-constricted and well rounded anteriorly; occipital ring of constant width (sag. and exsag.), without lobes; preglabellar field short (sag.), about a seventh of the sagittal length of the glabella. Eye small, forwardly placed, with its centre nearly half way up the glabella; eye socle well developed; cephalic border rather narrow, brim-like; thoracic axis rather narrow, tapering constantly and gently backwards; pygidium subparabolic, axis with 6 ill-defined rings, pleural areas with 4 pairs of ribs; pygidial doublure rather wide.

DESCRIPTION

See Warburg, 1925, p. 167.

DISCUSSION

Törnquist (1884, p. 46), and later Warburg (1925, p. 169) compared this species with Decoroproetus decorus (Barrande), and Pribyl (1946, p. 5) used it as the type species for his subgenus Proetus (Warburgaspis). Kielan (1960, p. 69) considered Warburgaspis a nomen nudum, and placed modestus in her genus Ogmocnemis, which is here regarded as a junior synonym of Decoroproetus. Comparison of Plate 10 K with Plate 45, Figs. 9-11 reveals the great similarity between this species and the type species of Decoroproetus, D. decorus (Barr.). Decoroproetus mactaggarti (Begg) from the Ashgill of the Girvan district, Scotland (see Plate 22, Figs. 16-17) is very similar to D. modestus and differs only in small details, such as the degree of divergence of the anterior branches of the facial sutures and the number of pygidial pleural ribs. D. asellus (Esmark) from the Harjuan Tretaspis Series (Stage 4) of Norway is also exceedingly similar (see Plate 8 N), and differs only in trifling details, and it is suggested elsewhere (see above) that it may be conspecific with D. modestus.

Decoroproetus papyraceus (Tornquist, 1884)

Plate 10, I, J, M-O, Plate 11, A, B, D, G, O.

1884 Proetus papyraceus Tornquist, p. 48, Pl. 2, Figs. 4-6.

LECTOTYPE (here selected)

A cranidium (L) 597T), figured Tornquist, Pl. 2 Fig. 2, and refigured herein as Pl. 11, A.

MATERIAL

Numerous cranidia, free cheeks and pygidia.

TYPE STRATUM AND TYPE LOCALITY

Harjuan, Fjäcka Shale, Fjäcka, Lake Siljan district, Sweden.

OCCURRENCE

Harjuan, Fjäcka Shale, Fjäcka, Vikarbyn, Draggån, Gulleråsen-Sanden, Lake Siljan district, Sweden.

DIAGNOSIS

Glabella tapering very gently forwards, frontal lobe bluntly rounded; anterior branches of facial sutures weakly divergent; base of eye socle circumscribed by a deep furrow, which diverges from the upper margin at either end; pygidial axis with 6-7 rings separated by rather shallow interannular furrows; pleural areas with 6-7 ribs, pleural furrows deep, of constant depth along their length, interpleural furrows shallow deepest abaxially; sculpture of fine raised striations, covering entire exoskeleton.

DESCRIPTION

The cranidium has the palpebral width about three quarters of the sagittal length. The glabella is subquadrate, marginally longer (sag.) than wide (trans.). From the bluntly rounded posterolateral corners it tapers gently forwards to the bluntly rounded frontal lobe, and is defined by distinct conjoined axial and preglabellar furrows. 1p is weakly impressed, situated opposite the middle of the palpebral lobe and directed backwards at about 45° to an exsagittal line. It dies out well before reaching the occipital furrow. There is sometimes a suggestion of 2p (e.g. Pl. 10, N), which is situated a short distance behind gamma.

The occipital furrow is wider and deeper than the axial and preglabellar furrows. The median section runs nearly transversely, and the lateral ends bend quite strongly forwards. The occipital ring is rather narrow (sag.), less than a quarter of the length of the glabella, and not narrowing laterally. Transversely it is slightly wider than the glabella. A small median tubercle is present, situated in the centre of the ring. There are no lateral occipital lobes.

The preglabellar field is broad, about one quarter of the length (sag.) of the glabella and sigmoidal in profile. The wide, shallow anterior border furrow separates it from the rather narrow, upturned anterior border, which is weakly convex. The anterior branches of the facial sutures are weakly divergent, with an exsagittal line drawn backwards from beta falling on the palpebral lobe. Gamma is a wide angle, close to the axial furrow, and gamma-beta is very weakly abaxially convex. The posterior branches, with epsilon and zeta as one angle, curve close to the axial furrow behind thepalpebral lobe, and then diverge strongly on the posterior border to cut the posterior margin close to the base of the genal spine.

The palpebral lobe is crescentic in outline, approaching half the length of the glabella and backwardly placed. The eye is large and crescentic, supported on a distinct eye socle. The lower margin of the eye socle is defined by a deep furrow, which diverges from the upper margin at either end. The field of thefree cheek is broad and gently convex. The lateral border is rather narrow, separated from the rest of the free cheek by a shallow lateral border furrow. The posterior border furrow is rather wide, with a rather angular crest to the top of the anterior slope. The posterior border widens slightly abaxially, and is gently inclined towards the posterior. The genal spine is broad based, and tapers quite rapidly backwards. The cephalic doublure is rather narrow, of equal width to the border, quite strongly ventrally convex and bears fine parallel terrace lines, which run parallel to the margin.

The pygidium is subparabolic in outline, nearly twice as broad (trans.) as long (sag.). Anteriorly the axis is about one third of the total pygidial width (trans.) and between two thirds and three-quarters of the pygidial length (sag.). It tapers gradually backwards to a bluntly rounded point, and the postaxial ridge is hardly apparent. There are 6-7 axial rings, separated by rather shallow inter-annular furrows, which are arched gently forwards. The articulating furrow is deep and distinct. The axial furrows are deep, but shallow at the posterior end of the axis. One specimen (Pl. 10, M) shows the under-side of the exoskeleton, and photographed under alcohol, it shows muscle areas at either end of each axial ring.

The pleural areas are broad, with 6-7 pairs of ribs. The pleural furrows curve evently, and quite strongly backwards and almost reach the margin. Their depth is more or less uniform along their entire length. The interpleural furrows are shallow, and deepen a little distally, and are often not seen except at the distal end. The adaxial portion does not turn so strongly backwards as the pleural furrow, but the abaxial extremity turns more strongly backwards. The pygidial doublure is rather narrow, weakly ventrally convex and marked with fine, parallel terrace lines.

The exoskeleton has a sculpture of fine, raised striations.

DISCUSSION

Decoroproetus papyraceus (Törnquist) occurs frequently in the Fjäcka shale to which it is apparently restricted, and is not known from contemporaneous beds of different facies. D. papyraceus belongs to a group of Decoroproetus species which have a strong lower marginal furrow to the eye socle, which includes D. asellus (Esmark), D. modestus (Törnquist) and D. aff. subornatus (Cooper and Kindle). The first two species are described in this chapter (see Pl. 8, N, Plate 10, K, L) while the latter is described in Chapter 3 (see Pl. 22, Figs. 15, 20-23, 25-27) and comes from the Cautleyan of northern England. D. aff. subornatus is perhaps the most closely related to D. papyraceus,. and it differs in the wider anterior border, the laterally constricted glabella, the narrower field of the free cheek and the laterally narrowed occipital ring.

Decoroproetus remotus (Warburg, 1925)

Plate 11, C, E, F, H-J, P.

1925 Proetus remotus n. sp.: Warburg, p. 170, Pl. 5, Fig. 7.

HOLOTYPE

A nearly complete cranidium (UM D 52), figured, Warburg, Pl. 5, Fig. 7 and refigured herein as Plate 11, E, F, P.

MATERIAL

Besides the type, 4 cranidia, 2 free cheeks.

TYPE STRATUM AND TYPE LOCALITY

Harjuan, Boda Limestone, Kallholn.

OCCURRENCE

Boda Limestone, Kallholn.

DIAGNOSIS

Similar to D. modestus, from which it differs in: a more strongly forwardly tapering glabella; an abaxially narrowed occipital ring; a larger eye; a more poorly defined furrow at the lower margin of the eye socle; a wider lateral border. Sculpture of dense raised striations on the glabella, less dense raised striations on the free cheek and preglabellar field.

DISCUSSION

Warburg (1925, p. 170) only had two cranidia available, but search through museum collections has yielded extra specimens, including two free cheeks. Because the free cheeks have similar sculpture and striations on the border to the cranidium, there can be little doubt that they belong to the same species. D. remotus seems to be closely related to D. modestus, from which it differs in features indicated in the diagnosis.

Decoroproetus sp. B

Plate 9, B, C, K.

MATERIAL

A fragmentary cranidium, a free cheek and a pygidium, all on the same slab (RM Ar 15262).

HORIZON AND LOCALITIES

Harjuan, Jonstorp Formation, Bestorp, Mösseberg and Ålleberg, Västergötland.

DESCRIPTION

Only the anterior part of the cranidium is preserved. The glabella has a well rounded frontal lobe, and the axial and preglabellar furrows are narrow and distinct. Short, narrow, weakly impressed 2p and 3p furrows are present, 2p opposite gamma and directed weakly backwards and 3p a short distance in front, running more or less transversely. The preglabellar field is sigmoidal, fairly short and merges insensibly with the weakly upturned anterior border region, as the anterior border furrow region is broad and shallow. The anterior branches of the facial sutures are weakly divergent. The stretch from gamma to beta is almost straight.

The free cheek shows the ventral surface, with part of the doublure preserved. The eye seems to be supported on an indistinct eye socle, and the field of the free cheek is convex. The lateral border furrow is apparently shallow and distinct - more so than the anterior border furrow. The lateral border seems to be weakly convex and fairly wide. The posterior border furrow is narrower and deeper than the lateral.

The pygidium is subparabolic in outline, without a border and about five eighths as long (sag.) as it is wide (trans.). Anteriorly the axis is a little over a quarter of the total pygidial width, and it tapers backwards quite rapidly to a blunt point, and is four fifths of the sagittal length of the pygidium. The axis is badly preserved, but at least six axial rings are present. There is a narrow, distinct postaxial ridge. The broad pleural areas are weakly convex and have six, possibly seven pleural ribs which curve gently backwards and widen distinctly abaxially. The pleural furrows are deep and wide, and extend almost to the pygidial margin, and divide the ribs into anterior and posterior pleural bands of approximately equal width (exsag.). The pleural furrows have steep anterior slopes and shallow posterior ones. The interpleural furrows are narrower and shallower than the pleural, but are distinct along their entire length, and reach the pygidial margin. The abaxial portion is deeper than the remainder, and has a steep anterior slope. The pygidial doublure is rather wide, very weakly ventrally convex and marked with strong, parallel terrace lines.

DISCUSSION

A cranidium labelled Proetus brevifrons (Pl. 9, A) in the collections of the Riksmuseum, Stockholm, is one of the two labelled 'original' of Angelin, and is unlike the other specimens of D. brevifrons in that it has a very weak, non-defined anterior border furrow. In this feature it is similar to the cranidium described above as Decoroproetus sp. A, and like it is preserved in a drab coloured shale. There is a strong likelihood that this cranidium is conspecific with Decoroproetus sp. B rather than with D. brevifrons.

The weel defined interpleural furrows on the pygidium are unusual in Decoroproetus, and in this feature the pygidium of D. sp. B shows some similarity with that of D. papyraceus (see Pl. 11, D, G, O).

Decoroproetus sp. C.
Plate 11, Fig. K.

1925 Proetus sp. ind. b: Warburg, p. 181, Pl. 5, Fig. 63.

MATERIAL

One pygidium (LO 3118T)

HORIZON AND LOCALITY

Viruan, Kullsberg Limestone, Kullsberg.

DESCRIPTION

See Warburg 1925, p. 181.

DISCUSSION

This pygidium is the only proetid occurring in the Kullsberg Limestone apart from Stenoblepharum kullsbergense (Warburg), and Warburg's specimen still remains the only one available. It is particularly distinctive in the large number of pleural ribs (6) and axial rings (10), and shows some resemblance to the later Harjuan species D. evexus sp. nov, and D. papyraceus (Törnquist). As Warburg suggests, a new species is probably represented.

Decoroproetus sp. D.
Plate 11, L-N.

MATERIAL

1 cranidium and 1 free cheek.

HORIZON AND LOCALITY

Harjuan, Boda Limestone, Boda, Lake Siljan district, Sweden.

DESCRIPTION

The cranidium has the palpebral width two thirds of the sagittal length. The glabella is as long as wide anddefined by narrow, distinct, conjoined axial and preglabellar furrows. It is widest at the rounded posterolateral corners„ and is nearly parallel sided as far as the middle of thepalpebral lobes. From this position it narrows forwards strongly as far as the 2p furrow, and in front of this is again parallel sided as far as the bluntly angular antero-lateral corners. The margin of the frontal lobe is gently rounded. In lateral and longitudinal profiles the glabella is moderately convex. lp is situated three sevenths of the way forwards from the postero-lateral corner. The abaxial part runsbackwards and inwards at 70° to an exsagittal line for about a third of the distance towards the sagittal line, then turns abruptly backwards and runs almost exsagit-tally. The abaxial part is a non-impressed, smooth area, but the exsagittally running section is distinctly depressed as an ovate depression. Both parts are about the same length. On a line producedinwards andbackwards from the abaxial part of lp is a small, rounded auxiliary impression, interrupting the striated sculpture. 2p is at the change in direction of the lateral margin of the glabella. It is non-incised, and is a club-shaped smooth area, widest adaxially and directed backwards at about 70° to an exsagittal line. It extends about half way towards the sagittal line. 3p is an inconspicuous ovate area, isolated from the axial furrow and not far behind the anterolateral corner of the glabella.

The occipital furrow is deep and transverse medianally. Laterally it narrows and curves very gently backwards before curving quite strongly forwards at the lateral ends. In lateral profile the anterior slope is vertical, while the occipital ring, which is considerably below the height of the posterior margin of the glabella, is very gently inclined backwards from it. The occipital ring is sagittally as wide as the preglabellar area, or a third the sagittal length of the glabella. Transversely it is rather wider than the glabella. Unfortunately the lateral parts are damaged on the one available cranidium. In lateral profile the occipital ring is almost flat, and there is a distinct median tubercle.

The preglabellar field is about a fifth of the sagittal length of the glabella, and is gently concave in lateral profile. The anterior border furrow is rather weak, and from it the anterior border is inclined forwards. The inner section is very gently convex in lateral profile, while the outer section is steeply declined. There are two prominent terrace lines on the outer part of the anterior border, running parallel with the margin. Inside them is a third one, which is interrupted between its sagittal section and its lateral section. The anterior branches of the facial sutures are moderately divergent, with gamma-beta almost straight. Gamma lies close to the axial furrow near the anterolateral angle of the glabella, and is a wide inwardly convex angle. The palpebral lobe is imperfectly preserved, but from that part of it remaining, and from the eye, it appears to be about half the sagittal length of the glabella, backwardly placed and crescentic in outline. From the free cheek, the posterior branches have epsilon and zeta as one angle, and from here diverge strongly to cut the posterior margin about half way between the axial furrow and the lateral margin. The eye is large and crescentic, and supported on a narrow eye socle, whose lower margin is not defined by a furrow, and runs parallel with the upper margin.

The field of the free cheek is rather narrow, and weakly convex. The lateral border furrow is narrower and deeper than the anterior, and the lateral border is similar to the anterior, and has the same prominent terrace lines near the margin. The posterior border furrow is deep and incised, and is truncated at the base of the genal spine. The posterior border is as wide as the lateral, at least abaxially, and is gently inclined towards the posterior. The genal spine is rather narrow based and long, tapering gently backwards. Anteriorly, the median groove is as deep as the lateral border furrow, from which it is very slightly offset abaxially, and gradually shallows posteriorly. The inner and outer bands of the genal spine are both inclined from the median groove, and are of the same width (trans.). The genal spine has strong terrace lines on the inner and outer margins.

The entire cephalon is covered with fine, raised striations which are coarser and less continuous on the glabella and occipital ring. On the preglabellar field and on the field of the free cheek the striations are interspersed with granules. More sporadic granules are also present on the lateral border and on the outer band of the genal spine.

DISCUSSION

The cranidium and free cheek described here as Decoroproetus sp. D are considered to belong to the same animal because of the similar surface sculpture and marginal striations. This species does not particularly resemble any other Decoroproetus species in the Boda Limestone, except perhaps D. remotus (Warburg(see Pl. 10, C, E, F, H-J). It is perhaps closest to D. aff. subornatus (Cooper and Kindle (see Pl. 22, Figs. 15, 20-23, 25-27) from the Cautleyan of the British Isles, but lacks the very distinct eye socle of this species.

Decoroproetus? scanicus (Olin, 1906)
Pl. 12, O.

1906 Proetus scanicus n. sp. Olin, p. 59, Pl. 2, Fig. 17.
1960 "Proetus" scanicus Olin: Kielan, p. 28.

HOLOTYPE

External mould of a small cranidium (LO 1940T), Orig. Olin Pl. 2, Fig. 17, a cast of which is refigured herein as Plate 12, O. The only specimen known.

TYPE STRATUM AND TYPE LOCALITY

Harjuan, Jerrestad Mudstone, Röstånga, Skåne.

DESCRIPTION

The cranidium is weakly vaulted, with the sagittal length a little greater than the palpebral width. The glabella is elongated, a little longer (sag.) than wide (trans.) and weakly convex in lateral and longitudinal profiles, defined by deep, conjoined axial and preglabellar furrows. From its widest point at the bluntly angular postero-lateral corners it tapers forwards gradually and constantly to the bluntly rounded frontal lobe. 1p is situated about a third of the way up the glabella from the posterior, is deep and directed backwards at about 30° to an exsagittal line. It shallows just before reaching the occipital furrow, to which it is joined by a weak depression. The basal lobe is triangulate, about three fifths as wide (trans.) at its base as it is long (exsag.), and is about a quarter of the basal width (trans.) of the glabella. 2p is situated about half way up the glabella, is very obscure and weakly impressed, extends about three quarters of the way to the sagittal line, and is directed backwards at about 70° to an exsagittal line. 3p is similar to 2p, directed backwards at about the same angle, about half its length and situated half way between it and the anterolateral corner of the glabella.

The occipital furrow is about the same depth and width as the axial furrow, and runs more or less transversely but turns weakly forwards abaxially. The occipital ring is narrow, about a seventh of the length (sag.) of the glabella, and about the same width (trans.). It is gently convex in lateral profile and narrows abaxially. There is a distinct median tubercle, but no lateral occipital lobes. The preglabellar field is long (sag.), about a third of the sagittal length of the glabella and is sigmoidal in lateral profile. The anterior border furrow is broad and shallow, and the anterior border rather narrow and upturned. Gamma is distant from the axial furrow, and from it the anterior branch of the facial suture describes a rounded, abaxially convex curve, with an exsagittal line drawn backwards from beta falling on the abaxial margin of the palpebral lobe. Epsilon and zeta form a single angle, about the same distance from the axial furrow as gamma. From epsilon plus zeta the posterior branch runs outwards and backwards, defining a small triangulate posterior portion of the fixed cheek. The posterior border furrow is about the same depth as the axial furrow, which it meets at the posterolateral corner of the glabella. The posterior border is narrow, about the same width (exsag.) as the median part of the occipital ring.

The palpebral lobe is small, about two sevenths of the sagittal length of the glabella and situated some distance out from the axial furrow. A transverse line drawn through - crosses the axial furrow about half way between 1p and 2p. A shallow, rather obscure palpebral furrow runs in an exsagittal direction between gamma and epsilon. From it the palpebral lobe is gently inclined abaxially. The outline is subparabolic.

The entire cranidium seems to be smooth.

DISCUSSION

The position of the palpebral lobe, the path of the posterior branch of the facial suture, and the distinct basal glabellar lobe point to a similarity with Otarion, but the sigmoidal preglabellar field and weakly vaulted glabella are closer to Decoroproetus. Early holaspid cranidia of Decoroproetus scrobiculatus (see Pl. 25, Figs. 4 and 7) are comparable with D? scanicus in having a deep 1p furrow, the palpebral lobe well out from the axial furrow and the posterior branch of the facial suture running straight outwards and backwards from epsilon. Hence it is likely that D? scanicus is an early holaspid stage of a

Decoroproetus whose adult stage is unknown. The small size (1.6 mm sagittal length) of the cranidium supports such an idea.

Genus *STENOBLEPHARUM* gen. nov.

Type Species: *Paraproetus warburgae* Pribyl, 1964.

DERIVATION OF THE NAME

From the Greek *stenos*, narrow, and *blepharon*, an eyelid, pertaining to the narrow palpebral lobe. Gender: neuter.

DIAGNOSIS

Exoskeleton elongated, well vaulted; preglabellar field short (sag.), never wider than the anterior border; anterior branches of facial sutures parallel to weakly divergent; glabella parallel sided or weakly tapering forwards, well rounded, bluntly rounded or angular at the anterior margin; lateral glabellar furrow weakly formed; occipital ring laterally narrowed, without lobes; eye socle usually well developed; thorax of 10 segments; pygidium without border and short, bluntly terminating axis with 4-5 poorly defined axial rings; pleural areas with 3-4 pairs of pleural ribs, with deep pleural furrows and very indistinct interpleural furrows; the anterior pleural band is steeply inclined towards the posterior, particularly abaxially; no postaxial ridge; rostral plate trapezoidal, tapering backwards with adaxially convex connective sutures; sculpture of fine continuous or discontinuous striations, locally interspersed with minute granules.

Species: *S. warburgae* (Pribyl, 1964), *S. pentagonoides* (Warburg, 1925), *S. norvegicum* sp. nov., *S. kullsbergense* (Warburg, 1925), *S. strasburgense* (Cooper, 1953); doubtfully included is *S? zalesskyi* (Öpik).

OCCURRENCE

Middle Ordovician: Edinburg formation, Virginia, U.S.A.; Viruan, Kullsberg Limestone, Lake Siljan district, Sweden; ?Kukruse formation, Estonia;

Upper Ordovician: Harjuan, Boda Limestone, Lake Siljan district, Sweden; Tretaspis series, stage 5a, Oslo region, Norway; Ashgill series, Kildare limestone, Eire; Whitehead formation, Quebec.

DISCUSSION

Stenoblepharum is restricted to a large degree to the reef facies, and it has not been recorded from non-calcareous rocks.

Stenoblepharum is already present in the early Middle Ordovician, when the only abundant proetid genus present is Decoroproetus, from which it is probably derived. Decoroproetus differs from Stenoblepharum in the more depressed exoskeleton, the longer preglabellar field, the longer pygidium with more sharply defined pleural ribs and in not having the connective sutures of the rostral plate adaxially convex. Further differences are observed in different species.

Öpik (1937, p. 25, Pl. 1, Figs. 1-2, Pl. 2, Fig. 3) described and figured Proetus (Prionopeltis?) zalesskyi Öpik, from the Kukruse Beds of Estonia and the cranidium of this species is remarkably similar to that of Stenoblepharum strasburgense (Cooper, 1953, p. 19, Pl. 1, Figs. 15-18) from the Edinburg formation of Virginia, U.S.A. The pygidium differs in possessing two short spines on the margin, but is otherwise quite close. The species zalesskyi may be an early offshoot from themain Stenoblepharum stock.

Stenoblepharum warburgae (Pribyl, 1964)
Plate 14, A-M.

1925 Proetus convexus n. sp. Warburg, p. 170, Pl. 5, Figs. 8-13, 19-20 (non fig. 23).

1964 Paraproetus convexus nom. nov., pro Proetus convexus Warburg, 1925, non Hawle and Corda 1847, p. 77: Pribyl, p. 45.

LECTOTYPE

(See Pribyl, 1964, p. 45) a complete specimen (UM.D53), figd. Warburg 1925, Pl. 5, Fig. 8, and refigured herein as Pl. 14, A, B, E.

MATERIAL

One extra complete specimen, one pygidium with six attached thoracic segments, a few cephala and numerous detatched exoskeletal parts.

TYPE STRATUM AND TYPE LOCALITY

Harjuan, Boda limestone, Kallholn, Lake Siljan district, Sweden.

OCCURRENCE

Harjuan, Boda limestone, Kallholn, Boda, Unskarsheden, Lissberg, Ostbjorka, and Arfvet, Lake Siljan district, Sweden.

DIAGNOSIS

Glabella almost parallel sided, well rounded anteriorly;

anterior branches of facial sutures nearly parallel; lateral glabellar furrows do not interrupt the surface sculpture, but are crossed by coarser striations than the rest of the glabella; pygidial axis with three axial rings and three pleural ribs; sculpture of very fine striations; interspersed with sporadic, minute granules on the cheeks, preglabellar field and inner part of cephalic border; smaller, inconspicuous granules occur on the glabella and occipital ring.

DESCRIPTION

See Warburg, 1925, p. 170.

DISCUSSION

Warburg's description can be amended and amplified in a few points. Warburg (p. 171) states that on certain specimens the preglabellar field is almost obsolete, and figures one such specimen (Pl. 5, Fig. 23). These specimens do not belong to S. warburgae, but to Parvigena striata (see below). On the same page Warburg describes the lower eyelid - this is now called the eye socle (see Shaw and Ormiston, 1964, p. 1002). The ill defined postaxial ridge that Warburg states (p. 172) to be present has not been seen (see Pl. 14, G, K).

A characteristic feature of S. warburgae, also shared by S. norvegicum is the presence of two parallel raised terrace lines on the outer part of the cephalic border. At the inner one there is a sharp change in slope in lateral profile (see Pl. 14, B, J.). The stretch between the inner and outer terrace lines is straight, and below the outer the border turns inwards and backwards towards the doublure. The cephalic doublure is bent strongly upwards from the margins (see Pl. 14, A, B), and has fine, parallel terrace lines. The type specimen (see Pl. 14, E), has the anterior border damaged, and shows the small, trapezoidal rostral plate. The rostral suture is about five times the length (trans.) of the posterior margin, and the connective sutures converge backwards and are adaxially convex.

Stenoblepharum warburgae is the most widespread proetid in the Boda Limestone, although numerically Kallholnia dapsilis is more abundant, but is of very restricted occurrence. The closest species to S. warburgae is S. norvegicum, from the Harjuan of Norway, and the differences are indicated below.

Stenoblepharum novegicum sp. nov.

Pl. 15, A-L.

HOLOTYPE

A cranidium (PMO 70435), Pl. 15, A-C.

MATERIAL

About 30~~0~~ isolated cranidia, free cheeks and pygidia.

TYPE STRATUM AND TYPE LOCALITY

Harjuan, Tretaspis series, stage 5a, Holmenskjaeret, Holmen, Asker, Oslo.

OCCURRENCE

Only at the type locality.

DERIVATION OF THE NAME

From the occurrence in Norway.

DIAGNOSIS

S. norvegicum is very similar to S. warburgae, from which it differs in the following ways: glabella tapering more strongly forwards, and more strongly convex in lateral profile; posterior margin of occipital ring a more even curve; sculpture of short, rather coarse discontinuous striations, areas of lateral glabellar furrow smooth.

DISCUSSION

Apart from the differences indicated in the diagnosis, S. norvegicum is very close to S. warburgae (cf. Pl. 14, and Pl. 15), and the gross overall morphology is the same. The two species occur in slightly different environments - S. warburgae in the pure reef facies of the Boda Limestone, and S. norvegicum in the reef-like Palaeoporella facies of the Tretaspis series, Stage 5a. The great similarity between these species indicates that the Boda Limestone and Stage 5a are probably not far removed from one another in age.

Stenoblepharum kullsbergense (Warburg, 1925)

Plate 16, A-K, M.

1925 Proetus kullsbergensis n. sp. Warbug, p. 173, Pl. 5, Figs. 24-25.

Non 1932 Proetus cf. kullsbergensis Warburg; King, p. 104.

HOLOTYPE

(By original designation): an incomplete cranidium (UM.D61), figured Warburg 1925 as Pl. 5, Fig. 21, and refigurred herein as Pl. 16, A, B, F, H.

MATERIAL

A small number of isolated cranidia and pygidia.

TYPE STRATUM AND TYPE LOCALITY

Viruan, Kullsberg Limestone, Kullsberg.

OCCURRENCE

Viruan, Kullsberg Limestone, Kullsberg, Amtjärn, Skålberget, Siljan district, Sweden.

DIAGNOSIS

Glabella with bluntly rounded frontal lobe, weakly constricted laterally, tapering gently forwards and marginally longer (sag.) than wide (trans.); preglabellar field about one eighth the length of the glabella (sag.); near the anterior margin of the anterior border is a prominent, strong terrace line; eye socle with poorly defined lower margin; pygidium of subparabolic outline. Axis with 5 rings, separated by shallow but distinct interannular furrows; pleural areas with 4 pairs of pleural ribs, which turn rather strongly backwards; posterior end of axis and postaxial area are almost straight in lateral profile, and slope down steeply. Sculpture of fine striations, which cover the areas of the glabellar furrows; sporadic granules on the preglabellar field and occipital ring.

DESCRIPTION

The cranidium is between two thirds and three quarters as long (sag.) as it is wide (trans.) across the palpebral lobes. The glabella is marginally longer (sag.) than it is wide (trans.), and is defined by narrow, distinct, conjoined axial and preglabellar furrows; the axial furrow widening in the region of the palpebral lobe. From the posterolateral corners the glabella expands forwards weakly as far as a position opposite the middle of the palpebral lobe, where it narrows forwards distinctly, with the axial furrow describing a weakly adaxially convex course. From the anterolateral angles, the frontal lobe is bluntly rounded. In lateral profile the glabella is moderately convex, and is a little less so in longitudinal profile. Three pairs of lateral glabellar furrows are present, which are generally inconspicuous and are defined only as darker areas on the glabellar surface and are crossed by the striations which cover the rest of the surface of the glabella. 1p is triangular in outline, with the long straight posterior margin directed backwards and inwards at about 45° to an exsagittal line and the anterior margin running almost straight (trans.) inwards, before turning sharply backwards to join the posterior margin some distance in front of the occipital furrow. The nearest part of 1p to the sagittal line is at the posterior end, which is about half way between it and the axial furrow. 2p and 3p are simple and elongated, with 2p directed backwards a little less strongly than 1p, and situated opposite gamma, and 1p a short distance in front, directed inwards and apparently forwards.

The occipital furrow is narrow and rather deep, with a steep anterior slope and shallow posterior. The median stretch runs more or less transversely. Abaxially the occipital furrow turns forwards. The occipital ring is as wide, or sometimes a little wider (trans.) than the glabella. In lateral profile it is gently convex, while in longitudinal profile it is steeply declined abaxially. The posterior margin runs strongly forwards laterally, thereby producing distinct abaxial narrowing of the occipital ring. There are no lateral occipital lobes, but there is a distinct tubercle in a median position.

The preglabellar field is short (sag.), between one seventh and one eighth the length (sag.) of the glabella. In lateral profile it is convex immediately in front of the preglabellar furrow, then more or less straight, sloping down steeply to the wide, shallow but distinct anterior border furrow. The anterior border is marginally larger (sag.) than the preglabellar field and is upturned. The inner part, as far as the prominent errace line near the margin is convex. Immediately in front of the prominent marginal terrace line there is a distinct furrow. Below this furrow, near to where the anterior border turns underneath the cranidium to become the doublure, is another, less distinct, furrow (see Pl. 15, F, H). Between this lower furrow and the upper furrow is a rather broad, smooth band.

The anterior branches of the facial sutures are moderately divergent from gamma, with gamma-beta-alpha describing an abaxially convex curve. An exsagittal line drawn backwards from beta falls on the palpebral lobe. Behind the palpebral lobe, the posterior branch ocurrs close to the axial furrow for a short distance, before turning sharply outwards on the posterior border. Thepalpebral lobe is long and subcrescentic in outline, about half the sagittal length of the glabella, and situated posteriorly. In longitudinal profile itis weakly convex, and is not elevated to the height of the sagittal region of the glabella.

The eye is reniform, and rests on a rather indistinct eye socle. Only the median part of the lower margin has a rather weak furrow. The field of the free cheek is rather narrow and convex. The lateral border furrow is a little shallower than the anterior border furrow, while the lateral border is like the anterior. The posterior border furrow is deep and incised, and from it the posterior border is inclined gently backwards.

The pygidium is subparabolic in outline, about five eighths as long (sag.) as wide (trans.), with the region of the articulating facet turned strongly backwards. The axis is anteriorly about two fifths the total width of thepygidium, and tapers backwards gradually to a bluntly rounded end, and consists of 5 rings and a short end piece. In longitudinal profile it is strongly arched and semi-cylindrical, while in lateral profile slopes down gently from anterior to posterior, with each ring being weakly convex. The posterior end of the axis and the postaxial area slope down steeply in an almost straight line. There is no postaxial ridge. The first axial ring is narrower (sag.) than the remainder, which gradually decrease in width (sag.) towards the posterior. The interannular furrows are weak, but distinct, and are arched backwards weakly sagittally and also turn backwards abaxially. The articulating furrow is narrow and distinct. The adaxial part of the pleural field is almost flat and horizontally extended, while the abaxial section bends gently downwards to the margin. There are three obvious pairs of pleural ribs, with an ill-defined fourth pair. The pleural furrows are deep, with steep anterior and shallow posterior slopes, and they turn backwards quite strongly distally. The interpleural furrows are faint, but run more or less parallel to thepleural furrows, converging with the one behind slightly adaxially and abaxially. Neither the pleural nor the interpleural furrows reach the margin.

The entire cephalon and pygidium are covered with fine, continuous striations, which are arranged in a Bertillon pattern on the glabella and occipital ring. On the preglabellar field there are prominent. sporadic granules interspersed with the striations, which are also to be found, but in a more irregular arrangement in the median part of the occipital ring.

DISCUSSION

Warburg (see p. 174) only had two incomplete cranidia and two incomplete pygidia belonging to this species available to her, but now more complete specimens are available and it is possible to give a new, fuller description here.

Like the later species S. warburgae and S. norvegicum (see above), S. kullsbergense possesses an abaxially narrowed occipital ring, narrow elongated palpebral lobes and granules interspersing the striations on the preglabellar field. Like S. warburgae, S. kullsbergense has the striations which cover the glabella crossing over the areas of the lateral glabellar furrows. In this aspect, and in the striated sculpture consisting of continuous striations, S. kullsbergense is like S. warburgae, but unlike S. norvegicum. S. kullsbergense is distinct from both S. warburgae and S. norvegicum in the following features: the laterally constricted glabella, the longer (sag.) preglabellar field, the diverging, abaxially convex anterior branches of the facial sutures, the proportionately longer pygidium, with one more axial ring and one more pleural rib. The pygidial morphology as well as the abaxially convex anterior branches of the facial sutures are common features of S. kullsbergense and the early Middle Ordovician species S. strasburgense (Cooper).

Stenoblepharum pentagonoides (Warburg, 1925)
Plate 16, L, O-R.

1925 Proetus pentagonoides n. sp. Warburg, p. 176, Pl. 5, Fig. 22.

1964 Paraproetus pentagonoides (Warburg): Pribyl, p. 44.

HOLOTYPE

(By original designation): A cranidium (RM. Ar. 10838), figd. Warburg, 1925, as Pl. 5, Fig. 22, and refigurred herein as Pl. 16, O-R.

MATERIAL

Four cranidia.

TYPE STRATUM AND TYPE LOCALITY

Harjuan, Boda Limestone, Unskarsheden, Lake Siljan district, Sweden.

OCCURRENCE

Harjuan, Boda Limestone, Unskarsheden, Osmundsberget, Kallholn,

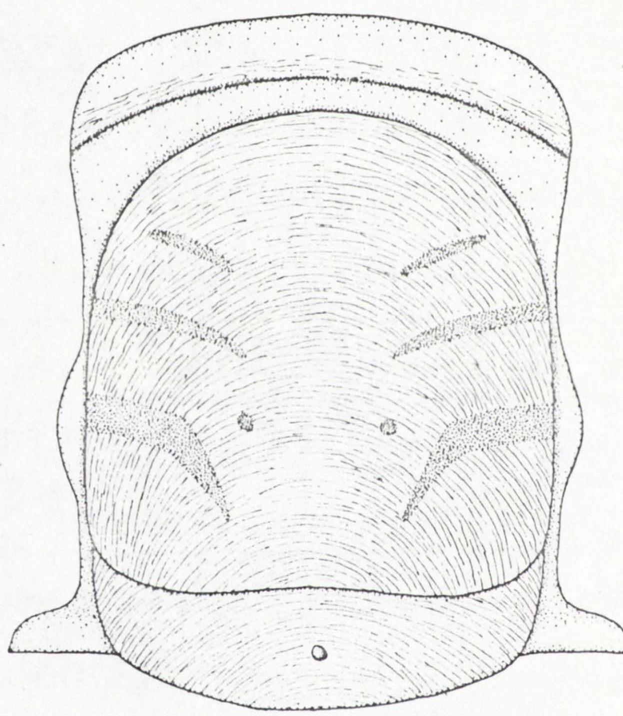


Fig. 2.3. Eremiproetus agellus. Holotype cranidium.

Lake Siljan district, Sweden. ?Kildare Limestone, Eire.

DIAGNOSIS

Glabella with anterolateral corners and frontal lobe distinctly angular, producing a pentagonal outline of the glabella; margin of glabella somewhat expanded opposite middle of palpebral lobe; palpebral lobe rather small, subtriangular; anterior branches of facial sutures slightly convergent.

DESCRIPTION

See Warburg, p. 176.

DISCUSSION

Most of Warburg's description is based on the holotype cranidium, which is an internal mould. This specimen is of considerable interest as it shows the lateral glabellar furrows as positive areas, which is unusual as they are normally negative, both on the external and internal mould. As the lateral glabellar furrows are positive on the internal mould, then they must have originally been negative features on the ventral surface of the carapace. The holotype also shows a slight ridge running along the sagittal line, which must also have been a negative feature on the ventral surface of the carapace. While the sagittal feature does not appear to have any dorsal expression, the lateral glabellar furrows are traversed by the striated sculpture of the glabella and are represented as darker areas - the same condition as in S. warburgae. The holotype of S. pentagonoides is the only specimen which clearly shows the positive lateral glabellar furrows and the sagittal features, as well as the expanded glabellar margin opposite the palpebral lobe. Precise information on the variability of these features must await better preserved material.

Subfamily EREMIPROETINAE Alberti, 1967

Genus EREMIPROETUS R. & E. Richter, 1919.

Type Species: Proetus dufresnoyi Hawle and Corda, 1847

Eremiproetus agellus sp. nov.

Plate 17, I-N, Plate 18, A-D, J, K, Text Fig. 2.3

1925 Proetus sp. ind. a. Warburg p. 180, Pl. 5, Figs. 14, 17.

HOLOTYPE

A cranidium (PMO 55817), Pl. 17, I, L.

MATERIAL

Numerous detatched exoskeletal parts.

TYPE STRATUM AND TYPE LOCALITY

Harjuan, Tretaspis Series, Stage 5a, Nøstest, Saelabon, Ringerike district, Norway.

OCCURRENCE

In Norway: Harjuan, Tretaspis Series, Stage 5a, Ringerike and Oslo-Asker districts; In Sweden: Harjuan, Boda Limestone, Osmundsberget, Unskarsheden, Kallholn and Solberga, Lake Siljan district.

DERIVATION OF THE NAME

From Latin agellus, a small field - from the short preglabellar field.

DIAGNOSIS

Glabella almost parallel-sided, with well rounded frontal lobe; anterior branches of facial sutures weakly divergent; occipital ring as wide (trans.) as the glabella; pygidium with short, conical axis with 5-6 rings separated by shallow interannular furrows; short postaxial ridge; pleural fields with 5-6 pairs of ribs; interpleural furrows, when present, are inconspicuous; sculpture of fine, dense striations.

DESCRIPTION

The cranidium is rather weakly vaulted, and distinctly longer (sag.) than it is wide across the palpebral lobes (trans.). The glabella is as long as wide, nearly parallel sided with a well rounded frontal margin. It is defined by narrow, distinct, conjoined axial and preglabellar furrows, and the former deeper and wider at the palpebral lobe. In lateral and longitudinal profiles the glabella is moderately convex, and in the former the frontal lobe and the preglabellar field form one continuous declined slope (see Pl. 17, I). Three pairs of very weak lateral glabellar furrows are present, which do not interrupt the glabellar sculpture. Their course is shown on Fig. 2.3, where they have been emphasised. A small, auxiliary impression is associated with lp.

The occipital ring is deeper than the axial furrows, and the median section runs nearly transversely, sometimes weakly forwards. The lateral ends curve first gently backwards, then quite strongly forwards. The anterior slope of the occipital furrow is inclined at about 60°, while the posterior slope is inclined at about 20°. The occipital ring is about as wide (sag.) as the preglabellar area, and does not narrow laterally, and transversely is marginally wider than the glabella. In lateral profile it is nearly flat and gently inclined towards the posterior. There is a distinct median tubercle, slightly posteriorly placed. There are no lateral occipital lobes, and the posterolateral corners of the occipital ring are bent down almost vertically. This causes the occipital ring to look as though it narrows laterally in dorsal aspect.

The preglabellar field is short (sag.), about half the sagittal width of the anterior border, and in lateral profile it is straight. The anterior border furrow is shallow, distinct and rather narrow. The anterior border is strongly convex in lateral profile. The anterior branch of the facial suture is a gentle, abaxially convex curve, and an exsagittal line drawn backwards from beta falls on the abaxial edge of the palpebral lobe. Gamma is a wide, adaxially convex curve, close to the axial furrow. The posterior branch has epsilon and zeta as independent angles, and the stretch between runs close to and parallel with the axial furrow. Epsilon is wide and ill defined, a little distance in front of the posterolateral corner of the glabella. Zeta is situated about half way along the lateral end of the occipital ring, and from it the posterior branch turns strongly outwards. The palpebral lobe is narrow, and subcrescentic in outline, close to the glabella and posteriorly placed. It is about two fifths of the sagittal length of the glabella, and is quite steeply inclined from the axial furrow. The eye is prominent and reniform, with a strongly convex visual surface and mounted on a distinct eye socle, whose lower margin is defined by a distinct furrow, and diverges from the upper margin at either end.

The field of the free cheek is rather narrow and weakly convex. The lateral border furrow is as deep as the anterior. The lateral border widens and becomes less convex, posteriorly, and is nearly flat at the base of the genal spine. The posterior border furrow is narrow and deep, and shallows at the base of the genal spine where it meets the lateral border furrow. The posterior border widens abaxially, and is gently inclined towards the posterior. The genal spine is broad based, flattened and rather short. The median groove is offset abaxially from the lateral border furrow, and quickly shallows and dies out.

The pygidium is subparabolic in outline, between three fifths and two thirds as long (sag.) as wide (trans.), without a border. From the axial furrow the anterior margin runs transversely for a short distance, then turns strongly backwards in a gentle, abaxially convex curve to meet the posterior margin on a transverse line running through the fifth axial ring. Anteriorly the axis is about two fifths of the total pygidial width, and extends for about two thirds of the pygidial length (sag.). Behind it is a weak postaxial ridge. The axis is conical, and tapers strongly backwards to a blunt point, and is gently longitudinally convex. It consists of 5-6 rings, separated by weak interannular furrows which arch gently forwards sagittally. The articulating furrow is deep, narrow and transverse, and the first axial ring is distinctly narrower than the second (sag.). The axis is defined by narrow axial furrows, which shallow and become obsolete near the posterior end. The pleural areas are gently convex, with 5-6 pairs of ribs which turn strongly backwards and widen a little abaxially. The pleural furrows are deep, with a steep anterior slope and a shallow posterior slope. Abaxially they widen andbecome shallower, and die out before reaching the margin. They turn backwards strongly as they cross above the inner edge of the doublure. The interpleural furrows are weak and hardly apparent, but seem to run close to and nearly parallel with the succeeding pleural furrow (see Pl. 18, D, on the left hand side),

The pygidial doublure is very broad and weakly ventrally convex. It bears 10-12 strong, parallel terrace lines, which are bunched together behind the axis where the doublure narrows considerably. Some of the outer ones die out towards the sagittal region behind the axis (see Pl. 17, N).

The cephalon and pygidium are covered with fine, dense, raised striations.

DISCUSSION

Eremiproetus agellus sp. nov. is the earliest member of the genus, considerably pre-dating the next oldest species E. senex Alberti, 1967, which occurs in the early Ludlovian of Bohemia. E. senex is quite similar to E. agellus (cf. Pl. 17, I-N, Pl. 18, A-D, J, K and Pl. 45, Figs. 1-6), differing from it in the more tapering glabella, wider occipital ring, smaller number of pygidial axial rings and pleural ribs and in having distinct interpleural furrows.

The cranidium of E. agellus is not far removed from those of Stenoblepharum warburgae and S. norvegicum, although the pygidium is much different. The cranidial similarities would suggest that Eremiproetus has its origins in Stenoblepharum, but the pygidium is rather closer to that of Decoroproetus.

Subfamily UNCERTAIN

Genus PARVIGENA gen. nov.

Type Species: Proetus parvigena Warburg, 1925.

DERIVATION OF THE NAME

From Latin parvus, small, and gena, a cheek - the free cheek of the type species is very small. Gender - feminine.

DIAGNOSIS

Cranidium subquadrate; glabella parallel sided, with weak lateral furrows sometimes present; occipital ring not narrowed laterally, without lobes; preglabellar field, when present, is minute; anterior border rounded; free cheek small, with eye taking up most of the field; furrows on cephalon may become partially obsolete; thoracic pleural very narrow (trans.); sculpture smooth or striated.

Species: Parvigena parvigena (Warburg, 1925), P. striata sp. nov.

OCCURRENCE

Harjuan, Boda Limestone, Siljan district, Sweden.

DISCUSSION

The subdued cephalic furrows and the broad thoracic axis seen in the type species, P. parvigena are suggestive of illaenids or certain nileids, e.g., Symphysurus (Kodymaspis). Whether this similarity is due to relationship or homeomorphy must await knowledge of the ventral cephalic sutures and the pygidium. The second species of Parvigena, P. striata is like proetids in its morphology. Pending further information, Parvigena is classified with the Proetidae.

Parvigena parvigena (Warburg, 1925)

Plate 17, A, D, G, H.

1925 Proetus parvigena n. sp. Warburg, p. 175, Pl. 5, Figs. 32-33.
1964 Paraproetus parvigenus (Warburg): Pribyl, p. 44.

HOLOTYPE (by monotypy)

A small cephalon with three attached thoracic segments (UMD 53), figur~~r~~ed Warburg Pl. 5, Figs. 32-33 and refigurred herein as Plate 17, A, D, G, H.

TYPE STRATUM AND TYPE LOCALITY

Harjuan, Boda Limestone, Kallholn, Lake Siljan district, Sweden.

DIAGNOSIS

Axial furrows becoming obsolete in front of the eyes, with the frontal lobe of the glabella merging insensibly into the anterior border; lateral border furrow obsolete; free cheek extremely narrow, with the eye close to the lateral margin; occipital furrow faint, obsolete abaxially; thorax with broad axis, and very narrow pleurae; exoskeleton smooth.

DESCRIPTION

The cranidium is as long as wide. The glabella is widest posteriorly, and tapers gently forwards. The axial furrow is clearly defined posteriorly, but becomes almost obsolete anteriorly, and the anterior border furrow is entirely obsolete, with only a very faint indication of its presence. In lateral profile the glabella is very weakly convex, and anteriorly slopes down in a continous curve with the anterior border, with no break in slope between the two (see Pl. 17, G). In longitudinal profile the glabella is more strongly convex. There is no evidence of any lateral glabellar furrows. As the frontal lobe of the glabella merges insensibly into the anterior border there is no preglabellar field. The occipital furrow is weak, and makes scarcely any impression in lateral profile, except for a slight change in slope (see Pl. 17, G). The median section runs more or less transversely, but the occipital furrow becomes obsolete abaxially, so that the lateral ends of the occipital ring are fused with the posterolateral corners of the glabella. The occipital ring is moderately wide (sag.), maintaining more or less the same width (exsag.) abaxially. In lateral profile it is gently inclined towards the posterior, achieving its greatest height a short distance from the posterior margin, to which it slopes down quite steeply from the point of greatest elevation. There are no indications of lateral occipital lobes, although Warburg (p. 175) is of the opinion that weakly defined ones are present. There is no median tubercle.

The anterior branches of the facial sutures are apparently weakly divergent, but their exact course is not clear. Gamma is well out from the axial furrows, and is more or less directly in front (exsag.) of epsilon. Epsilon is represented by a wide angle, close to the axial furrow, and from it the posterior branch turns abaxially, running in a more or less straight line to the posterior margin, close to the base of the genal spine. Thepalpebral lobe is subtriangular in outline and narrow (trans.), and is about three eighths the sagittal length of the cranidium. It is situated posteriorly, with epsilon approximately opposite (trans.) the occipital furrow. In longitudinal profile the palpebral lobe is almost straight, and declined abaxially. The eye is large, subreniform and is about five twelfths the sagittal length of the cranidium, the visual surface being gently convex. The eye is supported on a distinct eye socle, the lower margin of which is defined by a distinct furrow, which diverges from the upper margin at either end. The posterior end of the lower margin of the eye socle runs close to, but does not touch the posterior border furrow.

The free cheek is small and narrow, with the lateral border furrow obsolete. The lower margin of the eye socle runs close to the lateral margin, and would be almost confluent with the lateral border furrow if it were developed. The field of the free cheek is very weakly convex in longitudinal profile, and slopes down steeply from the eye region. The posterior border furrow is distinct, but shallow and narrow, shallowing near the axial furrow and becoming obsolete abaxially at the base of the genal spine. The genal spine is broad based, non-furrowed and triangular. It is rather short, and extends backwards as far as the third thoracic segment. The whole free cheek is so steeply declined that viewed dorsally part of the lateral margin is overlapped by the visual surface of the eye (see Pl. 17, A).

Three thoracic segments are preserved attached to the cephalon. The three axial rings are more or less the same width (trans.), and are separated by deep, more or less transverse interannular furrows, that between the first thoracic axial segment and the occipital ring running gently forwards distally, with the succeeding ones curving forwards less. In lateral profile each ring is of similar shape to the occipital ring, i.e. weakly inclined backwards as far as a highest point, not far from the posterior margin, then sloping down to the interannular furrow behind. The pleural areas of the thorax are extremely narrow, with the pleura being about one quarter the width (trans.) of its corresponding axial ring. Each pleura is turned quite strongly backwards, and is pointed abaxially. The fulcrum is close to the axial furrow, and from it the pleural is quite steeply declined. There is a narrow pleural furrow, which at the axial furrow divides the pleura into a wider posterior band and a narrower anterior band. It becomes obsolete about half way along the pleura, close to the anterior edge.

DISCUSSION

Only a single specimen of this species is known. Warburg (1925, p. 176) accounted for the subdued furrow on the cephalon by considering the specimen worn and damaged, but this does not seem to be so, and the subdued furrows are almost certainly primary.

Parvigena striata sp. nov.
Plate 17, B, C, E, F.

1925 *Proetus convexus* n. sp. *pars* Warburg, Pl. 5, Fig. 23, *non* figs. 8-13, 19-20.

HOLOTYPE

A cranidium (UM D.60), figd. Warburg Pl. 5, Fig. 23 and refigured herein as Pl. 17, F.

MATERIAL

Besides the type, 5 cranidia.

TYPE STRATUM AND TYPE LOCALITY

Harjuan, Boda Limestone, Kallholn, LakeSiljan district, Sweden.

OCCURRENCE

Harjuan, Boda Limestone, Kallholn, Unskarsheden, Lake Siljan district, Sweden.

DERIVATION OF THE NAME

From Latin *stria*, a line, due to the striated surface sculpture.

DIAGNOSIS

All furrows on cranidium distinct; cranidium with sagittal length a little greater than the palpebral width; preglabellar field minute, hardly interrupting the lateral profile; occipital ring a little wider (trans.) than glabella; sculpture striated.

DESCRIPTION

The cranidium is a little longer (sag.) than it is wide (trans.) across the palpebral lobes. The glabella is marginally wider (trans.) than it is long (sag.) and is roughly quadrate in outline. In lateral and longitudinal profiles it is rather weakly convex. The glabella is defined by narrow, but distinct axial and preglabellar furrows, and hardly tapers forwards. The part opposite the palpebral lobe is bowed outwards somewhat, more distinctly on some specimens than on others. The frontal lobe is well rounded. Three pairs of lateral glabellar furrows are present, not always discernible, but may be indicated as darker areas on the surface of the glabella, but are in all cases traversed by the striated sculpture of the glabella. On one specimen where they are clearly indicated, 1p is distally forked, with the principal part of the furrow directed backwards at about 45° to an exsagittal line. 1p extends about two thirds of the way towards the sagittal line. 2p is simple, and of comparable length and direction to 1p. 3p is short, directed backwards at a similar angle to 1p and 2p, but doesnot extend as far adaxially, nor does it reach the axial furrow.

The occipital furrow is deep, with a nearly vertical anterior slope and 45° posterior slope. It is arched forwards weakly sagittally, and again at either end. The occipital ring maintains more or less the same width (sag. and exsag.) abaxially, and transversely is as wide, or a little wider than the glabella. In lateral profile it is gently inclined backwards as far as the median tubercle, where there is a break in slope, and the stretch behind the median tubercle again is gently inclined backwards.

The preglabellar field is minute (sag.), less than one fifth the length (sag.) of the anterior border. In lateral profile it makes very little impression, and the slope of the frontal lobe of the glabella is continued with only a slight break onto the anterior border. The anterior border is moderately broad and weakly convex, and is defined by the rather wide, shallow but distinctly defined anterior border furrow.

The anterior branches of the facial sutures are weakly divergent, with beta forming a wide, weakly abaxially convex curve, and gamma forming a wide, adaxially convex curve. An exsagittal line drawn backwards from beta falls on the inner part of the palpebral lobe.

Gamma lies close to the axial furrow. The palpebral lobe is narrow and subcrescentic in outline, and is about a quarter the sagittal length of the glabella. Epsilon is a wide, adaxially convex curve, close to the axial furrow, and from it theposterior branches diverge strongly onto the posterior margin.

The cranidium has a sculpture of fine striations, arranged in a Bertillon pattern on the glabella and occipital ring. The preglabellar furrow and anterior border are apparently smooth.

DISCUSSION

Six cranidia are included in this species, and differ from the type species in having distinct furrows on the cranidium and a striated surface sculpture. Unfortunately no free cheeks or pygidia are available in association with these cranidia, so further characters cannot be compared with the type species.

Genus XENOCYBE gen. nov.

Type Species: Xenocybe micrommata sp. nov.

DERIVATION OF THE NAME

From the Greek xenos, stranger, and kybe (f), head, due to its distinctness from other proetids.

DIAGNOSIS

Glabella coniform, with 1p and 2p furrows deeply impressed; occipital ring without lobes, narrowing rapidly laterally. Preglabellar field rather long (sag.); eye small and backwardly placed.

Species: Xenocybe micrommata n. sp.

OCCURRENCE

Harjuan, Tretaspis Series, Stage 5a, Oslo-Asker and Ringerike districts, Norway.

DISCUSSION

The deeply furrowed glabella distinguishes Xenocybe micrommata from all contemporaneous proetids. The only other Ordovician proetid with glabellar furrows of comparable depth is Phaseolops sepositus Whittington (1963, p. 36, Pl. 4, Fig. 11-13, Pl. 5, Fig. 1-6) but the structure otherwise is rather different from Xenocybe micrommata, although both species share the rather long, declined preglabellar field, strongly divergent anterior branches of the facial suture and small eyes. The direction of 2p is forwards in Phaseolops sepositus, but backwards in Xenocybe micrommata. The position of 3p produces a short frontal lobe in the former, but a rather long one in the latter. It seems highly unlikely, therefore, that Xenocybe and Phaseolops can be closely related. The age difference is also great, as Phaseolops sepositus comes from the Whiterock stage, of Llanvirn age. Only the cephalon of Xenocybe micrommata is known, and as this does not fit into any established proetid subfamily I am placing it in subfamily uncertain.

Xenocybe micrommata sp. nov.
Plate 18, C, E-H, L.

DERIVATION OF THE NAME

From the Greek micrommatos, small eyed, because of the small size of the eyes.

HOLOTYPE

Cranidium (PMO 8831), Plate 18, E, F.

MATERIAL

Three cranidia, and two free cheeks.

TYPE STRATUM AND TYPE LOCALITY

Harjuan, Tretaspis Series, Stage 5a, Holmenskjaeret, Holmen, Asker, nearOslo.

OCCURRENCE

At the type locality and at Stavnestangen, Ringerike district, Norway.

DIAGNOSIS

Preglabellar field about one quarter the length of the glabella; occipital ring with its anterolateral corners confluent with the posterolateral corners of the glabella; an almost imperceptible groove traverses the preglabellar field and free cheek, close to and parallel with the border; sculpture of fine striae, interspersed with fine granules.

DESCRIPTION

The cephalon has a narrow, upturned convex border. The cranidium has the sagittal length much greater than the palpebral width. The glabella is a little longer than wide, conical and defined by deep, conjoined axial and preglabellar furrows. It is widest near the posterolateral corners and tapers forwards moderately rapidly as far as a position opposite gamma, from which it tapers rapidly to the bluntly pointed anterior lobe. In longitudinal profile the glabella is moderately convex, and in lateral profile, it slopes down very weakly as far as the frontal lobe, where it curves down steeply to the preglabellar furrow. Three pairs of glabellar furrows are present, 1p and 2p deeply incised into the glabellar surface, and 3p non-incised. 1p is situated opposite the posterior part of the palpebral lobe. It is shallow proximally and quickly deepens inwards and is directed slightly backwards. Distally it forks with the anterior branch very shallow and directed slightly forwards, and the posterior branch deep and bent strongly backwards. The anterior branch is shorter than the posterior, and both are shorter than the proximal part of the furrow. The posterior branch quickly shallows and does not reach the occipital furrow. The 1p furrow partially isolates a subquadrate 1p lobe, which has an independent convexity from the rest of the glabella. 2p is situated opposite the anterior part of the palpebral lobe, about half-way up the glabella, and is unbranched and is directed backwards at a slightly greater angle than the proximal part of 1p, and is of about the same length as it. At the distal end of 2p there is a small smooth area where the striated sculpture is greatly subdued. 3p is situated a short distance in front of 2p, opposite gamma. It is represented by an inconspicuous area interrupting the striated sculpture, and is directed slightly forwards. 3p is far back from the anterior end of the glabella, producing a long frontal lobe.

The occipital furrow is narrow and deep, its middle section running almost transversally, bending forwards at the lateral ends. The anterior slope is almost vertical. The occipital ring is wide (sag.), of about the same length as the preglabellar field. The posterior edge curves strongly forwards from the sagittal line, thereby producing marked lateral narrowing of the occipital ring. In longitudinal profile the occipital ring bends down steeply to the lateral ends, which are fused with the posterolateral corners of the glabella. In lateral profile the occipital ring rises up gently towards the posterior. No lateral occipital lobes are present, but there is a small median tubercle. One specimen (Pl. 18, G) shows the doublure of the occipital ring where the upper surface has been broken away. It is weakly convex dorsally and is ornamented with strong parallel transverse terrace lines.

The preglabellar field is long (sag.), about one quarter the total length of the glabella. It slopes steeply downwards from the preglabellar furrow and is weakly concave in profile. It is traversed by a very shallow depression, indicated by darker colouration on the specimens, which runs close to and parallel with the anterior border. It continues onto the free cheek, where it extends almost as far as the genal corner. The anterior and lateral border furrows are rather wide and shallow, separating the preglabellar field and the field of the cheek from the rather narrow, upturned, weakly convex border.

The anterior branches of the facial suture are strongly divergent, forming a wide, open curve. The palpebral lobe is rather narrow and is subcrescentic in outline, steeply rising up from the axial furrow and flattening off distally. It is slightly under one third the total length of the glabella. The eye is rather small, bean-shaped and supported by a distinct eye socle, whose lower margin is defined by a shallow furrow which diverges from the upper margin at either end. The posterior branch of the facial suture has epsilon and zeta as separate angles, and the stretch between them runs close to the axial furrow. From zeta the posterior branches diverge strongly on the posterior border.

The free cheek has a wide, weakly convex field. The genal corner is producedinto a long genal spine. The posterior border is a little narrower than the lateral and anterior borders.

The entire cephalon is ornamented with fine striae, which are arranged in a Bertillon pattern on the glabella. On the occipital ring the striae are arched forwards, and on the main part of the preglabellar field and on the cheek they are arranged transversally. On the anterior part of the preglabellar field and on the adjacent part of the anterior border they are arranged in a transversely elongated ellipse. On the palpebral lobe the striae run strongly forwards and slightly outwards. The striae are interspersed with very fine granules.

The thorax, pygidium and hypostome are unknown.

DISCUSSION

Xenocybe micrommata has only been found in Stage 5a of the

Tretaspis Series of southern Norway. Cranidia recently figured in Temple (1969, pl. Figs. 7, 8 and 12) from beds which he supposed to be of Lower Llandovery age at Keisley, Westmorland, may represent a second species. The specimens are rather badly preserved, but possess deep glabellar furrows, a feature distinctive of Xenocybe.

Xenocybe micrommata, although rather different from other proetids is nevertheless taken to be one, as its overall structure, ignoring the deep glabellar forrws, is generally proetid-like. Such features as the opisthoparian suture, the preglabellar field, the forwardly tapering glabella and the striated sculpture are all proetid features. Only when the other parts of the exoskeleton are known will it possibly be possible to relate it to other proetids.

PROETID HYPOSTOME

Plate 18, I

1925 Proetus sp. ind. d. Warburg, p. 182, Pl. 5, Fig. 21.

MATERIAL

3 hypostomes

HORIZON AND LOCALITIES

Harjuan, Boda Limestone, Kallholn and Klittberg.

DISCUSSION

Warburg (p. 182) described three proetid hypostomes from the Boda Limestone, and figured one of them (UM D.59), which is refigured herein as Plate 18, I. Unfortunately, it is unknown which, if any proetid species they were originally associated with. They lack the distinctive 'A' pattern formed in Kallholnia dapsilis (see Plate 13, G), and have a more transverse anterior margin and more rounded posterior lobe than does that species. There is a strong likelihood that they belong to the most abundant proetid in the Boda Limestone, which is Stenoblepharum warburgae, but more positive evidence is required to be certain.

? Family PROETIDAE Salter, 1864

Genus ISBERGIA Warburg, 1925

Type Species: Isbergia planifrons Warburg, 1925

DIAGNOSIS

Exoskeleton small, strongly vaulted, glabella tapers evenly forwards; occipital ring narrowed abaxially; preglabellar field very strongly declined; posterior branch of facial suture runs straight outwards and backwards from epsilon, and defines small triangulate posterior portion of fixed cheek; free cheek steeply declined; genal spine lacking; thorax of 8 segments; pygidium subparabolic, without border, axis with 5-6 rather poorly defined rings; pleural areas with 5-6 pairs of ribs; pleural and interpleural furrows parallel; former shallow and wide, latter narrow and sharp; exoskeleton smooth.

Species: Isbergia planifrons Warburg, 1925, I. parvula Warburg 1925

OCCURRENCE

Harjuan, Boda Limestone, Siljan district, Sweden; Tretaspis Series, Stage 5a, Oslo region, Norway; Ashgill Series, Kildare Limestone, Eire.

DISCUSSION

Warburg (1925, p. 187) was of the opinion that Isbergia possessed a combination of characters of the families Proetidae and Cyphaspidae (= Otarionidae), citing the position of the eyes as being proetid, and the path of posterior branches of the facial sutures as being cyphaspid. The path of the posterior branches found in Isbergia does, however, occur in many proetids. Search through collections in the Naturhistoriska Riksmuseet, Stockholm has produced a complete specimen of Isbergia planifrons, so that information on the thorax and pygidium of Isbergia is now available. The thoraxpossesses 8 segments like that of Kallholnia dapsilis sp. nov. (see below), and the pygidium has wide, shallow pleural furrows and narrow, sharp interpleural furrows - also like Kallholnia dapsilis. These common thoracic and pygidial characters suggest a relationship between Isbergia and Kallholnia. The type of pleural and interpleural furrows are distinctive, and are unlike the pattern found in Decoroproetus or Proetus, but are comparable with Panarchegonus. The type species of this genus, P. parvus, shows similar cranidial features with the early species of Kallholnia, K. sp. A (cf. Öpik, 1937, Pl. 1, Fig. 3 and herein Pl. 13, K-M) - e.g. glabellar outline, shape of palpebral lobe and path of the posterior branch of the facial suture. There is thus a possibility that Isbergia and Kallholnia are derived from Panarchegonus. If this is so, then they are not proetids, as

Panarchegonus shows close affinities with the Otarionids and Dimeropygids. In the present paper, Isbergia and Kallholnia are doubtfully assigned to Proetidae.

Isbergia is obviously specialised for the reef environment, and its remains have only been recorded from reef or reef-like deposits - the Boda Limestone, the Tretaspis Series, Stage 5a and the Kildare Limestone. In its gross overall morphology, Isbergia is reminiscent of the isocolids, especially Isocolus sjogreni Angelin (see Whittington, 1956, Pl. 123, Figs. 1-11), but such a similarity is more likely to be the result of a similar response by two different groups to the same environment (I. sjogreni also occurs in the Boda Limestone) than to be one of relationship.

Besides the species considered to belong here to Isbergia, two additional species have been assigned to this genus. Cooper (1953, p. 20, Pl. 1, Figs. 20-22,27) described and figured ~~herein~~ Isbergia virginica from the Middle Ordovician Effna Limestone of Virginia. The pygidium figured by Cooper is quite similar to that of I. planifrons, but the pleural and interpleural furrow pattern is different, while the cranidium is distinctly different, especially the forwardly expanding claviculate glabella and the strongly divergent anterior branches of the facial sutures. I. virginica does not, in my opinion, belong to Isbergia, but it may be an isocolid. Lesperance (1968, p. 816) lists "Isbergia n. sp." from the Lower Llandovery of the Perce region, Quebec. He has kindly sent me a cast of the specimen, which has a forwardly expanding, ovate glabella, and approaches Isocolus in morphology. It is probably not an Isbergia, but if it is an Isocolus then it is the first post Ordovician record of this genus.

Isbergia planifrons Warburg 1925.

Plate 12, A-F, I, K, N.

1925 Isbergia planifrons n. sp. Warburg, p. 187, Pl. 5, Figs. 54-57, text figure 17.

1925 "Cyphaspis" sp. ind. c; Warburg, p. 209, Pl. 5, Fig. 58.

LECTOTYPE (here selected)

A cephalon (U.M.), figured Warburg, p. 187, text figure 17.

TYPE STRATUM AND TYPE LOCALITY

Harjuan, Boda Limestone, Kallholn, Siljan district, Sweden.

MATERIAL

One complete specimen, a few cephala , many cranidia and a few pygidia.

OCCURRENCE

Harjuan, Boda Limestone, Kallholn, Osmundsberget, Östbjörka, Arfvet, Siljan district, Sweden; Tretaspis Series, Stage 5a, Oslo region, Norway; Ashgill Series, Kildare Limestone, Chair of Kildare, Eire.

DIAGNOSIS

Glabella tapering weakly forwards; in lateral profile forms one almost continuous curve with the preglabellar field, with only a slight break in slope at the preglabellar furrow; eye about half the length of the glabella, situated at about half its own length from the posterior margin of the cephalon.

DESCRIPTION

The exoskeleton is strongly vaulted. The cephalon is semioval in outline, about two thirds as wide (trans.) as long (sag.). Posteriorly the glabella occupies a little over half the cephalic width (trans.). The glabella is slightly wider (trans.) than it is long (sag.). It is defined by shallow, but distinct axial and preglabellar furrows, and narrows forwards gently to the well rounded frontal lobe. In longitudinal profile it is quite strongly convex, while in lateral profile it is less convex, sloping down constantly from posterior to anterior. Three pairs of lateral glabellar furrows are present, but these are extremely faint and are only evident on some specimens. 1p is situated opposite the centre of the palpebral lobe, and 2p opposite gamma. Both extend about half way towards the sagittal line, and both are directed backwards at about the same angle - 70°. 3p is directed backwards at a similar angle, situated near the anterolateral corner of the glabella and not joining the axial furrow.

The occipital furrow is deep, with anterior and posterior slopes rising at about 45°. It is arched forwards strongly sagittally, and the lateral ends turn slightly forwards. The occipital ring narrows almost to a point abaxially, and lacks lateral lobes. In lateral profile it is gently convex. The preglabellar field is long (sag.) about one third the sagittal length of the glabella. It is bent down almost vertically. In lateral profile it is very weakly convex, and forms an almost continuous curve with the profile of the glabella, with only a very slight interruption at the preglabellar furrow. The anterior border furrow is shallow but distinct, and the inner part of the narrow anterior border slopes up to it at about 45°. On the edge of the anterior border there is a strong terrace line, and in front of this the anterior border slopes down vertically. Abaxially the anterior border widens slightly.

The anterior branches of the facial sutures are nearly parallel, and gamma is a little way out from the axial furrow. The palpebral lobe is rather narrow, subcrescentic and a little under half the length of the glabella and situated close to it. Its posterior end (epsilon) is about one eighth of the way up the glabella. In longitudinal profile the palpebral lobe is very weakly convex and almost horizontal. The posterior branches of the facial suture run straight outwards and backwards from epsilon to cut the posterior margin of the cephalon a short distance inside the genal angle. The eye is long, crescentiform and about half the sagittal length of the glabella. The visual surface is strongly convex, and composed of at least fifty small facets. It is supported on an indistinct eye socle. The free cheek is steeply declined from the eye, with a weakly convex field. The lateral and posterior border furrows are wide and shallow, and the lateral border widens towards the posterior and is more steeply inclined than the inner part of the anterior border. There is no genal spine, and the genal angle is bluntly angular. The posterior border widens abaxially to become about as wide as the posterior part of the lateral border.

The thorax consists of 8 segments. The axis tapers gently backwards so that the last ring is about four sevenths the width (trans.) of the first. In longitudinal profile the axis is fairly strongly arched. In lateral profile each ring is nearly flat, sloping down gently towards the articulating furrow, at the anterior end. The articulating furrow is arched weakly forwards sagittally, and laterally either end curves slightly forwards. There is no preannulus. The pleurae are about half the width of the axis anteriorly, but posteriorly they are nearly half its width (trans.). The fulcrum is rather close to the axial furrow on the anterior segments, but on the posterior ones is about half way along the pleurae. The pleurae bend down quite steeply and turn gently backwards abaxially from the fulcrum. Each pleura carries a distinct pleural furrow, which extends nearly to the distal extremity. It divides the pleura into a wider posterior pleural band and a narrower anterior pleural band, each of which is very weakly convex in lateral profile. The distal end of the pleura terminates bluntly with a rounded anterolateral corner and an angular posterolateral corner.

The pygidium is subparabolic in outline, without a border. It is about twice as wide (trans.) as it is long (sag.). The axis anteriorly occupies nearly one third of the total pygidial width, and tapers quite rapidly backwards to a blunt point, andextends nearly three quarters of the pygidial length. Behind it the postaxial area is rather steeply declined, and is more or less straight in profile. The axis consists of 5-6 rings, separated by shallow interannular furrows, which curve gently forwards sagittally. In lateral profile each ring is weakly convex. The pleural areas are convex and bend quite steeply down to the margin. Five to six pairs of ribs are present, which curve gently backwards, with the pleural and interpleural furrows running more or less parallel. The first pair of pleural furrows are deep and incised, while the remainder are rather shallow and wide. The interpleural furrows are narrow and sharp, and more distinct than the pleural. The pleural and interpleural furrows both extend close to the margin, and the anterior and posterior pleural bands are of similar width and convexity. The pygidial doublure is rather narrow, with fine, parallel terrace lines, and is weakly ventrally convex.

The entire exoskeleton is smooth.

DISCUSSION

A pygidium described by Warburg (1925, p. 209, Pl. 5, Fig. 58) as "Cyphaspis" sp. ind. C has been shown to belong to Isbergia planifrons through the discovery of a complete specimen. Warburg recorded I. planifrons from the Boda Limestone and from the Kildare Limestone. In addition to these occurrences, the species has been identified in the Tretaspis Series, Stage 5a, from Stavnestangen, Ringerike, Oslo, represented by a cranidium and a pygidium (see Pl. 12, E, N).

Isbergia parvula Warburg, 1925

Plate 12, G, H, J, M, P.

1925 Isbergia parvula n. sp. Warburg, p. 188, Plate 5, Figs. 49-53.

LECTOTYPE (herein selected)

A cephalon (UM D.73), figured Warburg Plate 5, Figs. 51-53, and refigured herein as Pl. 12, G, H, J, M.

MATERIAL

A number of cranidia.

TYPE STRATUM AND TYPE LOCALITY

Harjuan, Boda Limestone, Kallholn, Siljan district, Sweden.

OCCURRENCE

Only at the type locality.

DIAGNOSIS

This species differs from I. planifrons in the following ways: in lateral profile the preglabellar field does not form a continuous curve with the glabella, and the preglabellar furrow is more distinct; the eye is smaller, about one third of the sagittal length of the glabella, and separated from the posterior margin of the cephalon by a distance equal to its own length.

DESCRIPTION

See Warburg, 1925, p. 188.

DESCUSSION

The differences between this species and I. planifrons are small. One of the differences between them is eye length, a feature which Clarkson (1969) has recently postulated as being of sexual significance in the Carboniferous trilobite Weberides shunnerensis. Thus it is possible that I. parvula and I. planifrons are sexual dimorphs - both occur at the same horizon and locality, although the latter is far more abundant and widespread.

Genus KALLHOLNIA gen. nov.

Type species: Kallholnia dapsilis sp. nov.

DERIVATION OF THE NAME

From Kallholn, Lake Siljan district, where the type species is abundant.

DIAGNOSIS

Exoskeleton up to 9 mm. long; glabella trapezoidal, with weakly impressed lateral furrows; occipital ring narrows weakly to strongly laterally; preglabellar field broad, weakly sigmoidal or straight in profile; palpebral lobe with gamma a little way out from the axial furrow; posterior branch of facial suture defined triangulate posterior portion of the fixed cheek; hypostome with strongly convex median body, almost parallel sided; posterior border of hypostome narrow, upturned; anterior wings short; thorax with 8 segments; pygidium subparabolic, without border; axis conical, with 6-7 rings; pleural areas with wide, rather shallow pleural furrows and narrow, sharp interpleural furrows. Exoskeleton smooth, or very finely granular.

Species: _Kallholnia dapsilis_ sp. nov., _K._ sp. A.

OCCURRENCE

Viruan, Macrourus Limestone (erratics), Oland, Harjuan, Boda Limestone, Lake Siljan district, Sweden.

DISCUSSION

Kallholnia is created for two species, one, the type species, occurring in vast numbers in the Boda Limestone at Kallholn and the other represented by a single cranidium from the Macrourus Limestone in Oland. _Kallholnia_ is compared above with _Isbergia_, with which it shares the same number of thoracic segments and has a similar pattern of pygidial pleural and interpleural furrows. _Isbergia_ and _Kallholnia_ differ strongly, however, in the morphology of the cephalon (cf. Pl. 12 and Pl. 13). In the Harjuan, _Kallholnia_, like _Isbergia_, is restricted to the reef environment.

Outside the Ordovician _Eodrevermannia bouskai_ (Pribyl, 1946, p. 13, Plate 3, Figs. 1-5, Plate 4, Figs. 1-2) from the Lower Devonian of Bohemia is quite similar to _Kallholnia_ in glabellar shape and number of thoracic segments, but the pygidium has a greater number of axial rings and pleural ribs, and the facial sutures run almost exsagittally, with a minute palpebral lobe. It is possible that this and other _Eodrevermannia_ species are related to _Kallholnia_.

Kallholnia dapsilis gen. et sp. nov.

Plate 13, A-G, I, J.

HOLOTYPE

An almost complete exoskeleton (RM Ar. 47518), Plate 13, A, B, D.

MATERIAL

Hundreds of nearly complete specimens, a smaller number of entire specimens and numerous detatched exoskeletal parts, including hypostomes.

TYPE STRATUM AND TYPE LOCALITY

Upper Ordovician Boda Limestone, Kallholn, Lake Siljan district, Dalarna.

OCCURRENCE

Only known from the type locality.

DERIVATION OF THE NAME

From the Latin dapsilis, plentiful. This species occurs in vast numbers.

DIAGNOSIS

Glabella with its posterolateral corners fused with the anterolateral corners of the occipital ring which narrows strongly laterally; preglabellar field about one quarter the length of the glabella (sag.); palpebral lobe small, forwardly placed; hypostome with irregular raised ridges on the anterior part of the median body arranged in a triangle, whose apex points forwards.

DESCRIPTION

Exoskeleton ovate, with the cephalon about twice as wide (trans.) as it is long (sag.) and slightly longer (sag.) than the thorax, and about twice as long (sag.) as the pygidium. The cephalon is semioval in outline with a rather narrow, flattened border. The cranidium has the sagittal length a little greater than the palpebral width. The glabella is trapezoidal, slightly wider than long, tapering quite strongly forwards and bluntly rounded anteriorly, and is widest at the posterior end. It is defined by shallow, but distinct conjoined axial and preglabellar furrows. In lateral profile it is weakly convex, sloping gently down to the frontal lobe, where the slope becomes a little steeper. In longitudinal profile it is quite strongly convex. Three pairs of lateral glabellar furrows are present. 1p widens distally and forks. The posterior branch continues backwards towards the occipital furrow, where it meets a small depression running forwards and strongly outwards from it. The anterior proximal part of 1p is situated opposite the posterior end of the palpebral lobe. 2p and 3p are both of simple construction, 2p situated opposite the anterior end of the palpebral lobe and curving gently backwards. 3p is a short distance in front, is shorter than 2p and runs almost transversely. The occipital furrow is of variable depth, and may be very shallow and obscure (e.g. Pl. 13, C), or deeper and more sharply defined (e.g. Pl. 13, A), but is never very deep. It is arched strongly forwards sagittally, with the lateral parts running outwards and slightly backwards. The occipital ring is widest sagittally, where it is nearly one quarter of the sagittal length of the glabella, and transversely is the same width as the glabella. It narrows rapidly laterally, and the anterolateral corners are confluent with the posterolateral corners of the glabella. At a median position is a prominent median tubercle, placed quite close to the occipital furrow, and in lateral or longitudinal profile this tubercle represents the highest point on the animal (see Pl. 13, F).

The preglabellar field is broad (sag.), about one third the sagittallength of the glabella. In lateral profile it slopes down quite steeply from the preglabellar furrow, and is weakly sigmoidal. The anterior border furrow is rather shallow. The anterior branches of the facial sutures are strongly divergent, and run almost straight from gamma to beta. An exsagittal line produced backwards from beta touches the outer edge of the eye. The posterior branches run outwards and backwards from epsilon, cutting the posterior margin of the cephalon near the base of the genal spine, and define a small triangulate posterior portion of the fixed cheek.

The palpebral lobe is rather small, about one third of the sagittal length of the glabella and placed well forwards with its posterior end one third of the way up the glabella from the posterior. Epsilon is fairly close to the axial furrow, while gamma is some distance from it. In longitudinal profile the palpebral lobe slopes gently upwards from the axial furrow, and its outer margin is elevated to the height of the axial furrow. The eye is rather small and crescentic, with the individual lenses clearly visible (see Pl. 13, B, C, E). There is no eye socle. The free cheek is declined fairly steeply from the eye to the lateral border furrow, which, like the anterior border furrow, is rather shallow. The posterior border furrow is rather deeper than the lateral, and shallows at the base of the genal spine where it meets the latter. The genal spine is broad based, with a shallow median furrow, and tapers rapidly to the pointed end, which is opposite the fourth thoracic segment. One or more raised ridges run forwards from the genal angle and extend about half way up the genal spine. There is a single raised ridge circumscribing the margin of the cephalon.

The hypostome has a convex median body which widens only slightly posteriorly. The median furrow is rather faint and weakly impressed. The lateral border furrow is deep, with the lateral border strongly upturned. The posterior border is very narrow. There is no anterior border furrow, so that the median body merges into the anterior border in front of the rather small, upturned anterior wings. The posterior wings are small, represented by a small upward flexure of the lateral border before it bends inwards towards the posterior. On the anterior lobe there are a series of irregular raised ridges in an area defined by three longer ridges in a triangle, whose apex points forwards.

The thorax consists of 8 segments. The axis tapers so that the last ring is about two thirds of the width of the first (trans.). Each axial ring runs more or less straight (trans.), curving forwards slightly laterally. There is no preannulus, and the articulating half ring is about half the length (sag.) of the annulus. In longitudinal profile each ring is subparabolic, and in lateral profile each is weakly convex and slopes down gently from posterior to anterior. Anteriorly the axis is wider (trans.) than the pleurae, but posteriorly the reverse is the case. The pleura has a deep pleural furrow, running outwards and slightly backwards, and at the extreme distal end is truncated by the articulating facet. The fulcrum is situated about half way along the pleura, and the distal part of the latter is gently declined from it. The pleural furrow divides the pleuron into a narrower anterior band and a wider posterior band. In lateral profile the anterior band slopes steeply upwards from the pleural furrow while the posterior band slopes up more gently. The distal end of the pleura is truncated, with the posterolateral corner bluntly pointed.

The pygidium is subparabolic in outline, without a border and more than twice as wide as long. The axis is about three quarters of the length (sag.) of the pygidium, and anteriorly is slightly less than one third the width (trans.). The axis tapers rapidly to a blunt point, and consists of 6 rings and a short terminal piece. In lateral profile the axis slopes gently backwards, with each ring sloping down towards the posterior, the interannular furrows being shallow and not forming distinct breaks in slope. The posterior end slopes steeply downwards to the postaxial area which is declined in a gently convex curve to the posterior margin. In longitudinal profile each ring is subparabolic. The pleural areas are broad, with 5-6 pairs of ribs. They widen slightly distally, and curve gently backwards. The posterior pleural band is slightly wider than the anterior, and the pleural and interpleural furrows run almost parallel for most of their length. The pleural furrows are deeper, deepening very slightly distally before shallowing near the margin. The narrow, sharp interpleural furrows are not as deep as the pleural furrows proximally, but deepen distally so that their extreme distal ends are deeper than those of the pleural furrows. There is no postaxial ridge.

The cephalic and pygidial doublures are narrow and marked with fine, parallel terrace lines. The exoskeleton is smooth.

DISCUSSION

Many slabs of pink, impure limestone from Kallholn are covered solely with the remains of Kallholnia dapsilis. Unfortunately these slabs have not been seen in situ, and the material was collected by quarrymen. A high proportion of the specimens are nearly complete, lacking only the free cheeks, and a smaller number are entirely complete. Like other highly fossiliferous patches in the Boda Limestone (see Whittington 1960, p. 1193 and 1963, p. 11), those containing Kallholnia dapsilis probably accumulated in the original area in which the animals lived. This is the more likely due to the high proportion of complete or near complete material. Kallholnia dapsilis has only been recorded from the type locality, but it is not known whether the material originated from one or more accumulations. It is obviously of highly restricted occurrence within the reef itself.

Kallholnia sp. A

Plate 13, H, K, L, M.

MATERIAL

One cranidium (RM Ar 19169)

HORIZON AND LOCALITY

Viruan, Macrourus Limestone (erratic block) Eriksöre, Öland.

DESCRIPTION

The cranidium is fairly strongly vaulted, and has the sagittal length a little greater than the palpebral width. The glabella is broadly conical, and is distinctly wider (trans.) than it is long (sag.). It is defined by the conjoined axial and preglabellar furrows, the former of which are narrow and fairly deep as far as a position opposite gamma, while the latter, together with the anterior part of the former is very shallow. From the bluntly angular posterolateral corners the glabella tapers rather strongly forwards to the bluntly angular frontal lobe. In lateral and longitudinal profiles the glabella is rather weakly convex. 1p is situated opposite the anterior part of the palpebral lobe and the abaxial part is directed backwards at about 65° to an exsagittal line, and the furrow runs in this direction for about two thirds of the way towards the sagittal line, when the extreme adaxial end turns and runs nearly exsagittally, and dies out well before reaching the occipital furrow. The whole of 1p is non-incised, and represents a smooth area on the glabellar surface. 2p is situated a short distance behind gamma, and runs backwards in the same direction as the abaxial part of 1p. It is fainter than 1p, and about half its length. There is no evidence of 3p on the cranidium.

The occipital furrow is narrow and a little deeper than the axial furrows, and is distinctly arched forwards sagittally. In lateral profile the anterior and posterior slopes are both short, and rather steeply inclined. The occipital ring is rather narrow, and the estimated sagittal length is about a quarter that of the glabella. Transversely it is as wide as the glabella, and narrows slightly abaxially. There are no lateral occipital lobes. In lateral profile the occipital ring is almost flat. The preglabellar field is long (sag.), about half the sagittal length of the glabella, steeply declined towards the anterior and nearly straight in lateral profile. The anterior border furrow appears to be duplicated, with the inner one half way along the preglabellar field, and the outer one a short distance behind the anterior border. Both are very shallow and obscure and produce shallow depressions in lateral profile. The anterior border is narrow and weakly convex.

The anterior branch of the facial suture forms a weak, outwardly convex curve, and an exsagittal line drawn backwards from beta falls on the palpebral lobe. Gamma is situated some distance out from the axial furrow. The posterior branch has epsilon and zeta as a single angle, well out from the axial furrow and from it, the posterior branch runs strongly outwards, close to the posterior border furrow for some distance, and gradually converging with it. The posterior border furrow is rather shallow, only a little deeper than the preglabellar furrow. It shallows a short distance before running into the axial furrow, opposite the occipital furrow. The posterior border is about the same width (exsag.) as the anterior and is weakly convex and inclined towards the posterior.

The palpebral lobe is subcrescentic in outline, backwardly placed and well out from the axial furrow. It is about half the sagittal length of the glabella. In longitudinal profile it is flat, and very gently declined from the axial furrow.

The entire cranidium, apart from the lateral glabellar furrows, which are smooth, has a "ground glass" texture.

DISCUSSION

The single cranidium from the Viruan Macrourus Limestone is the earliest representative of *Kallholnia*, and shows a number of distinctions from the later *K. dapsilis*, notably the larger palpebral lobe, the less clearly defined anterior border furrow and the non-fused anterolateral corners of the occipital ring and posterolateral corners of the glabella. Eye reduction in Erben's (1961, p. 84) "*Waribole*-mode" is clearly illustrated in the two species of *Kallholnia*.

C H A P T E R 3

BRITISH ORDOVICIAN PROETIDAE

ABSTRACT

British Ordovician species of Proetus, Ascetopeltis, Cyphoproetus, Paraproetus, Decorproetus, Astroproetus and Rorringtonia are described, and one new species of Ascetopeltis (A. barkingensis sp. nov.) and two new species of Decoroproetus (D. avioclivalis sp. nov. and D. pristinus sp. nov.) are defined. The Girvan and Anglo-Welsh faunas are distinct, with only one species common to both. The Girvan area has provided the richest proetid material from the British Isles.

INTRODUCTION AND HISTORICAL REVIEW

Prior to 1949, all the Ordovician Proetidae described from the British Isles originated from the Girvan area. Most species were included in the genus Proetus Steininger, by authors such as Nicholson and Etheridge (1879), Reed (1904-1940) and Begg (1939-1950), but Begg included some in his new subgenera Astroproetus and Cyphoproetus, and in Warburgella Reed. Since Reed's and Begg's work, Pribyl (1964, p. 42) has erected the new genus Paraproetus (type species P. girvanensis Nicholson and Etheridge), but did not figure any specimens. Whittington (1966) refigured the types of Astroproetus and Clypoproetus and placed the latter in synonymy with the former, and this view is supported here. Tripp (1954, 1962, 1967) has described a few new proetids from the Middle Ordovician of the Girvan district.

Bancroft (1949) erected a new genus, Proetidella (type species P. fearnsidesi Bancroft), for a species from the Caradocian of South Shropshire. This genus has been used since, particularly by Dean (1959-1963) to include Caradocian species from the Anglo-Welsh area. Pribyl (1953) considered Proetidella to be a synonym of Decoroproetus Pribyl, while Whittington (1966) considered it a synonym of Astroproetus Begg. In this paper I follow Pribyl, and species formerly included in Proetidella are placed in Decoroproetus, and Astroproetus is considered a distinct genus. Ogmocnemis Kielan, used by Whittard (1961) for the British species calvus is also considered to be a synonym of Decoroproetus.

SPECIES		CARADOC									ASHGILL												
	LLANDEILO	COSTONIAN	HARNAGIAN	SOUDLEYAN	L. LONGVILLIAN	U. LONGVILLIAN	MARSHBROOKIAN	ACTONIAN	ONNIAN	GIRVAN CARADOC	PUSGILLIAN	CAUTLEYAN	RAWTHEYAN	HIRNANTIAN	UNDIFFERENTIATED ASHGILL	Girvan	Lake District	Cross Fell Inlier	Cautley	Horton-inRibblesdale	South Wales	N. Wales and Berwyns	South Shropshire
Proetus berwynensis															×							×	
Proetus cf. berwynensis												×									×		
Ascetopeltis barkingensis															×				×				
Paraproetus girvanensis													×	×		×	×					×	
Paraproetus procerus													×			×							
Decoroproetus avioclivalis															×						×		
Decoroproetus calvus				×	×	×	×	?									?	×			×	×	×
Decoroproetus fearnsidesi		×	×																				×
Decoroproetus irregularis													×						×	×			
Decoroproetus jamesoni										×						×							
Decoroproetus mactaggarti													×			×							
Decorporoetus piriceps											?	×							×				
Decoroproetus pristinus	×																				×	×	
Decoroproetus aff. subornatus															×			×		×			
Decoroproetus sp. E										×						×							
Decoroproetus sp. F										×						×							
Decoroproetus sp. G										×						×							
Decoroproetus sp. H															×		×						
Astroproetus reedi													×			×							
Astroproetus asteroideus													×			×							
Cyphoproetus facetus										×						×							
Cyphoproetus rotundatus													×			×							
Rorringtonia flabelliforme		×																					×
Rorringtonia vetula										×						×							

Fig. 3.1. Stratigraphical and Geographical distribution of Proetidae in the British Ordovician.

Decoroproetus and Astroproetus are members of the subfamily Proetidellinae Hupe, 1953, which was established by late Llandeilo times. Proetus, Ascetopeltis and Paraproetus belong to the subfamily Proetinae, Salter, 1864, and none of these are known from pre Ashgill rocks. The ancestry of the Proetinae may lie in Cyphoproetus, whose earliest known species, C. facetus Tripp is found in the Caradocian of Girvan. British specimens have provided evidence that two important proetid subfamilies extend well back into the Ordovician, and seem to have been differentiated at least as early as the Caradocian.

STRATIGRAPHY

Stratigraphical nomenclature and correlation follow currently accepted ideas as far as possible. Bancroft's (1933) stage names are used for the Caradocian, and Ingham and Wright's (1970) for the Ashgillian. Following Ingham and Wright, I include the Pusgillian Stage in the Ashgillian. Local names are used to a large extent for the Girvan succession, as there remains much uncertainty in its detailed correlation with the Anglo-Welsh area.

DISTRIBUTION

Two major groups of proetids occur in the British Ordovician, in the Anglo-Welsh and in the Girvan areas, and only one species is common to both. The Middle Ordovician of the Anglo-Welsh area is dominated by Decoroproetus species, accompanied by a single species of Rorringtonia. No species is common to any area outside. The Girvan area at the same period is again dominated by Decoroproetus, whose species show greater affinity to those of Eastern North America and Norway than to those of the Anglo-Welsh area. It is accompanied by Cyphoproetus and Rorringtonia, both represented by one species. Numerically, proetids are about equal in abundance in the Anglo-Welsh and Girvan areas in the Middle Ordovician.

In the Ashgill, Decoroproetus, Ascetopeltis, Proetus and Paraproetus species occur in the Anglo-Welsh area. One species of Decoroproetus, D. irregularis is also found in the Holy Cross Mountains in Poland, and a second shows affinities with the Quebec species D. subornatus. Paraproetus girvanensis is the one species common to the Anglo-Welsh area and Girvan. Numerically proetids are rather scarce in the Anglo-Welsh area in the Ashgill, but locally can be quite abundant. At Girvan, proetids are particularly abundant in the sandy mudstones of the Upper Drummuck Group starfish beds, where many complete specimens have been found. The dominant genus is Paraproetus, which is accompanied by smaller numbers of Astroproetus, Decoroproetus and Cyphoproetus. Astroproetus is unknown in the Ashgill outside Girvan, and Paraproetus is only known in the Anglo-Welsh area and Poland. The Decoroproetus and Cyphoproetus species, like their Caradocian forerunners, show close affinities with those occurring in Scandinavia and eastern North America.

SYSTEMATIC DESCRIPTION

Family PROETIDAE Salter, 1864
Subfamily PROETINAE Salter, 1864
Genus PROETUS Steininger, 1831
Type species Calymmene concinna Dalman, 1828

Proetus berwynensis (Whittington 1966)
Plate 19, Figs. 1-2.

1966 Astroproetus berwynensis sp. nov. Whittington, p. 83, Pl. 25, figs. 14-16.

HOLOTYPE

Internal mould of a complete specimen, with counterpart external mould (BM 59355), the only specimen known.

TYPE STRATUM AND TYPE LOCALITY

Ashgillian (probably Ddolhir Beds), Cynwyd, 2½ miles south-west of Gorwen.

DESCRIPTION

See Whittington 1966, p. 83.

DISCUSSION

Whittington (1966, p. 83) assigned this species to Astroproetus. Revision of Astroproetus has shown that berwynensis possesses a number of features not characteristic for that genus (e.g. the lack of lateral occipital lobes, the presence of the preannulus, and the short, blunt pygidial axis). The same features are, however, characteristic for Proetus, so that here berwynensis is included in that genus. Along with Proetus cf. berwynensis (see below), Proetus berwynensis is one of the earliest known representatives of the genus. The closest Silurian species are Proetus latifrons (M'Coy) from the Upper Llandovery of Eire, and a species of *Proetus* from the Middle Llandovery of the Girvan district. These species, and *Proetus berwynensis* are apparently subgenerically distinct from *Proetus* (*Proetus*), and may be more closely related to *Proetus* (*Coniproetus*).

Proetus cf. *berwynensis* (Whittington 1966)
Plate 19, Figs. 3-8, 15.

MATERIAL

Several cranidia, free cheeks and pygidia, preserved as internal moulds.

HORIZON AND LOCALITIES

Ashgill (probably Cautleyan), Robeston Wathen; Ashgill (precise age unknown), Cresswell and Bron-haul, S.W. Wales.

DISCUSSION

The south Wales material seems to be slightly earlier than *P. berwynensis*, and it differs from that species in the shorter preglabellar field and the presence of the genal spine. These differences are small, and may be of no significance. The absence of the long genal spine on *P. berwynensis* may be more apparent than real. Topotype material of *P. berwynensis* may well demonstrate that the south Wales material is conspecific.

Genus ASCETOPELTIS Owens
Type Species: *Ascetopeltis bockeliei* Owens

Ascetopeltis barkingensis sp. nov.
Plate 19, Figs. 9-14, 18-19.

HOLOTYPE

A cranidium (SMC 43029), Pl. 19, Figs. 9, 10, 12, 13.

MATERIAL

Besides the type, 2 cranidia and 3 pygidium.

TYPE STRATUM AND TYPE LOCALITY

Ashgill (probably late), Barking, Dent.

OCCURRENCE

Unknown outside the type locality

DERIVATION OF THE NAME

From the type locality.

DIAGNOSIS

A very short (sag.) preglabellar field is present, the occipital ring does not narrow laterally; the palpebral lobe is small; sculpture of fine striations, not interspersed with granules.

DESCRIPTION

The cranidium has the sagittal length a little greater than the palpebral width. The glabella is broadly coniform, and is a little wider (trans.) than it is long (sag.). It is defined by deep, distinct, conjoined axial and preglabellar furrows. From the bluntly angular posterolateral corners the glabella is parallel sided until a position opposite the middle of the palpebral lobes from where it tapers forwards quite rapidly to the well rounded frontal lobe. There is a weak lateral constriction between 1p and 2p. In both lateral and longitudinal profiles the glabella is weakly convex. 1p is situated a little anterior to the middle of the palpebral lobe, and is represented by a smooth area interrupting the glabellar sculpture. The abaxial end runs inwards and backwards at about 75° to an exsagittal line. About half way along its length, 1p turns sharply backwards towards the occipital furrow, but dies out long before reaching it. Associated with 1p there is a small, ovate auxiliary impression, situated between the sharp bend in 1p and the sagittal line. 2p is situated opposite gamma, and runs inwards and backwards at about 75° to an exsagittal line, extending a little closer to the sagittal line than 1p. Like 1p it is represented by a smooth area interrupting the glabellar sculpture, 3p is represented by an inconspicuous ovate impression, isolated from the axial furrow and partially interrupting the glabellar sculpture. It is situated in front of the adaxial part of 2p, about the same distance from it as 2p is from 1p.

The occipital furrow is deeper and rather wider than the axial and preglabellar furrows. The median portion is arched forwards very gently, while the abaxial portions are arched forwards rather strongly. The anterior slope is nearly vertical, while the short posterior slope is inclined backwards at about 50°. The occipital ring is a little wider (sag.) than the anterior border, and maintains the same width laterally. Transversely it is a little wider than the glabella. Poorly defined, transversely elongated lateral occipital lobes are developed, with independent convexity from the remainder of the occipital ring. A small, distinct median tubercle is present, placed slightly towards the posterior. In lateral profile the occipital ring is very weakly convex, and gently inclined towards the posterior.

The preglabellar field is minute, about one third of the width (sag.) of the anterior border. The anterior border furrow is narrow and distinct. In lateral profile the anterior border is distinctly convex. Gamma lies a short distance out from the axial furrow. From it the anterior branches of the facial sutures diverge strongly in an abaxially convex curve, with beta a well rounded angle. An exsagittal line drawn backwards from beta falls on the outer edge of the palpebral lobe. The posterior branches of the facial sutures have epsilon and zeta as distinct angles. Epsilon is situated a little anterior to the posterolateral corner of the glabella, while zeta is close to the antero-lateral corner of the occipital ring. The stretch between lies close to, and runs parallel with the axial furrow. From zeta the posterior branches diverge strongly onto the posterior border. The posterior border furrow is shallow but distinct, and runs into the axial furrow about half way along (exsag.) the lateral end of the occipital ring. The posterior border is rather narrow, and weakly convex.

The palpebral lobe is small, subtriangular and about a third of the sagittal length of the glabella. It is posteriorly placed, and in longitudinal profile is gently inclined from the axial furrow.

The pygidium is subparabolic in outline, and is about three fifths as long (sag.) as it is wide (trans.). The anterior margin runs transversely for a short distance, then turns backwards at about 20° on the anterior edge of the articulating facet, which is quite strongly declined from the rest of the pleural region. Anteriorly the axis occupies about two fifths of the total pygidial width, and tapers gently backwards to the well rounded posterior end. There is no postaxial ridge. In lateral profile the axis slopes down gently towards the posterior, with the slope gradually increasing. The extreme posterior end drops almost vertically to the gently convex postaxial area. Six axial rings are present. The articulating furrow of the first is deep and distinct, and is very gently forwardly arched. The interannular furrow between the first and second rings is shallow, but more distinct than the succeeding furrows, which are very weak. The first and second interannular furrows are arched weakly forwards, but the remainder become progressively more strongly arched towards the posterior. In lateral profile the first ring is gently convex, while the articulating half ring and the remaining axial rings are almost flat, with the latter gently declined towards the posterior. On the abaxial part of each ring, not far from the axial furrow, and running into the next interannular furrow behind, is a small, exsagitally elongated depression, which is devoid of striations. A very short end piece is present. In longitudinal profile the axis is strongly arched. The pleural areas are weakly convex, with three pairs of ribs discernible. There may be a fourth pair. Each rib widens slightly abaxially, and curves gently backwards. The firstpleural furrow is narrow and incised, but the remainder are shallow and non-incised. All extend close to the pygidial margin. Only the first two pairs of interpleural furrows are discernible, and each is very faint and runs more or less parallel to the pleural furrows. The anterior and posterior pleural bands are of more or less equal width and convexity. There is no pygidial border.

The entire cranidium and pygidium are covered with a sculpture of fine incised striations, with the exception of the anterior part of the anterior border, which is crossed by prominent, parallel raised terrace lines. On the glabella, occipital ring and pygidial axis the striations are arched forwards. On the anterior portion of the fixed cheek the striations run outwards and weakly forwards, and on the palpebral lobe run outwards and more strongly forwards. On the pleural areas of the pygidium the striations run outwards and forwards from the axial furrow, and then turn gently backwards towards the margin where they run into sporadic incurved marginal terrace lines. On the postaxial area, the striations form a concentric pattern.

DISCUSSION

Dr. J.K. Ingham (Glasgow (Personal communication) has seen these specimens, but has not seen any beds of similar lithology to the matrix in which they are preserved, nor has he recorded this species from the inliers of the Cantley-Dent region. There are presently no exposures of Lower Palaeozoic in the region called "Barking, Dent", so that the specimens may originate from exposures no longer available, or from glacial erratics. In Scandinavia and Estonia *Ascetopeltis* occurs only in the higher Ashgillian (i.e. Rawtheyan or later), so that it is reasonable to suppose that A. barkingensis too comes from the higher Ashgillian. A. barkingensis differs from the type species of Ascetopeltis, A. bockeliei in having a short preglabellar field, small palpebral lobes and in not having the occipital ring narrowed laterally. It also differs in details of sculpture (cf. Pl. 19, Fig. 9 and Pl. 6, C.). Ascetopeltis sp. A and A. lepta both have the preglabellar field, but the former (see Pl. 7, A) has a larger palpebral lobe and a different type of sculpture, as well as a less tapering glabella. While the latter (see Pl. 7, D) also differs in these features as well as having a laterally narrowed occipital ring. A. barkingensis seems to be quite closely related to A. bockeliei and A. sp. A, with perhaps closer affinities with the latter. It is the only known representative of Ascetopeltis from the British Ordovician.

Genus PARAPROETUS Pribyl, 1964.

Type Species: Proetus girvanensis Nicholson and Etheridge, 1879

DIAGNOSIS

Cephalon with narrow border; glabella subquadrate or pyriform, with three pairs of weakly impressed furrows generally present; occipital ring without lateral lobes; a short (sag.) preglabellar field is always present, convex in lateral profile; anterior branches of facial sutures parallel or moderately divergent; posterior branches run close to and parallel with the axial furrow, with epsilon and zeta as independent angles; palpebral lobe small, situated about half way along the glabella; eye small, with distinct eye socle; thorax of ten segments, preannulus absent; pygidium with well differentiated axial rings; short postaxial ridge present; pleural areas with narrow, shallow pleural furrows, and very weak, indistinct interpleural furrows; sculpture of fine raised striations, sometimes with sporadic granules.

Species: P. girvanensis (Nicholson and Etheridge), P. procerus (Nicholson and Etheridge), P. sp. ("Proetus" sp. A of Kielan, 1960).

OCCURRENCE

Upper Ordovician, Girvan area, Lake District and North Wales, British Isles, and Holy Cross Mountains, Poland.

DISCUSSION

Pribyl (1964, p. 44) supposed Paraproetus to be closely related to Proetus (Proetus), mentioning as common characters "the form of the glabella and number of glabellar furrows, the lateral occipital lobes and the wide thoracic and pygidial axes etc." (author's translation). He distinguished Paraproetus from Proetus (Proetus) by "the sub parabolic cephalon and long genal spines, the narrow preglabellar field, the straighter course of the facial suture, the cuspidate, reflexed pleurae and longer, flatter pygidium without a border". He also pointed out differences in surface sculpture - generally granular in Proetus (Proetus), and generally finely striated in Paraproetus. Many of Pribyl's "differences" are not valid, as long genal spines and a pygidium without a border, for example, are found on many species of Proetus (Proetus), including the type species, P. (P) concinnus. The difference in surface sculpture is an important one, as striated sculptures are not found in Proetus (Proetus). The most important features distinguishing Paraproetus from Proetus, besides the sculpture are the lack of the preannulus and the cephalic panderian notch in the former and the structure of the pygidial pleural ribs. Narrow, shallow pleural furrows and very weak interpleural furrows are characteristic for Paraproetus, while wider pleural and interpleural furrows of comparable depth are characteristic for Proetus.

It is likely that Paraproetus is a small, specialised offshoot of the early Proetinae, with diminutive eyes. The pygidial structure is in some ways intermediate between that of Proetus and Decoroproetus, and is also comparable with Cornuproetus. There are arguments in favour of classifying Paraproetus with the Proetinae, the Cornuproetinae or with the Proetidellinae, but on present evidence, association with the Proetinae is preferred.

Paraproetus girvanensis (Nicholson and Etheridge, 1879)
Plate 19, Figs. 16, 17, 20-22, Plate 20, Figs. 1, 2, 4-10, 13-20.

1879 Proetus girvanensis sp. nov.: Nicholson and Etheridge, p. 169, Plate 12, Figs. 7-10.

1899 Proetus girvanensis Nicholson and Etheridge: Mem. Geol. Surv. Scot. p. 524, 673, 689.

1904 Proetus girvanensis Nicholson and Etheridge: Reed, p. 74, Plate 11, Figs. 1-3.

Non 1911 Proetus aff. girvanensis Nicholson and Etheridge: Wade, p. 429.

1916 Proetus girvanensis Nicholson and Etheridge: Marr, p. 200,

1931 Proetus girvanensis Nicholson and Etheridge: Reed, p. 14.

1943 Proetus girvanensis Nicholson and Etheridge: Begg, p. 57, Plate 2, Figs. 7, 7a.

1945 Proetus scobiei sp. nov. Begg, In Begg and Reed, p. 261, Pl. 1, Figs. 1, 2.

1964 Paraproetus girvanensis (Nicholson and Etheridge): Pribyl, p. 42.

LECTOTYPE

(See Pribyl, 1964, p. 42), a complete exoskeleton (BM In. 21926) figd. Nicholson and Etheridge, Plate 12, Fig. 10, Reed, Plate 11, Fig. 1 and refigured herein as Plate 19, Fig. 16.

MATERIAL

A large number of complete specimens and detatched exoskeletal parts.

TYPE STRATUM AND TYPE LOCALITY

Ashgill, late Rawtheyan, Upper Drummuck Group, Drummuck Mudstones, Thraive Glen, Girvan, Ayrshire.

OCCURRENCE

Upper Drummuck Group, Girvan district, Ayrshire, Ashgill (Rawtheyan and Hirnantian), Lake District and Caernarvonshire.

DIAGNOSIS

Glabella subquadrate, sometimes with a weak lateral constriction; anterior branches of facial sutures almost parallel to weakly divergent; row of granules present on posterior margin of the occipital ring, and each thoracic and pygidial axial ring; thoracic and pygidial axes quite broad.

DESCRIPTION

The cephalon is subparabolic in outline, with a narrow, convex border. The glabella is subquadrate in outline, as wide, or a little wider (trans.) than long (sag.), and defined by narrow, distinct, conjoined axial and preglabellar furrows. At its greatest width, at the posterolateral corners, the glabella occupies about a third of the total cephalic width. In lateral profile it is moderately convex, and slopes down evenly and constantly to the preglabellar furrow, from its highest point at the occipital furrow. In longitudinal profile it is more strongly convex. From the posterolateral corners, which are bluntly rounded, the glabella tapers forwards moderately rapidly to the bluntly rounded frontal lobe. Three pairs of weakly impressed lateral glabellar furrows are present. 1p is situated opposite the palpebral lobe, is directed backwards and adaxially at about 45° to an exsagittal line and expands adaxially into a roughly triangulate area. It does not reach the occipital furrow. Situated between the anterior end of 1p and the sagittal line is a small, ovate auxiliary impression. 2p is situated opposite gamma, and extends a little over half way towards the sagittal line and is directed transversely or slightly backwards. It widens slightly adaxially. 3p is a short distance in front of 2p, and is a little shorter and fainter and directed slightly forwards. All three pairs of furrows are represented by smooth areas on the otherwise striated glabellar surface.

The occipital furrow is deeper and wider than the axial furrow and is flexed forwards sagittally, and again more strongly abaxially. The anterior slope is nearly vertical, while the short posterior slope is inclined at about 45°. The occipital ring is about as wide (sag.) as the preglabellar area, and is very weakly convex and gently inclined towards the posterior in lateral profile. Transversely it is marginally wider than the glabella, and maintains about the same width along its length (trans.). There are no lateral occipital lobes, but there is a small median tubercle. The anterolateral corners of the occipital ring are drawn out towards the anterior and fuse with the posterolateral corners of the glabella.

The preglabellar field is short (sag.), less than one sixth the sagittal length of the glabella. In lateral profile it is weakly convex, and quite steeply declined towards the anterior. The anterior border furrow is narrow and distinct and the anterior border is narrow, convex and upturned. The anterior branches of the facial sutures are almost parallel to weakly divergent. Beta is a sharp rounded bend, and an exsagittal line drawn backwards from it falls on the palpebral lobe. The stretch gamma to beta is almost straight, with gamma a wide angle lying close to the axial furrow. Epsilon and zeta are independent angles on the posterior branch, and the stretch between them runs close to, and nearly parallel with the axial furrow, gradually diverging from it towards the posterior. Zeta is situated approximately opposite (trans.) the occipital ring, and from it the suture turns sharply abaxially to cut the posterior margin about half way between the axial furrows and the lateral margin.

The palpebral lobe is small, semioval in outline and situated close to the glabella, about one third of the way forwards from its posterior end. It is inclined at about 55° from the axial furrow, and flattens abaxially. The eye is small, about a quarter of the sagittal length of the glabella. The visual surface is crescentiform, with a strongly convex visual surface, composed of many facets. The base of the visual surface of the eye is circumscribed by a distinct furrow at the top of the eye socle. The base of the eye socle is defined by a shallow furrow, which diverges from the upper margin strongly at either end.

The field of the free cheek is rather broad and is convex, and has a marked flexure a little above and parallel with the lateral border furrow. There is a similar flexure parallel with the posterior border furrow, and the two meet near the base of the genal spine. The lateral border and lateral border furrow are of a similar nature to the anterior. The posterior border furrow is rather wide and shallow, with the stretch inside the facial suture rather narrower and deeper. The genal spine is narrow and short, extending backwards as far as the third thoracic segment. The wide median furrow at thebase quickly narrows and becomes obsolete towards the posterior.

The thorax consists of ten segments, with a broad, gently tapering axis, which is strongly convex in longitudinal profile and is wider (trans.) than the pleurae anteriorly, but narrower at the posterior end. The last axial ring is about two thirds the width (trans.) of the first. Each ring is arched gently forwards sagittally. In lateral profile the annulus is flat and gently inclined towards the posterior. The articulating furrow is deep, and the articulating half ring is convex in profile and not as wide (sag.) as the annulus. The doublure of the axial ring is dorsally convex, with strong, parallel, transverse terrace lines. The pleura runs nearly straight (trans.) abaxially, and curves very gently backwards distally, being declined quite strongly at the fulcrum, which is about half way along it. The pleural furrow is deep, and is truncated abaxially by the posterior margin of the articulating facet. Continuing along the line of the pleural furrow, along the posterior edge of the articulating facet is a distinct ridge, with an almost vertical posterior slope (see Plate 19, Figs. 21-22). This continues as far as the posterolateral corner. On more posterior pleurae, it is not so well defined. The pleural furrow divides the pleura into a wide posterior pleural band and a narrow anterior pleural band. The formeris almost flat and gently inclined from the pleural furrow, while the latter is declined in a quite strongly convex curve to the pleural furrow. The anterolateral corner of the pleura is rounded, while the posterolateral corner is angular.

The pygidium is subparabolic in outline, and is about twice as wide (trans.) as it is long (sag.), and has no border. At the anterior end the axis is about one third of the total pygidial width. It is strongly arched in longitudinal profile, and tapers gently backwards to the well rounded posterior end. A narrow indistinct postaxial ridge is present. There are five axial rings and a short terminal piece, with the first ring distinctly elevated above the remainder, and separated from the second ring by a deep interannular furrow. The interannular furrows become progressively shallower towards the posterior, and run more or less transversely. In lateral profile the first ring is steeply inclined from the articulating furrow, flattening a little towards the posterior. The succeeding rings become progressively less steeply inclined. The posterior end of the axis slopes steeply down towards the posterior margin in a more or less straight slope.

The pleural areas are convex, with three, possibly four pairs of pleural ribs, which curve gently backwards and widen slightly abaxially. The pleural furrows are narrow and shallow, with the first pair deeper and more distinct than the remainder. All extend close to the lateral margin. The interpleural furrows are shallow and inconspicuous, and run more or less parallel with the pleural furrows, each diverging slightly from the succeeding pleural furrow. The anterior and posterior pleural bands are of more or less equal width, and there is little difference in height except on the first pair of pleural ribs, where the anterior pleural band is strongly elevated above the posterior. The pygidial doublure, like the cephalic, is narrow and ventrally convex and bears, strong, parallel terrace lines.

The glabella, occipital ring, and the pygidial and thoracic axes have a sculpture of distinct, forwardly arched striations, and on the posterior margin of the occipital ring, and the thoracic and pygidial axial rings there is a row of small granules. The pleural areas are more or less smooth, but fine terrace lines occur on the cephalic border and on the genal spine. A single row of granules is present on the lateral border of the lectotype (Plate 19, Fig. 16). The ventral surface of the free cheek seems to have been granular, as fine pitting is present on the free cheek on internal moulds (see Plate 20, Figs. 2, 4-8).

DISCUSSION

Proetus scobiei Begg (1945, p. 261, Pl. 1, Figs. 1-2) is considered to be a synonym of P. girvanensis, the only real difference exhibited between the type (Plate 20, Figs. 13-14), and that of P. girvanensis (Plate 19, Fig. 16) being the more strongly divergent anterior branches of the facial sutures. There is, however, a continuous variation in degree of divergence of facial sutures found in P. girvanensis from nearly parallel to moderately divergent. P. girvanensis occurs most commonly at Girvan, but also occurs in the Anglo-Welsh area. Specimens from all districts are figured to indicate the range of variation and preservation.

Paraproetus procerus (Nicholson and Etheridge, 1879)
Plate 20, Figs. 3, 11, 12, 21.

1879 Proetus procerus sp. nov. Nicholson and Etheridge, p. 174, Pl. 12, Fig. 11.

1899 Proetus procerus Nicholson and Etheridge: Mem. Geol. Surv. pp. 524, 673, 689.

1904 Proetus procerus Nicholson and Etheridge: Reed, p. 77, Pl. 11, Figs. 5, 6, 6a.

1960 Proetus procerus Nicholson and Etheridge: Kielan, p. 69.

1961 Proetus procerus Nicholson and Etheridge: Whittard, p. 187.

1964 Paraproetus procerus (Nicholson and Etheridge): Pribyl, p.44.

HOLOTYPE

A complete internal mould (BM In. 21942), figd. Nicholson and Etheridge, Pl. 12, Fig. 11, Reed, Pl. 11, Figs. 5, and refigured herein as Pl. 20, Figs. 11-12.

MATERIAL

Besides the type, two complete specimens, one showing the hypostome.

TYPE STRATUM AND TYPE LOCALITY

Ashgill, late Rawtheyan, Upper Drummuck Group, Drummuck Mudstones, Thraive Glen, Girvan.

OCCURRENCE

Only at the type locality.

DIAGNOSIS

Closely related to P. girvanensis, from which it differs in: a more elongated exoskeleton, with narrower thoracic and pygidial axes; an elongated, pyriform glabella; strongly divergent anterior branches of the facial sutures; one extra pygidial axial ring.

DISCUSSION

The differences between P. procerus and P. girvanensis are small, and Reed (1931, p. 14) and Begg (1939, p. 373) have already suggested that these species are conspecific. However, the different proportions exhibited by P. procerus do seem to be significant, but could be sexual rather than specific. P. procerus is retained as an independent species pending the discovery of specimens with the dorsal surface preserved.

A third species of Paraproetus occurs high in the Ashgill of the Holy Cross Mountains, Poland, described by Kielan (1960, p. 181, Pl. 3, Figs. 1-2, Pl. 21, Fig. 1) as "Proetus" sp. a. This seems to be close to P. girvanensis, but differs, among other features, in a more coarsely striated surface sculpture, interspersed with granules.

Subfamily PROETIDELLINAE Hupe, 1953

Genus DECOROPROETUS Pribyl, 1946

Synonyms: Proetidella, Bancroft, 1949; Ogmocnemis Kielan, 1960, Warburgaspis Pribyl, 1946.

Type Species: Proetus decorus Barrande, 1846.

DIAGNOSIS

Exoskeleton depressed; cephalon with flat or rolled border, with shallow, often indistinct border furrow; preglabellar field always present, sigmoidal or straight in lateral profile; glabella parallel sided or tapering forwards, sometimes laterally constricted; lateral glabellar furrows weak or absent; occipital ring without well defined occipital lobes; rostral plate trapezoidal; thorax of 8 or 10 segments, pleurae distally pointed; no preannulus; pygidium subparabolic, without a border; axis with 5-10 rings, often only separated by very shallow interannular furrows; pleural areas with 4-6 pairs of ribs, which widen distally; pleural furrows deep, deepening and bending backwards abaxially; interpleural furrows shallow, often only apparent abaxially, where they curve backwards more strongly than the pleural furrows; postaxial ridge usually present; sculpture of fine raised continuous or discontinuous striations.

OCCURRENCE

Ordovician (Llandeilo) to Lower Devonian. British Isles, Scandinavia, Poland, Czechoslovakia, Estonia, Soviet Union, Eire, Morocco, North America.

DISCUSSION

Examination of the type species of *Decoroproetus* (*Proetus decorus* Barrande), *Proetidella* (*Proetidella fearnsidesi* Bancroft), *Ogmocnemis* (*Ogmocnemis irregularis* Kielan) and *Warburgaspis* (*Proetus modestus* Törnquist) has shown that although they are specifically distinct, they are impossible to separate generically, and all share the characters given in the diagnosis above, which is for *Decoroproetus*, the senior synonym. Whittington (1966, p. 81) considered *Proetidella*, *Ogmocnemis* and probably *Warburgaspis* to be synonymous with *Astroproetus* Begg, 1939. *Astroproetus* does, however, possess characters which distinguishes it from all these; distinct lateral occipital lobes, much shallower pygidial pleural furrows, which do not deepen abaxially and it never has striated sculpture. The rostral plate, at least in the type species of *Astroproetus*, *A. reedi* appears to be transversely elongated and trapezoidal, which is in contrast to the longer (sag.) and narrower (trans.) more triangulate rostral plate which is apparently characteristic for *Decoroproetus*. On the basis of these characters, I prefer to place *Proetidella*, *Ogmocnemis* and *Warburgaspis* in synonymy with *Decoroproetus* rather than with *Astroproetus*.

Decoroproetus is a conservative genus throughout its long history, and its morphology changes little (cf. *D. fearnsidesi* (Middle Ordovician), Pl. 21, Figs. 22-23, *D. modestus* (Upper Ordovician), Pl. 10, Figs. K, L, and *D. decorus* (Wenlock) Pl. 45, Figs. 9-13). *Decoroproetus* seems to have formed a rootstock from which several other proetid lines arose, e.g. the Eremiproetinae and the Tropidocoryphinae. While *Decoroproetus* is widespread and occurs in nearly all facies during the Ordovician, its distribution is markedly limited during the Silurian, where it occurs in dark, impure limestones and shales in association with "Bohemian" faunas.

Decoroproetus avioclivalis sp. nov.

Plate 21, Figs. 1-7, 9, 11.

HOLOTYPE

A partially exfoliated cranidium (BM It 8827), Pl. 21, Fig. 1.

MATERIAL

About 12 cranidia, 5 free cheeks and 6 pygidia.

TYPE STRATUM AND TYPE LOCALITY

Ashgill, Birdshill Limestone, Quarry 200 yards NW of Birdshill Farm, 1½ miles WNW of Llandeilo, Carmarthenshire.

OCCURRENCE

At the type locality.

DERIVATION OF THE NAME

From Latin avis, bird and clivus, hill, from the type locality.

DIAGNOSIS

Glabella pyriform, a little wider (trans.) than long (sag.), with 2, possibly 3 pairs of weakly impressed lateral furrows; occipital ring with small, weakly developed lateral lobes, more apparent on internal moulds; eye with well developed eye socle, whose lower margin is defined by a shallow, distinct furrow; pygidium with 6 well defined axial rings and 3-4 pairs of pleural ribs; postaxial ridge hardly apparent.

DESCRIPTION

The cranidium has the sagittal length somewhat greater than the palpebral width. The glabella is a little wider (trans.) than long (sag.), pyriform and defined by narrow, distinct but non-incised conjoined axial and preglabellar furrows. From the bluntly rounded posterolateral corners it widens forwards quite rapidly as far as the middle of the palpebral lobes, then tapers forwards strongly to the well rounded frontal lobe, being distinctly constricted opposite the anterior ends of the palpebral lobes. In lateral and longitudinal profiles it is rather weakly convex. Two pairs of lateral glabellar furrows are present, and there may be a third, and these are more pronounced as internal moulds (cf. Pl. 21, Figs. 1, 2). 1p is weakly impressed, and situated opposite the anterior part of the palpebral lobe. It is directed backwards at an angle of between 50° and 60° to an exsagittal line, and does not reach the occipital furrow. 2p is situated a little anterior to the constriction of the glabella, is short, weakly impressed and runs nearly transversely.

The occipital furrow is deeper and wider than the axial and preglabellar furrows, and is arched weakly forwards sagittally and laterally. The anterior slope is nearly vertical, while the posterior slope is inclined backwards at about 45°. The occipital ring is about three quarters the width (sag.) of the preglabellar area, and transversely is a little wider than the glabella. It maintains more or less the same width (sag. and exsag.), and is weakly convex in lateral profile. There is a small median tubercle, and ill defined lateral occipital lobes are present which are small and ovate. These are more obvious on internal moulds than they are on the external surface (cf. Pl. 21, Figs. 1, 2). The preglabellar field is rather short (sag.), about a seventh of the sagittal length of the glabella. In lateral profile it is nearly straight, and is quite steeply declined towards the anterior. The anterior border furrow is narrow, shallow and distinct, and the anterior border is upturned, convex and about equal width (sag.) to the preglabellar field.

The anterior branches of the facial sutures are quite strongly divergent, with gamma a wide angle, close to the axial furrow and beta a rounded, acute angle. The stretch gamma to beta is nearly straight, and an exsagittal line drawn backwards from beta falls on the abaxial part of the palpebral lobe. On the posterior branches, epsilon and zeta are one angle, close to the axial furrow. From this position the posterior branches diverge strongly onto the posterior border. The eye socle is ill preserved on the available specimens, but from the shape of the eye seems to be rather large and crescentic. The eye is crescentic, and about two fifths the sagittal length of the glabella, situated posteriorly and close to it. The eye is supported by a prominent eye socle, whose lower margin diverges from the upper at either end and is defined by a shallow but distinct furrow. There is some variation in the course of the lower marginal furrow of the eye socle - in some specimens (e.g. Pl. 21, Fig. 6), the central portion runs more or less straight and exsagittally, while in others (e.g. Pl. 21, Fig. 7), it is curved. This may be a sexual difference.

The field of the free cheek is narrow and weakly convex. The lateral border furrow is narrow and shallow, and the lateral border is rather broad and weakly convex. The posterior border furrow is narrower and deeper than the lateral, and the posterior border widens abaxially so that it is nearly as wide as the lateral at the base of the genal spine. It is weakly convex, and gently inclined towards the posterior. The genal spine is fairly short, and tapers rapidly backwards. The median furrow follows the line of the lateral border furrow, and is about the same width and depth, becoming obsolete near the posterior end of the spine. The inner and outer bands of the genal spine are both inclined from the median furrow, and are both of approximately equal width.

The cephalic doublure is rather narrow, and quite strongly ventrally convex, and bears prominent, parallel terrace lines. One specimen (Pl. 21, Fig. 3) shows the right hand connective suture of the triangular or trapezoidal rostral plate.

The pygidium is roughly semicircular in outline, without a border and about twice as wide (trans.) as long (sag.). Anteriorly the axis occupies about a third of the total pygidial width, and tapers gently backwards to the rounded posterior end. Six axial rings are present, defined by distinct interannular furrows. The first ring is elevated above the remainder, and all are gently declined towards the posterior. The first three are weakly convex, and the rest are nearly flat. On the abaxial extremities of each ring, close to the axial furrow is a small, smooth depression, which interrupts the striated sculpture. In lateral profile the axis as a whole is gently convex and declined towards the posterior, with the posterior extremity steeply declined towards the postaxial area, which is weakly convex. The postaxial ridge is hardly apparent. The pleural areas are convex with three clearly defined pairs of ribs, and traces of a fourth. The ribs curve gently backwards and widen abaxially. The first pair of pleural furrows is deep, with a distinct, steep anterior slope. The remainder of the pleural furrows are shallower, but deeper slightly distally. The interpleural furrows are weak and shallow, and deepen a little at the extreme abaxial end. The adaxial part runs more transversely than the pleural furrows, while the abaxial part turns more strongly backwards. The pleural furrows reach the pygidial margin, while the interpleural furrows do not. Adaxially, the anterior and posterior pleural bands are of more or less equal width (exsag.), but abaxially, the former are distinctly wider.

The whole cephalon and pygidium are covered with fine raised striations, forwardly arched on the glabella, occipital ring and pygidial axis, transverse on the preglabellar area and pleural areas of the pygidium, forwardly and outwardly directed on the palpebral lobe and lateral border (running almost exsagittally on the latter) and backwardly and outwardly directed on the field of the free cheek.

Two or three distinct terrace lines run parallel with the cephalic margin.

DISCUSSION

Decoroproetus avioclivatis sp. nov. is abundant in the Birdshill Limestone, a coarse, crinoidal limestone, believed to be of early Ashgill age (Mr S.F. Morris and Mr D. Price, personal communication). The species has not been found outside the type locality, and may be strictly facies controlled.

D. avioclivalis is similar to D. calvus of Caradoc age, and D. piriceps of Ashgill (Cautleyan) age. From the former it differs in having a more constricted glabella, more prominent lateral glabellar furrows, in having a weak lateral occipital lobe present, a more distinct eye socle and less dense raised striations over the exoskeleton. From the latter it differs in having a shorter preglabellar field, a more distinct anterior border furrow and a broader glabella. A close relationship certainly exists between D. avioclivalis, D. calvus and D. piriceps. With its rather subdued pygidial pleural furrows, D. avioclivalis could be on the line leading from Decoroproetus to Astroproetus (cf. D. fearnsidesi, Pl. 21, Figs. 22-23, D. avioclivalis Pl. 21, Figs. 4, 11 and A. reedi, Pl. 23, Figs. 21-22.).

Decoroproetus calvus (Whittard 1961)
Plate 21, Figs. 8, 10, 12-21, 26

1911 Proetus aff. girvanensis Nicholson and Etheridge: Wade, p. 429.

1959 Proetidella aff. fearnsidesi Bancroft: Dean, p. 206.

1961 Ogmocnemis calvus sp. nov. Whittard, p. 186, Pl. 24, Fig. 15.

1962 Proetidella? marri sp. nov. Dean, p. 124, Pl. 16, Figs. 4, 6, 9; Pl. 17, Figs. 5, 6, 8, 9.

1963a Proetidella cf. fearnsidesi Bancroft: Dean, p. 245, Pl. 45, Figs. 9-11.

?1963b Proetidella? sp. Dean, p. 55, Pl. 1, Figs. 8-9.

?1966 Astroproetus cf. fearnsidesi (Bancroft): Whittington, p. 82, Pl. 25, Fig. 12, Pl. 26, Figs. 2, 3, 5.

1966 Astroproetus marri (Dean): Whittington, p. 83.

HOLOTYPE

Internal mould of a cranidium, with counterpart external mould (GSM 87169). Figd. Whittard, Pl. 24, Fig. 15, and refigured herein as Pl. 21, Figs. 17-18.

MATERIAL

About 10 cranidia, 2 free cheeks and 3 pygidia.

TYPE STRATUM AND TYPE LOCALITY

Lower Soudleyan, zone of Broeggerolithus broeggeri, near the base of the Whittery Shales, Whittery Quarry, at the southern end of Whittery Wood, near Chirbury.

OCCURRENCE

Caradoc, Soudleyan - Marshbrookian (?Actonian), Welsh Borders, Berwyn Hills, S.W. Wales, N. England.

DIAGNOSIS

Glabella tapering forwards weakly, and slightly constricted laterally; sometimes with weak lateral furrows; frontal lobe bluntly rounded to nearly transverse; anterior border brim-like and clearly differentiated from the preglabellar field; pygidium with 6 well defined axial rings and 4 pairs of pleural ribs.

DISCUSSION

Whittard (1961, p. 186) described a single cranidium from Shelve as Ogmocnemis calvus, and distinguished it from Decoroproetus fearnsidesi by its better developed preglabellar field and lack of basal glabellar furrows. The last feature of D. fearnsidesi was later pointed out by Dean (1963, p. 243) to be a result of crushing on the holotype. Dean (1962, p. 126, 1963, p. 245) has suggested that calvus and fearnsidesi may be conspecific, and drew attention to the similarity of cranidia from the Soudleyan of South Shropshire (figd. Dean, 1963, Pl. 45, Figs. 9-11) to the holotype of D. calvus. Dean (1962, p. 124) described Proetidella? marri from the Lower Longvillian of the Cross Fell Inlier, which he distinguished from D. fearnsidesi by the narrower frontal lobe of the glabella, its more transverse frontal margin and better differentiated preglabellar field and anterior border. There is some range in glabellar shape in marri (see Dean, 1962, Fig. 17, Figs. 5, 8), and some specimens are very close to D. calvus. Both calvus and marri can be distinguished from fearnsidesi on the well differentiated preglabellar field and anterior border, but it is difficult to distinguish marri and calvus from one another. On the present evidence, therefore, I prefer to consider marri and calvus as conspecific, and the latter is the senior synonym. The specimens listed in the synonymy are mostly regarded as D. calvus, agreeing with the diagnosis for this species (doubtful cases being specimens from the Bala area (see Whittington, 1966, pl. 25, Figs. 12, and Pl. 26, Figs. 2, 3, 5) and from the Stile End Beds (see Dean, 1963b Pl. 1, Figs. 8-9)). The species therefore has a range from the Soudleyan to the Marshbrokian (or Actonian) and seems to replace the earlier species D. fearnsidesi in the Anglo-Welsh area after the Harnagian. Relationships with D. avioclivalis and D. piriceps are discussed previously.

Decoroproetus fearnsidesi (Bancroft, 1949)
Plate 21, Figs. 22, 23, 27, 29.

1949 Proetidella fearnsidesi: Bancroft, p. 304, Pl. 10, Fig. 23.
1953 Decoroproetus fearnsidesi (Bancroft): Pribyl, p. 60.
1958 Decoroproetus fearnsidesi (Bancroft): Dean, pp. 201, 219.
1962 Proetidella fearnsidesi Bancroft: Dean, p. 126.
1963a Proetidella fearnsidesi Bancroft: Dean, p. 243, Pl. 45, Figs. 3-8, 12, 14.
1963b Proetidella fearnsidesi Bancroft: Dean, p, 55.
1966 Astroproetus fearnsidesi (Bancroft): Whittington, p. 81.

HOLOTYPE

Complete external mould (BM In. 42083), figd. Bancroft, Pl. 10, Fig. 23, Dean Pl. 45, Fig. 3. A silicone cast of this specimen is figured herein as Pl. 21, Figs. 22, 23.

MATERIAL

Two complete specimens, and numerous more incomplete exoskeletal remains.

TYPE STRATUM AND TYPE LOCALITY

Shaly mudstones of basal Harnagian, Reuscholithus reuschi zone, Old cartway near the southern end of Smeathen Wood, Horderley, Shropshire.

OCCURRENCE

Costonian stage, zone of Harknessella subquadrata, Harnagian stage, zone of Reuscholithus reuschi, South Shropshire (Horderley, Woolston and Harnage).

DIAGNOSIS

Glabella tapering evenly forwards with a well rounded frontal lobe, no lateral glabellar furrows; eye elongated, crescentic, eye socle weakly developed; cephalic border furrow weakly defined; pygidial axis with 6-7 clearly defined axial rings, pleural areas with 5 pairs of ribs; small postaxial ridge extends to margin.

DESCRIPTION

See Dean 1963a, p. 243.

DISCUSSION

This species is evidently closely related to the earlier D. pristinus sp. nov. (see below), from which it differs in having a less well defined cephalic border, a broader thoracic axis and more pygidial axial rings and pleural ribs. D. calvus (see above) is also close, and differences between it and D. fearnsidesi are pointed out above.

The type of D. fearnsidesi, and an additional specimen figured by Dean (1963a, Pl. 45, Fig. 8) are refigured here for comparison, as well as another complete specimen from the collections of the British Museum (Pl. 21, Fig. 27). It is likely that this specimen originates from, or near from the type locality, as the lithology is similar to that of the type.

A cranidium from the collections of the Geological Survey Museum, associated with specimens of D. fearnsidesi has 3 pairs of glabellar furrows (see Pl. 21, Fig. 24). The glabella is also constricted quite distinctly at 2p, and the anterior border is quite well defined. The nature and depth of the glabellar furrows distinguish this cranidium from both D. fearnsidesi and D. calvus, and it is probably a new species.

Decoroproetus irregularis (Kielan 1960)
Plate 21, Figs. 28,30

1960 Ogmocnemis irregularis n. sp.: Kielan, p. 70, Pl. 3 Figs. 6-9, Pl. 4, Figs. 8-9, Pl. 26 Fig. 1, Text Fig. 17, p. 71.

?1966 Decoroproetus (Ogmocnemis) cf. irregularis (Kielan): Ingham, p.473.

1966 Astroproetus irregularis (Kielan): Whittington, p. 81.

?1970 Astroproetus? cf. irregularis (Kielan): Ingham, Pl. 4 Figs. 34-38.

MATERIAL FROM BRITAIN

Two external moulds of cephala with some attached thoracic segments. Specimens figured by Ingham (1970); 4 cranidia and 1 free cheek, probably belong to this species.

HORIZON AND LOCALITIES

Ashgill (Rawtheyan, Zone 6), Upper Calcareous Shales below Wharfe conglomerate, Austwick Beck, just below Wharfe Mill Dam, near Austwick, N.W. Yorkshire, and Ashgill (Rawtheyan, Zone 6), Murthwaite and Westerdale Inliers, Cautley district (Ingham's specimens).

DISCUSSION

Ingham (1970, Pl. 4, Figs. 34-38) has recently figured specimens from the Ashgill (Rawtheyan, Zone 6) of the Cautley district as Astroproetus? cf. irregularis (Kielan). More complete material from a similar horizon at Austwick has been found in the collections of the Sedgwick Museum, Cambridge. Comparison between the holotype of D. irregularis (Kielan, 1960, Pl. 3, Fig. 8) and one of these specimens (Pl. 21, Fig. 30) reveals great similarity in glabellar outline, length of preglabellar field, degree of divergence of anterior branches of facial sutures and size of palpebral lobe, which is sufficient to assign the British specimen to D. irregularis. The second specimen from Austwick (Pl. 21, Fig. 28) presents a rather different appearance, due to lateral compression, but may also be assigned to D. irregularis. On the posterior margins of the thoracic axial rings of this specimen there is a line of granules, similar to those in P. girvanensis (see Pl. 19, Figs. 21-22). This feature is absent from other specimens of D. irregularis, but this may be due to preservation. Ingham's specimens from Cautley are likely to be referrable to D. irregularis, but more material is required before this can be demonstrated with certainty.

Decoroproetus jamesoni (Reed 1914)

Plate 22, Figs. 1-9, 12-14.

1914 Cyphaspis jamesoni sp. nov.: Reed, p. 27, Pl. 4, Fig. 8.

1925 ?'Phaetonides' jamesoni (Reed) Warburg, p. 186.

1931 Cyphaspis? jamesoni Reed: Reed, p. 15.

1940 Proetus vicinus sp. nov.: Reed, p. 159, Pl. 8, Fig. 1.

1947 Proetus (Eremiproetus?) reedi nom. nov.: pro Proetus vicinus Reed (non Barrande, 1872), Pribyl, p. 1, Text Fig. 1.

1947 Proetus ardmillanensis sp. nov. Begg, p. 42, Pl. 3, Fig. 3.

1951 Proetus balclatchiensis sp. nov. Begg, p. 362, Pl. 1, Fig. 1.

1951 Proetus trefoileum sp. nov. Begg, p. 364, Pl. 1, Fig. 2.

1951 Proetus sp. Begg, p. 365, Pl. 1, Fig. 3.

HOLOTYPE

A complete internal mould, with counterpart external mould (BM In 21971), figd. Reed, Pl. 14, Fig. 8, and refigured herein as Pl. 22, Figs. 1-4.

MATERIAL

The types of ardmillanensis, balclatchiensis, trefoileum and vicinus, and a few additional cranidia.

TYPE STRATUM AND TYPE LOCALITY

Balclatchie Mudstones (Caradocian), Balclatchie, Girvan, Ayrshire.

OCCURRENCE

Caradocian, Balclatchie Group, Balclatchie Mudstones, Girvan area (Balclatchie, Penwhapple Glen, Dow Hill and Glendrissaig), and equivalents of the Balclatchie Group at Grangegeeth, Co. Meath, Eire.

DIAGNOSIS

Glabella subquadrate, slightly constricted laterally and sometimes with weak lateral glabellar furrows; preglabellar field sigmoidal in lateral profile, between one quarter and one third of the sagittal length of the glabella; anterior border flat and upturned; anterior branches of the facial sutures quite strongly divergent; eye socle large, with median part of lower margin running exsagittally; genal spine broad based, with a deep median furrow; thorax of ten segments, with a strongly arched axis; pygidium subparabolic, without border and about twice as wide as long (sag.). Axis with 4/5 rings, pleural areas with ?3 pairs of ribs. Sculpture of fine, continuous striations.

DESCRIPTION

Cephalon subparabolic in outline, with a rather narrow, upturned border. Glabella of subquadrate outline, of almost equal length and breadth, defined by deep, conjoined lateral and preglabellar furrows, which shallow opposite the palpebral lobe. The glabella is widest opposite the posterior ends of the eyes, and at this point is about one third the width of the cephalon (trans.). It narrows forwards fairly rapidly to the bluntly rounded frontal lobe. In lateral and longitudinal profiles the glabella is moderately convex, with the frontal lobe bending down steeply to the preglabellar furrow. Three pairs of glabellar furrows, weakly impressed, can be seen on the type of ardmillanensis, two pairs on the type of trefoileum, and one pair on the counterpart of the type of jamesoni, but the distinctness is probably due to preservation, and in all cases the furrows are comparable in structure. 1p is situated opposite the middle of the palpebral lobe, and is directed backwards at angle of about 45° and reaches close to the occipiral furrow. 2p is situated at the anterior end of the palpebral lobe, and runs backwards in a similar direction to 1p. 3p is short, situated near the anterolateral corner of the glabella.

The occipital furrow is deep, flexed forwards weakly sagittally and more strongly laterally. The anterior and posterior slopes both rise up steeply from it. The occipital ring is rather narrow (sag.), flattened in lateral profile and rising up towards the posterior. In longitudinal profile it slopes down steeply from the sagittal region to the lateral extremities. There are no lateral occipital lobes.

The preglabellar field is between one quarter and one third of the sagittal length of the glabella, and is sigmoidal in lateral profile. The anterior border furrow is rather weak, its position emphasised by the change in slope between the downsloping preglabellar field and the upturned anterior border, which is flat in lateral profile. On the holotype the impression of the trapezoidal rostral plate is easily see (see Pl. 22, Figs. 1-2), and its connective sutures converge backwards. The right connective suture is seen on the type of balclatchiensis (see Pl. 22, Figs. 5, 8).

The anterior branches of the facial sutures are quite strongly divergent, with beta forming a wide, even curve. The posterior branches apparently have epsilon and zeta as one angle, from which they diverge to cut the posterior margin about half way from the axial furrow to the lateral margin. The palpebral lobe is poorly preserved on all the material studied, as is the eye, which is apparently reniform. It is ~~They are~~ situated close to the glabella in a posterior position, and approaches half the length of the glabella. The eye socle is large, with the median portion of the lower marginal furrow running nearly exsagittally. Anteriorly and posteriorly the lower margin diverges strongly from the upper (see Pl. 22, Figs. 1-2, 8 etc.).

The field of the free cheek is weakly convex, and is strongly declined from the eye region. The lateral border furrow and the lateral border are similar to the anterior. The posterior border furrow is considerably deeper than the anterior and lateral, and behind it the posterior border slopes steeply upwards from it. The genal spine is long, extending backwards as far as the sixth thoracic segment, and broad based. It is bisected by the deep median furrow.

The cephalic doublure is of similar width to the border, and is ventrally convex, with prominent, parallel terrace lines. On the right hand side of the glabella of the holotype the impression of the hypostome may be seen (see Pl. 22, Figs. 1-2). This has a strongly convex median body, and deep lateral border furrows.

The thorax has ten segments, with a strongly arched axis which tapers evenly backwards so that the last ring is a little under half the width (trans.) of the first. Each axial ring is arched weakly forwards, and in lateral profile is weakly convex. The pleura runs transversely from the axial furrow to the distal end, and bears a strong pleural furrow which produces a narrow anterior band and a wider posterior band. The pleura bends down quite steeply at the fulcrum, and the distal end is pointed.

The pygidium is rather small, subparabolic in outline, without a border and almost twice as wide as long. The axis is short, strongly convex in longitudinal profile and consists of four or five rings. It is uncertain if a postaxial ridge is present. The pleural areas seem to have three pairs of ribs, but it is difficult to judge, as the only pygidium known, that of the holotype, is poorly preserved.

The pygidial doublure extends as far inwards as the end of the axis, is ventrally convex and like the cephalic doublure has prominent parallel terrace lines.

The counterpart external mould of the holotype indicates that the exoskeleton is ornamented with fine, continuous striations.

DISCUSSION

Since Reed (1914, p. 27) erected jamesoni, other proetids from the Balclatchie Group have been described as Proetus vicinus Reed (non Barrande 1872), P. ardmillanensis, P. trefoileum, Begg, and P. balclatchiensis Begg. Examination of the types of these species, which are sometimes the only specimens of them, and comparison between them and jamesoni has revealed some variation in glabellar shape and prominence of glabellar furrows. This variation is not considered here to be of specific significance, but rather variation within the species, or the result of preservation and distortion. Hence all these Balclatchie proetids are considered to belong to only one species, and jamesoni is the senior synonym.

Reed (op. cit.) compared D. jamesoni with 'Cyphaspis' matutina Ruedemann and with 'C' parvula Pompecki. The latter is probably referrable to Warburgella, and so is not directly comparable with D. jamesoni. The former, although similar in glabellar outline, has a preglabellar field which is straight in lateral profile, unlike the sigmoidal profile in D. jamesoni. D. jamesoni is comparable with D. furubergensis Owens, 1970 (see Pl. 1, A-K, and Pl. 2, E, G-M) from the Middle Ordovicina of the Oslo region of Norway, and also with three 'Proetidella' (= Decoroproetus) species from the Middle Ordovician of Kentucky, recently described by Ross (1967, Pl. 2, Figs. 8-18). D. furubergensis differs from D. jamesoni in having a sculpture of discontinuous striations, but the shape and proportions of the cranidium and pygidium are similar. Ross's species have a much shorter preglabellar field, and are distinctive in being the only known species of Decoroproetus to possess a distinct pygidial border. If this feature is found to recur in other species, it may be worth separating them generically from Decoroporetus. The cephalon of D. jamesoni is quite similar to that of D. fearnsidesi, but the glabella has a different shape, and the cephalic border is more clearly differentiated. The pygidium of D. jamesoni is proportionately shorter than that of D. fearnsidesi and has less axial rings, four to five, compared with six/seven in the latter. There also seem to be less pleural ribs in D. jamesoni. Closest affinities, therefore, are with American and Norwegian, rather than Anglo-Welsh species.

Decoroproetus mactaggarti (Begg, 1946)
Plate 22, Figs. 10, 11, 16, 17.

1946 Proetus mactaggarti sp. nov.: Begg, p. 40, Pl. 3, Figs. 1-2.

HOLOTYPE

A complete internal mould (HM A 3961), figd. Begg, Pl. 3, Figs. 1-2, and refigured herein as Pl. 22, Figs. 16-17.

MATERIAL

Besides the type, 3 complete internal moulds, one with a counterpart external mould.

TYPE STRATUM AND TYPE LOCALITY

Ashgill (late Rawtheyan), Upper Drummuck Group, a few feet above starfish bed no. 3, Lady Burn, Girvan.

OCCURRENCE

Upper Drummuck Group, Girvan district, Ayrshire.

DIAGNOSIS

Very similar to D. modestus (Törnquist) from which it differs in having less divergent anterior branches of the facial sutures, a more bluntly rounded frontal lobe of the glabella, a less distinct eye socle, and one more pygidial pleural rib.

DESCRIPTION

The cephalon is weakly vaulted, subparabolic in outline with a rather narrow, upturned border. The glabella is about one third of the total cephalic width at its posterior end, tapering forwards gently from the rounded posterolateral angles to the bluntly rounded frontal lobe. It is somewhat longer than wide, weakly convex in lateral and longitudinal profiles and defined by narrow, conjoined axial and preglabellar furrows. No lateral glabellar furrows are apparent on any of the specimens.

The occipital furrow is somewhat deeper than the axial and preglabellar furrows, and is flexed forwards very slightly sagittally, and more strongly laterally. The occipital ring is about three quarters of the width (sag.) of the preglabellar area, and maintains more or less the same width laterally. Transversely it is about the same width as the glabella. It is almost flat in lateral profile, and in longitudinal profile it is bent downwards quite strongly at the lateral ends. There are no lateral occipital lobes.

The preglabellar field is short (sag.), about one fifth of the sagittal length of the glabella, gently declined from the preglabellar furrow to the ill defined anterior border furrow, which is marked merely by a change in slope between the declined preglabellar field and the weakly convex, upturned anterior border. The anterior branches of the facial sutures diverge weakly at a nearly constant angle after running nearly parallel for a quarter of the eye length in front of gamma. The stretch gamma to beta is straight, and an exsagittal line drawn backwards from beta, falls on the outer part of the palpebral lobe. The posterior branches run close to and parallel with the axial furrows for a short distance behind the eyes, with epsilon and zeta as independent angles. On reaching the posterior border furrow they diverge strongly to cut the posterior margin about half way between the axial furrow and the lateral margin.

The palpebral lobe is small and narrow. The eye is narrow and crescentiform, lying posteriorly and close to the glabella and a little under half its length on the holotype. The anterior end of the eye lies about half way up the glabella. There is a narrow, rather poorly defined eye socle, whose lower margin is defined by a shallow furrow which diverges markedly from the upper margin at either end. The field of the free cheeks is rather broad, gently convex and gently declined from the eye region to the lateral border furrow. The lateral border furrow is wide, shallow and non-incised, and the lateral border is narrow and weakly convex. The posterior border furrow is deeper than the lateral, and from it the weakly convex posterior border is inclined backwards. It is wider than the lateral border, and maintains about the same width (exsag.) along its length. The long, narrow, genal spine extends backwards as far as the sixth thoracic segment, and apparently bears a narrow, shallow median groove.

The thorax consists of ten segments. The axis is rather narrow, strongly convex longitudinally, and tapers backwards so that the last axial ring is about half the width (trans.) of the first. In lateral profile each ring is almost flat and very gently inclined towards the posterior. The axial furrow is non incised, but distinct. The pleurae run straight abaxially from the axial furrow, and curve gently backwards and are gently declined at the fulcrum. The posterolateral corner terminates in a short, backwardly directed spine. Each pleura is traversed by a deep pleural furrow, which runs almost parallel with the inter-pleural furrow on the proximal part of the pleura, but curves more strongly backwards abaxially, where the anterior pleural band widens at the expense of the posterior. The pleural furrow dies out just before reaching the abaxial end of the pleura. The posterior pleural band is wider than the anterior for most of the length of thepleura, but the latter is wider abaxially. In lateral profile the posterior pleural band is flat and gently inclined towards the posterior, while the anterior is slightly convex and is strongly declined to the pleural furrow. Thus the pleural furrow has a steep anterior slope and a shallow posterior slope.

The pygidium is subparabolic, about twice as wide as long, and without a border. Anteriorly the axis is about two sevenths of the total pygidial width. It is narrow and strongly convex longitudinally, tapering very gradually backwards to a blunt point, not quite reaching the posterior margin. A small postaxial ridge is present, extending from the end of the axis to the margin. There are at least 5 axial rings, separated by weak interannular furrows. The first ring is narrower and elevated higher than the remainder. The pleural areas are convex, with 5 pairs of ribs, and sometimes the anterior pleural band of a sixth. The pleural furrows are distinct, with a steep anterior slope and shallow posterior slope, the former increasing in height abaxially, reaching its greatest height about two thirds of the abaxial distance from the axial furrow. The interpleural furrows are obscure, but they can be detected on the first two pairs of ribs on theholotype. Adaxially they curve backwards less strongly than the pleural furrows, but abaxially they curve backwards more strongly. Each pleural rib widens distally, and curves strongly backwards. The anterior pleural band is elevated higher than the posterior in lateral profile, and each band is inclined towards the posterior.

The pygidial and cephalic doublures are rather narrow, weakly ventrally convex and bear distinct, subparallel terrace lines.

On none of the specimens is there evidence of much of the original surface sculpture, but an external mould (BM In 40922) does show traces of fine raised striations.

DISCUSSION

Decoroproetus mactaggarti (Begg) is very similar to D. modestus (Törnquist), from the Boda Limestone of Sweden, and must be very closely related. D. asellus (Esmark), with which D. modestus may be synonymous, is also very similar. All three of these species also show considerable similarity to D. decorus (Barrande) (cf. Pl. 8, Fig. D, Pl. 10, Figs. K, L, Pl. 22, Figs. 10, 11, 16, 17 and Pl. 45, Figs. 9-13), and also to D. fearnsidesi (Bancroft) (see Pl. 21, Figs. 22, 23, 27, 29), although this last species has a broader thoracic axis, which does not taper so evenly backwards. The species fearnsidesi, asellus, modestus and decorus seem to be on the main evolutionary line of Decoroproetus.

Decoroproetus piriceps (Ingham, 1970)

Plate 21, Fig. 25.

1948 Proetus sp.: King and Williams, p. 210.

1966 Proetidella sp. nov. Ingham, p. 498.

1970 Astroproetus? piriceps sp. nov. Ingham, Pl. 4, Figs. 20-26, 28, 30-32.

HOLOTYPE

A cranidium (HUD 2.56), figd. Ingham, Pl. 4, Fig. 21.

MATERIAL

Several cranidia, pygidia and free cheeks. One pygidium with 6 attached thoracic segments.

TYPE STRATUM AND TYPE LOCALITY

Ashgill (Cautleyan, Zone 1), Sally Brow, near Cautley.

OCCURRENCE

Ashgill (Cautleyan and ?Pusgillian), Cautley district, N.W. Yorkshire.

DISCUSSION

Ingham (1970) has recently described and figured this species as Astroproetus? piriceps sp. nov., but its characters are in agreement with the new diagnosis for Decoroproetus given here, and so it is assigned to that genus. This species is considered here to be closely related to D. avioclivalis and D. calvus, and details are discussed under the former.

Decoroproetus pristinus sp. nov.

Plate 22, Figs. 19, 24, 28, 29, 30, Plate 23, Figs. 1-12, 19.

1963 Proetidella sp. MacGregor, p. 795, Pl. 116, Figs. 11-13.

HOLOTYPE

A cranidium (SMC A 46912), figd. MacGregor Pl. 116, Fig. 13, and refigured herein as Pl. 22, Fig. 28.

MATERIAL

Two complete specimens (of unknown origin), several cranidia, free cheeks and pygidia. Also some early holaspid cranidia and pygidia. Many of these specimens are silicified.

TYPE STRATUM AND TYPE LOCALITY

Upper Llandeilo, 200 yards NNW of Nant, 1 mile S of Llanrhaiadr-ym-Mochnant, Montgomeryshire.

OCCURRENCE

Llandeilo, Montgomeryshire, Llandeilo district and SE Pembrokeshire.

DERIVATION OF THE NAME

From the Latin pristinus, early, original, as this is the earliest known species of Decoroproetus.

DIAGNOSIS

Glabella tapers evenly forwards with well rounded frontal lobe; 1p and 2p lateral glabellar furrows rarely apparent; preglabellar field short (sag.), narrower than the anterior border; anterior border furrow weak, lateral border furrow a little deeper and more clearly defined; thorax of 10 segments; pygidial axis with 4/5 rings, separated by weak, shallow interannular furrows; 4 pairs of pleural ribs; eye socle with a weak lower marginal furrow.

DESCRIPTION

The following points may be added to the description given by MacGregor (1963, p. 795): The anterior branches of the facial sutures are more divergent than MacGregor (p. 796) suggests. Two complete specimens (Pl. 23, Figs. 2, 3) have 10 thoracic segments. The axis tapers evenly backwards so that the last ring is little over half the width (trans.) of the first, and longitudinally the axis is moderately convex. Each ring is arched forwards very weakly sagittally, and has a deep distinct articulating furrow. There is no preannulus. Anteriorly the axis is wider than the pleurae, but posteriorly the latter are wider. The pleurae run nearly straight (trans.) out from the axial furrow, and curve only very gently backwards. They are gently declined at the fulcrum. Each pleura has a wide, distinct pleural furrow which dies out shortly before reaching the abaxial extremity. The posterior pleural band is wider (exsag.) than the anterior, and is gently inclined backwards from the pleural furrow. The anterior pleural band is gently convex, and is quite steeply declined to the pleural furrow, giving it a steep anterior slope. The posterolateral corners of the pleurae are angular.

One specimen (Pl. 23, Fig. 2) shows the trapezoidal rostral plate quite distinctly where the anterior border has been damaged.

This species seems to have the entire exoskeleton covered with very fine, raised striations.

DISCUSSION

This species differs from the closely related D. fearnsidesi in the features indicated under that species. It differs from D. calvus in the shorter, less distinct preglabellar field, more poorly defined anterior border, and shallower interannular furrows on the pygidial axis, which has less rings.

D. pristinus, from the Llandeilo, is the earliest species of Decoroproetus. Since MacGregor (1963, p. 795) described material from Montgomeryshire as Proetidella sp., more specimens have come to light. In the collections at Oxford University Museum two complete specimens (Pl. 23, Figs. 2 and 3) have been found. Unfortunately, these specimens are unlabelled, but Professor H.B. Whittington and Dr. C.P. Hughes have examined the surrounding matrix, which contains fragmentary trinucleids, and are of the opinion that they are probably of Llandeilo age.

From the Llandeilo of Llandeilo and Pembrokeshire, silicified specimens have been dissolved out with dilute acetic acid. These specimens are of particular interest as several early growth stages are present. The smallest cranidia (Pl. 23, Figs. 8-11) have an elongated, finger shaped glabella and a long palpebral lobe placed some distance out from the axial furrow. These specimens are of great interest as they are exceedingly like the similar sized cranidia belonging to Proetus pluteus figured by Whittington and Campbell (1967, Pl. 1, Figs. 23, 24, 30, 31) and text fig. 6C, p. 464). This demonstrates a close relationship between the genera Proetus and Decoroproetus. Small pygidia (Pl. 23, Figs. 4-7) are also like those of P. pluteus (see Whittington and Campbell, Pl. 3, Figs. 6-8, 10, 13-16). One specimen (Pl. 23, Figs. 4-5) is closer to those of P. pluteus in the rib structure than the other (Pl. 23, Figs. 6-7), which has ribs more like the adult D. pristimus. The former specimen also has a distinct pygidial border.

Stereoscan pictures showing details of the doublure and terrace lines are included in the Appendix, where they are fully discussed.

Decoroproetus aff. subornatus (Cooper and Kindle, 1936)
Plate 22, Figs. 15, 20-23, 25-27.

1932 Proetus cf. kullsbergensis Warburg, King, p. 104.

BRITISH MATERIAL

Three cranidia, two free cheeks.

OCCURRENCE

Ashgill (Cautleyan), Keisley Limestone, Keisley, and limestone of Horton Neptunean dyke, rail cutting south of Horton in Ribblesdale railway station.

DESCRIPTION

Cranidium with the palpebral width about three quarters of the sagittal length. Glabella subquadrate, as long as wide, tapering weakly forwards and slightly constricted opposite the anterior end of the palpebral lobe, with the frontal lobe bluntly rounded. The glabella is defined by narrow, but distinct conjoined axial and preglabellar furrows. In longitudinal profile it is weakly convex, sloping down gently to the preglabellar furrow. In longitudinal profile it is moderately convex. Three pairs of lateral glabellar furrows are present, more clearly defined on some specimens than on others. 1p sometimes weakly impressed, and crescentiform with its anterior end opposite the centre of the palpebral lobe and the posterior end reaching close to, but not running into the occipital furrow. 2p is situated opposite gamma, directed slightly backwards and is club shaped. 3p is a short distance in front of 2p, and is shorter and directed slightly backwards.

The occipital furrow is rather deep, with a steep anterior slope and a shallow posterior slope. Its median portion runs more or less transversely, but the lateral ends are bent quite strongly forwards. The occipital ring is rather broad (sag.), where it is a little longer than the preglabellar field. The posterior margin curves quite strongly forwards laterally, producing transverse narrowing of the occipital ring. The occipital ring is slightly wider (trans.) than the glabella. In lateral profile it rises gently upwards from the occipital furrow, and is more or less straight. In longitudinal profile it bends down steeply to the lateral ends. In the centre is a small median tubercle.

The preglabellar field is between one quarter and one fifth the length of the glabella (sag.). In lateral profile it is concavo-convex. The anterior border furrow is wide and shallow, and the anterior border is weakly convex and upturned, slightly narrower (sag.) than the preglabellar field. The anterior branches of the facial sutures are weakly divergent, with gamma close to the axial furrow. An exsagittal line drawn backwards from beta falls on the palpebral lobe. The posterior branches lie close to the axial furrow behind the palpebral lobe, and diverge strongly on the posterior border to cut the posterior margin a short distance inwards from the base of the genal spine. The palpebral lobe is rather large, slightly less than one half the length of the glabella, and crescentic in outline. In longitudinal profile it rises up quite steeply from the axial furrow, flattening out distally. The eye is apparently crescentiform, but it is not preserved on any of the available material. It is supported on a distinct eye socle, whose lower margin is incised. The median part of the lower margin runs almost exsagittally, while the anterior and posterior ends run almost parallel to the upper margin.

The field of the free cheek is rather narrow and weakly convex. The lateral border furrow is rather narrow and quite deep, and the posterior is of similar width and depth, shallowing near the base of the genal spine. The lateral border is moderately wide and weakly convex, while the posterior border is a little wider. The genal spine is rather narrow and moderately long, with a short median furrow which quickly shallows and dies out about one third of the way along. The cephalic border has two parallel continuous raised ridges running along the margin. The doublure is ventrally convex and bears a number of strong, parallel terrace lines.

The whole cephalon is covered with fine, raised striations, arranged in a Bertillon pattern on the glabella and occipital ring. They are arranged transversely on the preglabellar field, and run backwards and outwards on the field of the free cheek, turning forwards on the lateral border. On the palpebral lobe they run forwards and outwards, and on the eye socle run moreor less parallel with the upper margin.

DISCUSSION

The description given above is based on the British specimens. Comparison between these and a topotype cranidium of D. subornatus, whose cast was kindly sent to the author by Professor P.J. Lesperance, has shown that there is very little difference between it and the British specimens. However, I have not seen any free cheeks from D. subornatus, and for this reason have described the British material as Decoroproetus aff. subornatus. If the British specimens do not belong to the same species as the Canadian, then they are certainly very closely related.

One of the characteristic features of D. aff. subornatus is the distinctive eye socle. Other species with a similarly shaped eye socle include D. papyraceus (Törnquist) from the Fjäcka Shale of the Siljan district, Sweden and D. avioclivalis sp. nov. from the Birdshill Limestone (see above). Species with this type of eye socle seem to form a well defined group within Ordovician representatives of Decoroproetus, although other features, such as glabellar shape are rather variable.

Decoroproetus sp. E

1962 Proetidella sp.: Tripp, p. 13, Pl. 2, Fig. 15.

HORIZON AND LOCALITY

Caradoc (confinis flags), Kirkdominae, Girvan district, Ayrshire.

DISCUSSION

From the single, ill preserved cranidium, it is difficult to compare this with other Decoroproetus species.

Decoroproetus sp. F

Plate 23, Figs. 15-16.

1967 Proetidella sp. A.: Tripp, p. 52, Pl. 2, Figs. 13-14.

HORIZON AND LOCALITIES

Caradoc (Upper Stinchar Limestone), Auchensoul and Aldons, Girvan district, Ayrshire.

DISCUSSION

The long preglabellar field and subquadrate glabella of this species are similar to the later Decoroproetus jamesoni from the Balclatchie Mudstones. There seem to be two pairs of weakly impressed lateral glabellar furrows, with 1p opposite the centre of the palpebral lobe and 2p opposite gamma. Lateral glabellar furrows are seen on some specimens of D. calvus, but are apparently absent from other early Caradoc species, including D. jamesoni and D. fearnsidesi.

Decoroproetus sp. G

Plate 23, Figs. 13, 17, 18.

1967 Proetidella sp. B.: Tripp, p. 53, Pl. 2, Figs. 15-17.

1970 'Proetidella sp. B' Tripp, Owens (in press)

HORIZON AND LOCALITY

Caradoc (Upper Stinchar Limestone), Aldons, Girvan district, Ayrshire.

DISCUSSION

This species is compared by the author (1970) to D. gyratus Owens in its glabellar outline (cf. Pl. 23, Figs. 17-18 and Pl. 2, A, B, D), but detailed comparison must await more material of both species.

Decoroproetus sp. H

Plate 23, Fig. 14.

MATERIAL

One internal mould of a free cheek (BM It. 8843).

HORIZON AND LOCALITY

Ashgill, by SE bank of Stockdale Beck, just below the junction with Brow Gill, Long Sleddale, Westmorland.

DISCUSSION

This single proetid free cheek seems to belong to Decoroproetus. The anterior branch of the facial suture appears to run almost exsagittally in front of the eye, which is rather large. These features are not immediately close to any established species, and a new species may be represented.

Genus *Astroproetus*, Begg 1939

Synonym: *Clypoproetus*, Begg 1939

Type species: *Astroproetus reedi* Begg 1939

DIAGNOSIS

Cephalon with well defined or rather shallow anterior border furrow. Preglabellar field always present, between one quarter and one seventh of the length of the glabella, sigmoidal or straight in lateral profile. Glabella tapering forwards evenly, not constricted laterally, sometimes with shallow lateral furrows. Occipital ring with distinct lateral lobes. Rostral plate trapezoidal, with the connective sutures converging backwards. Thorax with 9-10 segments, the pleurae pointed distally. Pygidium with rather narrow axis, with 7-8 rings and a short postaxial ridge. Pleural areas with 5-6 pairs of ribs which widen slightly distally. Pleural furrows deeper than the interpleural furrows, deepening only slightly distally, and curving gently backwards. Interpleural furrows faint, running more or less parallel with the pleural furrows. Sculpture smooth, finely granular or pitted.

Species: *A. reedi* Begg; *A. asteroideus* (Begg); *A. tertius* (Maximova); *A. bellus* (Maximova); *A. subtriangularis* (Begg); *A. scoticus* (Reed); *A. interjectus* (Reed); *A. pseudolatifrons* (Reed); and a number of undescribed species from Norway and Quebec.

DISCUSSION

The difference between this genus and *Decoroproetus* are pointed out above. *Astroproetus*, particularly the type species, *A. reedi* is quite similar to *Warburgella*, Reed 1931, a similarity appreciated by Whittington (1966, p. 82) and by Ormiston (1967, p. 62), who considered that *Astroproetus* may be a junior synonym of *Warburgella*. However, all species of *Warburgella* possess deep lp furrows and a tropidium, features which are not found on any species of *Astroproetus*, and these features suffice to justify keeping these two genera distinct. It seems likely, however, that *Astroproetus* may be ancestral to *Warburgella*.

The genus *Clypoproetus*, Begg 1939, type species *C. asteroideus* Begg, can justifiably be regarded as a synonym of *Astroproetus*, as there is not enough basis to separate it generically from *Astroproetus*.

The first record of *Astroproetus* is from the late Rawtheyan Upper Drummuck Group of the Girvan district, where two species are present, *A. reedi* Begg, and *A. asteroideus* (Begg). In the Ordovician, *Astroproetus* is unknown outside this region. In the Silurian, *Astroproetus* is quite widespread in the Llandovery, and it is known from the Girvan area, Quebec, Norway and the Siberian Platform. British Silurian species are described in Chapter 4.

OCCURRENCE

Upper Ordovician-Lower Silurian, British Isles, Quebec, Norway, Siberian Platform.

Astroproetus reedi Begg 1939

Plate 23, Figs. 20-25, Plate 24, Figs. 1-3.

1939 Proetus (Astroproetus) reedi Begg p. 375, Pl. 6, Fig. 2.

1950 Proetus fardenensis Begg, p. 285, Pl. 14, Figs. 1-2.

1966 Astroproetus reedi Begg: Whittington, p. 81, Pl. 25, Figs. 7, 10, 11.

1967 ?Warburgella reedi (Begg): Ormiston, p. 62.

HOLOTYPE

A complete internal mould (HM A 1082), figd. Begg, Pl. 4, Fig. 2, Whittington Pl. 25, Figs. 7, 10, 11 and refigured herein as Pl. 23, Figs. 21-22.

MATERIAL

Eight complete or near complete internal moulds, two of which have counterpart external moulds.

TYPE STRATUM AND TYPE LOCALITY

Ashgill (late Rawtheyan), Upper Drummuck Group, Starfish Bed No. 2, Lady Bunn, Girvan.

OCCURRENCE

Upper Drummuck Group, Girvan district.

DIAGNOSIS

Glabella coniform, longer or as long as wide; poorly developed 1p furrows sometimes apparent; eye large, backwardly placed; preglabellar field moderately long, sigmoidal; occipital ring with small, rounded lateral occipital lobes; thorax of 10 segments; pygidial axis with 7 rings, separated by shallow furrows, pleural areas with 5 pairs of pleural ribs.

DESCRIPTION

The exoskeleton is elongated and moderately vaulted. The cephalon is parabolic in outline with a rather narrow, weakly convex border. The glabella is broadly conical, as long or a little longer (sag.) than wide (trans.), defined by narrow conjoined axial and preglabellar furrows, with the former becoming wider and shallower at the palpebral lobes. The glabella expands forwards from the bluntly rounded posterolateral angles as far as the centre of the palpebral lobes, and then tapers quite rapidly forwards to the bluntly pointed frontal lobe. In lateral and longitudinal profiles the glabella is gently convex, with the extreme anterior edge bending down steeply to the preglabellar furrow. Indistinct 1p furrow is evident on the holotype, beginning opposite the anterior part of the palpebral lobe and directed strongly backwards to meet the occipital furrow about two thirds of the way from the axial furrow to the sagittal line.

The occipital furrow is deeper and wider than the axial furrow, and is arched forwards weakly sagittally and laterally. The anterior slope is inclined at about 90°, while the posterior slope is inclined at about half this angle. The occipital ring is slightly wider (sag.) than the anterior border, and maintains the same width laterally (exsag.). Transversely it is as wide as the glabella. In lateral profile the occipital ring is gently convex and inclined towards the posterior. The small rounded lateral occipital lobes are rather prominent, and can be well seen on the external surface (Pl. 23, Figs. 25). None of the specimens show a median tubercle, but its absence may be apparent rather than real.

The preglabellar field is about a quarter of the sagittal glabellar length, and is sigmoidal in lateral profile. The anterior border furrow is rather shallow, and from it the rather narrow, weakly convex anterior border is inclined towards the anterior at a low angle. The anterior branches of the facial sutures run parallel for a short distance at gamma and then diverge strongly so that an exsagittal line drawn backwards from beta falls on the abaxial edge of the eye. The stretch gamma-beta is almost straight, and beta is a rounded acute angle. The posterior branches have epsilon and zeta as independent angles, with the former close to the posterolateral corner of the glabella and the latter opposite the centre of the lateral occipital lobe. The short stretch epsilon-zeta runs close to, and parallel with the axial furrow, and from zeta the suture turns strongly abaxially to cut the posterior margin about half way between the axial furrow and the lateral margin.

The palpebral lobe is large, subsemicircular in outline and about a third of the sagittal length of the glabella. It is inclined at about

45° to the axial furrow and flattens abaxially. The eye is prominent, crescentic and elevated almost to the height of the sagittal region of the glabella. There is no distinct eye socle.

The field of the free cheek is quite strongly convex. The lateral border furrow is of similar breadth and depth to the anterior. The lateral border is a little wider than the anterior, and is gently inclined and weakly convex. The posterior border furrow is narrow and rather deep, adaxially meeting the axial furrow opposite the lateral occipital lobe, and abaxially truncated at the base of the genal spine. The posterior border is about the same width as the anterior, gently inclined towards the posterior and widening slightly abaxially. The genal spine is broad-based and extends backwards as far as the sixth thoracic segment. It appears to have a wide shallow median groove, which is a backward continuation of the lateral border furrow.

The cephalic doublure is narrow and strongly ventrally convex, ornamented with prominent, parallel terrace lines. The rostral plate (well seen on the holotype (Pl. 23, Figs. 21-22), and on another specimen (Pl. 23, Fig. 20) is narrow (sag. and exsag.), trapezoidal and elongated transversely, with the connective sutures converging backwards.

The thorax consists of 10 segments. The axis tapers evenly backwards so that the last ring is about half the width (trans.) of the first. Anteriorly it is a little wider than the pleurae, but posteriorly is distinctly narrower. Longitudinally the axis is quite strongly convex. In lateral profile each axial ring is gently convex. Each ring is arched forwards weakly sagittally and laterally. The pleurae run weakly backwards abaxially, and are gently declined at the fulcrum. Each pleura has a narrow, distinct pleural furrow, which runs more transverse than the pleura itself. The anterior and posterior pleural bands are of almost equal width (exsag.), and the pleural furrow is truncated by the posterior edge of the articulating facet, near the abaxial end of the pleura. The posterolateral angle of the pleura is angular.

The pygidium is subparabolic in outline, with a strongly longitudinally convex weakly tapering axis, which is about a quarter of the total pygidial width anteriorly. The axis does not quite reach the posterior margin, and between it and the latter is a narrow postaxial ridge. There seem to be 7 axial rings, separated by rather shallow interannular furrows. The first is narrower and elevated higher than the remainder, and all are gently convex in lateral profile. The pleural areas are gently convex, with 5 pairs of pleural ribs, which curve gently backwards and widen somewhat abaxially. The pleural furrows are narrow and distinct, and have the same depth along their length. The interpleural furrows are very faint, and run almost parallel with the pleurae. Both pleural and interpleural furrows die out before reaching the margin. The anterior and posterior pleural bands are of more or less equal width (exsag.) and convexity. The pygidial doublure is wider and less convex ventrally than the cephalic doublure, and like it is ornamented with fine, parallel terrace lines.

One specimen (Pl. 23, Fig. 20) has had the glabella damaged, and shows the external mould of the hypostome. This has a strongly convex median body, rather deep lateral border furrows, prominent anterior wings and a strongly forwardly curved anterior margin. The shoulder is prominent, and extends abaxially as far as the anterior wing. The posterior margin seems to be more or less transverse.

DISCUSSION

Search through collections in the British Museum (Natural History) has revealed several additional specimens of A. reedi, which was hitherto only known from the type specimen. Some of these specimens have counterpart external moulds, which demonstrate with certainty the presence of lateral occipital lobes, which Whittington (1966, p. 81) suspected were present, and the absence of a tropidium, which Ormiston (1967, p. 63) suggested might be present. These external moulds also indicate that the external surface is smooth. These three characters have enabled a more accurate diagnosis to be drawn up for Astroproetus, and demonstrate further distinctions between it and Decoroproetus and Warburgella.

Proetus fardenensis Begg is considered here to be conspecific with A. reedi. The type of this species (see Pl. 24, Figs. 2-3) does show a proportionately broader glabella and thoracic axis than that of A. reedi, but a continuous range of specimens between these two extremes is available, and there is little justification for retaining them as independent species. After Paraproetus girvanensis, Astroproetus reedi is the next most abundant proetid in the Upper Drummuck Group at Girvan, but its numbers are considerably fewer.

Astroproetus asteroideus (Begg 1939)

Plate 24, Figs. 4, 5, 6, 8.

1939 Proetus (Clypoproetus) asteroideus Begg, p. 374, Pl. 6, Fig. 1

(? non Fig. 3).

1966 Astroproetus asteroideus (Begg) Whittington, p. 81, Pl. 25, Figs. 8, 9, 13.

HOLOTYPE

A small, almost complete internal mould (HM A 1080), figd. Begg, Pl. 6, Fig. 1, Figd. Whittington Pl. 25, Figs. 8, 9, 13, and refigured herein as Pl. 24, Figs. 5-6.

MATERIAL

Besides the type, 3 complete internal moulds, and 1 small cephalon with 4 attached thoracic segments.

TYPE STRATUM AND TYPE LOCALITY

Ashgill (late Rawtheyan) Upper Drummuck Group, Starfish Bed No. 2, Lady Burn, Girvan.

OCCURRENCE

Upper Drummuck Group, Girvan district.

DIAGNOSIS

This species is close to A. reedi, from which it differs in the following ways: convex rather than sigmoidal preglabellar field; thorax with 9 segments; pygidial interannular furrows and pleural and interpleural furrows deeper; rostral plate less elongated (trans.) and proportionately longer (sag.).

DISCUSSION

Begg (1939, Pl. 6, Fig. 3) figured an additional specimen besides the type of this species (see Pl. 24, Fig. 7), which he assigned to asteroideus. This specimen, however, has a rather long, sigmoidal preglabellar field, a pyriform glabella and very ill defined cephalic border furrows. It is badly preserved, but it is doubtful if it belongs to A. asteroideus or A. reedi, and it is probably a new species.

Four specimens of A. asteroideus have been identified in the British Museum (Natural History) collections which are both better preserved than the type, and demonstrate that this species does have 9 thoracic segments. One specimen (Pl. 24, Fig. 8) has two pairs of shallow, backwardly curved lateral glabellar furrows. The differences between A. asteroideus and A. reedi (see above) are small, and they may be sexual rather than specific.

Subfamily UNCERTAIN

Genus CYPHOPROETUS Kegel, 1927

Type species: Cyphaspis depressa Barrande 1846

Cyphoproetus facetus Tripp, 1954
Plate 24, Figs. 18-21, 23, 24

1954 Cyphoproetus? facetus n. sp. Tripp, p. 671, Pl. 3, Figs. 13-20.

HOLOTYPE

A cranidium (HM A 3903), figd. Tripp Pl. 3, Figs. 13a-c and refigured herein as Pl. 24, Fig. 21.

MATERIAL

Cephalon with 5 attached thoracic segments, 31 cranidia, 17 free cheeks, ?2 hypostomes, 9 pygidia (see Tripp, p. 671).

TYPE STRATUM AND TYPE LOCALITY

Caradoc, Craighead (Kiln) Mudstones, Craighead Quarry,, near Girvan, Ayrshire.

OCCURRENCE

Only at the type locality.

DIAGNOSIS

Glabella with incompletely isolated basal lobes; lateral occipital lobes absent; anterior border narrow, weakly convex, anterior border furrow deep; sculpture of very fine striations and sporadic granules.

DESCRIPTION

See Tripp, p. 671.

DISCUSSION

Cyphoproetus facetus is of interest as it is the earliest known species of Cyphoproetus, which may have important implications in early proetid phylogeny (see Chapter 9). Unlike C. depressus from the Silurian, C. facetus seems to lack the preannulus. Tripp (p. 672) has pointed out similarities between C. facetus, C. bellus (Cooper and Kindle) and C. extermus Reed. Also similar is C. rotundatus (Begg), from the Upper Ordovician of Girvan (see below).

Tripp (Pl. 3, Fig. 19), figured a hypostome which he considered might belong to C. facetus, and figured a further hypostome (Pl. 3, Fig. 10) as "hypostome B". The latter hypostome is not unlike the one Tripp considered to belong to C. facetus, and is certainly a proetid. It is likely that both these specimens belong to C. facetus. The only other possible proetids Tripp records from the same locality are two spinose pygidia (Pl. 3, Figs. 11-12). Of these, Figure 11 may be a transitory lichid pygidium, ~~but~~

Cyphoproetus rotundatus (Begg 1939)
Plate 24, Figs. 10-12, 14, 16, 17.

1939 Warburgella rotundata Begg, p. 378, Pl. 6, Figs. 4-6
1967 ?Warburgella rotundata Begg: Ormiston, p. 62.

HOLOTYPE

A complete internal mould (HM A 1084) figd. Begg, Pl. 6, Fig. 6, and refigured herein as Pl. 24, Figs. 10, 11, 16, 17.

MATERIAL

Two complete internal moulds.

TYPE STRATUM AND TYPE LOCALITY

Ashgill (late Rawtheyan), Upper Drummuck Group, Starfish Bed No. 2, Lady Burn, Girvan.

OCCURRENCE

Upper Drummuck Group, Girvan district.

DIAGNOSIS

Very similar to C. facetus, from which it differs in: a more campanulate glabella, with more rounded, prominent basal lobes, separated by a slightly deeper furrow, and a larger number of pygidial axial rings.

DESCRIPTION

The cephalon is subparabolic in outline, with a rather narrow, weakly convex border. The glabella is campanulate, a little wider (trans.) than long and defined by narrow, distinct conjoined axial and preglabellar furrows, which widen and shallow at the palpebral lobes. The glabella is very weakly convex in lateral profile, and more strongly convex in longitudinal profile. From the rounded posterolateral corners the axial furrows curve abaxially round the basal lobes, and then converge quite strongly towards the anterior. The glabella is constricted at the anterior end of 1p, and the frontal margin is bluntly rounded or nearly transverse. 1p furrow is prominent, with its anterior end joining the axial furrow opposite the anterior end of the palpebral lobe. It is deepest at mid-length, and shallows again before running into the occipital furrow. It is disected backwards at an angle of between 25° and 40° to an exsagittal line, and defines a distinct, rounded, partially isolated basal glabellar lobe, which has independent convexity from the remainder of the glabella. The basal lobe is about threequarters as wide (trans.) as it is long (exsag.), and is about five twelfths the sagittal length of the glabella, and is a little over a quarter of its basal width. If additional lateral glabellar furrows are present, they are not preserved.

The occipital furrow is rather narrow and shallow, with the anterior and posterior slopes inclined at about 45°. The median portion is nearly transverse, while laterally it curves backwards behind the basal glabellar lobes before curving forwards at the extremities. The occipital ring is rather narrow, almost flat in lateral profile and gently inclined towards the posterior. There do not appear to be any lateral occipital lobes. There is no preglabellar field, and the anterior border furrow merges with the preglabellar furrow. The anterior branches of the facial sutures are nearly parallel, with the stretch gamma-beta straight. Gamma lies close to the axial furrow. The posterior branches seem to run close to the axial furrows behind the eyes, and then diverge strongly on the posterior border to cut the margin about a third of the way from the axial furrow to the lateral margin. The palpebral lobe is large, almost semicircular in outline and backwardly placed, elevated almost to the height of the sagittal region of the glabella. The eye is crescentic, with a strongly convex visual surface, and is about half the sagittal length of the glabella. There might be an indistinct eye socle, but the preservation is poor.

The field of the free cheek is rather narrow, convex and quite steeply declined. The lateral border furrow is apparently rather shallow, and the posterior border furrow is distinct, truncated at the base of the genal spine and meets the axial furrow opposite the lateral end of the occipital ring. The genal spine is rather narrow, and extends backwards at least as far as the fourth thoracic segment. The cephalic doublure is narrow and ventrally convex, and ornamented with fine, parallel terrace lines. One specimen (Pl. 24, Fig. 12) shows the course of the right-hand connective suture of the rostral plate, which runs inwards and backwards. The rostral plate would appear to be trapezoidal in outline.

There seem to be 9 thoracic segments. The axis is quite strongly convex longitudinally, and tapers evenly backwards so that the last ring is about half the width (trans.) of the first. Anteriorly the axis is wider than the pleurae, but posteriorly the latter are wider. The axial rings are a little narrower (exsag.) than the occipital ring, and each is arched very weakly forwards sagittally. The preannulus appears to be present (see lateral profile, Pl. 24, Fig. 11) on each axial ring. The pleura runs abaxially and weakly backwards from the axial furrow, and is quite steeply declined at the fulcrum. The pleural furrow is rather deep, dying out near the distal end, and dividing the pleura into anterior and posterior pleural bands of approximately equal width (exsag.). The posterolateral corner of the pleura is angular.

The pygidium is subparabolic in outline, about twice as wide (trans.) as long (sag.), without a border. The axis anteriorly occupies about a third of the total pygidial width, and tapers gently backwards to a blunt point, reaching close to the pygidial margin. There are at least 4 axial rings, separated by shallow interannular furrows. The pleural areas are convex, with 4 pairs of backwardly curving pleural ribs, which widen very slightly abaxially. The pleural and interpleural furrows are both distinct, and run nearly parallel, with the former a little deeper than the latter. Both extend close to the pygidial margin. The anterior and posterior pleural bands are of similar width and convexity. The pygidial doublure is about the same width as the cephalic, but is not so strongly ventrally convex. Like it, it is ornamented with fine, parallel terrace lines.

DISCUSSION

A topotype specimen identified by Begg as *Warburgella rotundata* has a short preglabellar field and lacks the well developed basal lobes. This specimen (see Pl. 22, Fig. 18) may be referrable to *Decoroproetus mactaggarti* (Begg), although the eye is smaller and further forwards along the glabella.

C. rotundatus and *C. facetus*, the only British Ordovician representatives of *Cyphoproetus* are restricted to the Girvan area. Closely related species occur in Quebec and Norway, further emphasising the close relationship of the Girvan faunas to these areas.

Genus *RORRINGTONIA* Whittard, 1966

Type Species *Rorringtonia flabelliforme* Whittard, 1966

DISCUSSION

Whittard (1966, p. 292) placed Rorringtonia in *incertae sedis*, and compared its cephalic characters with *Parabolinella* and its pygidial characters with *Platycalymene* and *Dionide*. These similarities are likely to be only superficial, and the overall exoskeletal characters are more suggestive of proetids (e.g. the forwardly tapering glabella, the preglabellar field, the opisthoparian suture and the number of thoracic segments (10)). The type of glabella, and the large number of pygidial pleural ribs and axial rings invite comparison with the Llandovery genus *Pseudoproetus* Poulsen (type species P. regalis Poulsen, 1934, Pl. 3, Figs. 1-4). The principal differences between *Rorringtonia* and *Pseudoproetus* are in the more vaulted exoskeleton and the path of the posterior branches of the facial sutures of the latter. *Analocaspis* (type species A. ursina Owens, Pl. 4, Figs. A-H) is also not dissimilar to Rorringtonia (see Chapter 1), but is not as close as Pseudoproetus. Rorringtonia, Pseudoproetus and possibly Analocaspis may belong to a small branch related to the Proetidae, which may have its origins in a form like '?Phaseolops sp. ind.' (Whittington 1965, Pl. 19, Figs. 1-5) from the Llanvirn White Rock Formation of Newfoundland.

Rorringtonia flabelliforme Whittard, 1966

Plate 24, Figs. 13, 22.

DISCUSSION

Whittard's specimens of this species are refigured here for comparison. For type data and description, see Whittard (1966, p. 292).

Rorringtonia vetula (Reed 1935)

Plate 24, Figs. 15, 25, 26

1935 Proetus vetulus sp. nov. Reed, p. 41, Pl. 2, Fig. 16.

HOLOTYPE

Internal mould of cranidium, with counterpart external mould (BM In. 36959), figd. Reed, Pl. 2, Fig. 16 and refigured herein as Plate 24, Figs. 25-26.

MATERIAL

Besides the type, two incomplete cranidia

TYPE STRATUM AND TYPE LOCALITY

Balclatchie Mudstones (Caradoc) Penwhapple Glen, near Girvan.

OCCURRENCE

Only at the type locality

DIAGNOSIS

This species differs from R. flabelliforme in its larger palpebral lobe, smaller posterior portion of the fixed cheek and lack of an ocular ridge.

DESCRIPTION

The cranidium is weakly vaulted and has the palpebral width and sagittal length almost equal. The glabella is about twice as wide as long, and is very weakly convex in lateral and longitudinal profiles. It is defined by deep, narrow conjoined axial and preglabellar furrows, and is widest in the posterior. From the angular posterolateral corners it tapers forwards very gently as far as the abaxial end of the 1p furrows, and then more rapidly to the rounded frontal lobe. 1p is situated about two fifths of the way up the glabella from the posterior. The abaxial section is shallow and only weakly backwardly directed, while the adaxial section is directed more strongly backwards and is rather deep, and terminates abruptly some distance in front of the occipital furrow. The adaxial end of 1p is about two thirds of the way from the axial furrow to the sagittal line. On the holotype there is a very weak anterior branch running forwards from the deep adaxial section of 1p. 1p partially defines a trapezoidal basal glabellar lobe, which is as wide (trans.) along its base as it is long (exsag.) at the axial furrow. 2p is situated a little posterior to gamma, and is simple, rather shallow, inclined backwards at about 70° to an exsagittal line, about as long as 1p and weakly convex towards the anterior. 3p, situated a short distance behind the anterolateral angles of the glabella is similar to 2p, but only about half as long.

The occipital furrow is narrow sagittally, but widens abaxially before narrowing again at the extreme lateral ends. It is arched strongly forwards sagittally, and the lateral ends are more or less transverse. The occipital ring is about a quarter of the sagittal length of the glabella, and transversely is about the same width as the glabella. It is widest sagittally, and narrows distinctly laterally. In lateral profile it is gently convex. There is a small median tubercle, situated slightly towards the posterior, and there are no lateral lobes.

The preglabellar field is about a quarter of the sagittal length of the glabella, and is distinctly convex in lateral profile. It is rather strongly declined to the weak, shallow anterior border furrow. The anterior border is narrow and distinctly convex in lateral profile.

The anterior branches of the facial sutures run nearly parallel, with gamma-beta nearly straight. Gamma is some distance out from the axial furrow. The posterior branches run straight outwards and backwards from epsilon and zeta, and define small triangulate posterior portions of the fixed cheeks. The posterior border furrow is deeper than the anterior and meets the axial furrow opposite the occipital furrow. The posterior border is narrow, and about the same width (exsag.) as the anterior border.

The palpebral lobe is rather narrow and semielliptical in outline. It is about one third the length of the glabella, and is gently inclined abaxially in longitudinal profile. The posterior end is situated about a fifth of the way up the glabella from its posterior margin.

DISCUSSION

Comparison of the type of Reed's Proetus vetulus with Rorringtonia flabelliforme Whittard has shown that it represents a second species of Rorringtonia. R. vetula differs from R. flabelliforme principally in its longer palpebral lobe. Unfortunately R. vetula is only known from cranidia, so comparison of the rest of the exoskeleton is not possible at present. '?Phaseolops sp. ind.' (Whittington 1965, Pl. 19, Figs. 1-5) from the Llanvirn White Rock stage of Newfoundland may represent a third species of Rorringtonia. The similar shaped glabella with deep lateral furrows, the laterally narrowed occipital ring and the straight (gamma-beta) anterior branch of the facial suture are all characters found in Rorringtonia.

PROETID, gen. et sp. indet.

Plate 24, Fig. 9

MATERIAL

One poorly preserved cephalon (SMC A 30941).

HORIZON AND LOCALITY

Ashgill, Slade Beds, Upper Slade, near Haverfordwest, Pembrokeshire.

DISCUSSION

The cephalon has the following characters: broad, flattened cephalic border; elongated, coniform glabella; long, crescentic eye; occipital ring without lateral lobes; narrow field of free cheek; broad based genal spine; apparently no preglabellar field; strongly divergent anterior branches of the facial sutures. These characters do not particularly agree with any established proetid genus, and the closest are Astroproetus and Proetus. From the former it differs in not having the preglabellar field, not having lateral occipital lobes and in having a wide cephalic border. From the latter it differs in having a broad, flattened cephalic border and narrow field of the free cheek. The cephalic characters suggest that it might be closer to Proetus, but other parts of the exoskeleton are required to assess its true affinities.

Link Paragraph 2

In Chapters 4-6 the Silurian Proetidae from the British Isles and central Bohemia are described, together with a few Scandinavian species. In Chapters 4 and 6 Proetidellinae and _Cyphoproetus_ from the British Isles and Bohemia respectively are described, and it is of interest to note the occurrence of species common to both. Reference is made to similar species occurring in the Ordovician. The earliest representatives of _Proetus_ are described in Chapters 2 and 3, and in 5 and 6 the Silurian species are investigated. In Chapter 5 the genus _Proetus_ is discussed in detail. Silurian _Cornuproetinae_ restricted (with one exception) to Bohemia are described in Chapter 6, where an attempt is made to relate them to earlier Ordovician forms as well as to later Devonian ones.

SPECIES	LLAND			WEN		LUDLOW											
	Lower	Middle	Upper	Wenlock Shale	Wenlock Limestone	Eltonian	Bringewoodian	Leintwardinian	Whitcliffian	S.W. Wales	Inliers of S. Welsh Borders	Malvern - Abberley Hills	Dudley	S. Shropshire	Long Mountain	N. England	Girvan
Decoroproetus scrobiculatus						X									X	X	
Decoroproetus?sp. N			X													X	
D. sp. J			X											X			
D. sp. K			X							X							
D. sp. L				X								X					
D. sp. M			X											X			
Astroproetus amplus	X	X															X
A.pseudolatifrons			X														X
A. interjectus		X															X
A. scoticus																	X
A. subtriangularis		X															X
A. sp.A			X							X							
Warburgella stokesi					X							X	X				
W. bellula					X						X	X	X				
W. pedina				X										X			
W. sp.A			X														
Ogmocybe pharangus								X						X			
O.trapeziceps								X						X			
O. ludloviensis								X						X			
Rutellum malvernense			X	X								X					
Cyphoproetus depressus				X	X							X	X				
C. strabismus				X											X		
C. externus	X	X															X
C. binodosus			X											X			
C. nasiger			X											X			

Fig. 4.1. Stratigraphical and geographical distribution of Proetidellinae and Cyphoproetus in the British Isles.

CHAPTER 4

SILURIAN PROETIDELLINAE FROM THE BRITISH ISLES

ABSTRACT

Twenty-five species distributed among the genera Decoroproetus, Astroproetus, Warburgella, Cyphoproetus, Ogmocybe and Rutellum are investigated, 7 of which are new. A further 8, only known from a few specimens are not given names, but are also probably new. The genera Ogmocybe and Rutellum are new. A branch of the Proetidellinae embracing these two genera and Astroproetus, Prantlia and Warburgella bears a series of common characters which distinguishes it from other genera in the subfamily, and may eventually form the basis of a new subfamily. Species from the Llandovery of Girvan show greater affinity with those of Norway and Quebec than they do with those of the Anglo-Welsh area. Decoroproetus and Cyphoproetus, of restricted distribution in the Wenlock, have species common to Britain and Scania or central Bohemia.

INTRODUCTION

Most of the species described herein are from the Llandovery and Wenlock, with a few from the Ludlow. This chapter, together with Chapter 5 embraces all the British Silurian Proetidae, together with a few closely related foreign forms. All the genera in this chapter belong to the subfamily Proetidellinae with the exception of Cyphoproetus, which may belong to the Proetinae. Cyphoproetus shows superficial resemblance to certain members of the Proetidellinae - Warburgella and Ogmocybe.

Many of the established species originate from the Llandovery of the Girvan area, which has yielded abundant and often complete material. These have been described by Reed (1904-1941) or by Begg (1950). Whittard (1938) described a few proetids from the Llandovery of South Shropshire, and also revised the old Wenlock species Warburgella stokesi (Murchison). All the illustrations given in these works are inadequate by modern standards, and all these species are refigured.

RELATIONSHIPS OF THE FAUNA

As in the Ordovician, the Llandovery proetids of the Girvan area show greater affinities to foreign faunas than they do to contemporaneous ones in the Anglo-Welsh area. Closest affinities are seen with species from the Oslo region of Norway and from Quebec. Proetids from these areas have not yet been figured or described, and until this is done a detailed comparison cannot be made.

In Wenlock times Proetidellinae are represented in Britain by the genera Decoroproetus, Warburgella and Rutellum. Cyphoproetus ranges upwards from the Llandovery and persists until the late Wenlock. Of these genera, Warburgella shows a marked preference for calcareous deposits of rather shallow water origin, and also occurs in similar deposits in the Oslo region and Gotland. In central Bohemia, Warburgella is apparently absent until its appearance in the early Devonian, when subspecies of W. rugulosa (Alth) become almost worldwide in their distribution.

Cyphoproetus is found in small numbers in the Wenlock of both Britain and central Bohemia, and also occurs in Gotland. This genus, represented by the species C. depressus (Barr.) and C. strabismus Owens apparently preferred deeper water muddy deposits, and in Britain is found in the Wenlock Shale or in shaly facies of the Wenlock limestone. Rutellum, so far only known at the type locality at Malvern also seemed to prefer muddy deposits.

In the Silurian, Decoroproetus is rather uncommon, and is of restricted occurrence, which contrasts strongly with the Ordovician, where it is usually the commonest proetid, and is widely distributed. In the Silurian it is found in shales or impure, dark limestones, but is absent from the shallow water bioherm facies, and has not been found in the Wenlock limestone of Britain, nor in Gotland. Decoroproetus sorobiculatus sp. nov. is the commonest British species, and ranges from late Wenlock to early Ludlow. It has only been found in two areas, the Cautley district (N.W. Yorkshire) and Long Mountain, but in each it is abundant. The same species also occurs in shales of Wenlock age in Scania, southern Sweden. D. sorobiculatus does not occur in Bohemia, where it is replaced by the closely related D. decorus, represented by two subspecies, which occur in the late Wenlock and early Ludlow. The fauna found in association with D. scrobiculatus has a distinct Bohemian affinity.

Apart from the occurrence of D. sorobiculatus in the early Ludlow, the Ludlovian of Britain is almost devoid of Proetidellinae and only one genus occurs - Ogmocybe. It is represented by three species, all of Leintwardinian age. One is apparently restricted to the Leintwardine channel facies, while the other two occur in the normal shelf facies.

Family PROETIDAE, Salter, 1864

Subfamily PROETIDELLINAE, Hupe, 1953

Genus *DECOROPROETUS*, Pribyl, 1946

Type species *Proetus decorus* Barrande, 1846

Decoroproetus sorobiculatus sp. nov. /c

Plate 25, Figs. 1-18, Plate 26, Figs. 1-10.

1915 *Proetus gracilis* Barr., Hede, Pl. 4, Figs. 22-24

1965 *Decoroproetus* sp. Rickards, p. 548

HOLOTYPE

Internal mould of cranidium (BM It. 8844), with counterpart external mould (Pl. 25, Figs. 1, 2, 5).

MATERIAL

Large number of cranidia, free cheeks and pygidia and a few hypostomes.

TYPE STRATUM AND TYPE LOCALITY

Basal Ludlow limestone, *nilssoni*-*scanicus* zone, Bluecaster, Cautley, N.W. Yorkshire.

OCCURRENCE

Basal Ludlovian, Cautley district; Upper Wenlock, *dubius*-*nassa* zone, Long Mountain, Wenlock, Scania, Sweden.

DERIVATION OF THE NAME

From the Latin *Scrobiculus*, a little trench, from the presence of impressed glabellar furrows.

DIAGNOSIS

Glabella with three pairs of weakly impressed furrows; irregular tropidial ridges are present on the frontal area and on the anterior part of the free cheek; anterior border flattened, about one third the total width (sag.) of the preglabellar area; lateral border broader than anterior, genal spine with broad outer and narrow inner band; pygidium of subparabolic outline, with strongly convex (long.) axis with 8-9 rings; pleural areas with 5-6 pairs of ribs, interpleural furrows almost imperceptible; pygidial doublure very broad; hypostome with strongly convex median body, and one pair of short spines on the posterior margin~~s~~.

DESCRIPTION

The cephalon is parabolic in outline, with the lateral border widening posteriorly; the cranidium has the sagittal length rather greater than the palpebral width. The glabella is rather weakly inflated, in lateral profile describing a gentle convex curve, and in longitudinal profile rising up to a crest in the sagittal region. The glabella is defined by distinct, conjoined axial and preglabellar furrows and from its widest point at the posterolateral angles, tapers forwards gently as far as the bluntly rounded frontal lobe. Three pairs of lateral glabellar furrows are present. 1p is situated opposite the anterior part of the palpebral lobe, is deeper than 2p and 3p and is directed inwards and backwards at about 45° to an exsagittal line. Between the anterior part of 1p, close to the sagittal line, is a small, ovate auxiliary impression (e.g. Pl. 25, Fig. 10). 2p is situated almost opposite gamma, and is shorter and shallower than 1p. It is directed nearly straight inwards (trans.), running only slightly backwards. 3p is isolated from the axial furrow, and runs nearly straight inwards (trans.), is about as long as 2p and situated between it and the anterolateral corner of the glabella.

The occipital furrow is of comparable width and depth to the axial and preglabellar furrows. It runs almost straight (trans.), and is arched very weakly backwards sagittally. The occipital furrow makes little impression on the lateral profile of the cranidium (see Pl. 25, Fig. 2). The occipital ring is about as wide (sag.) as the preglabellar field, and is as wide, or slightly wider (trans.) than the glabella. It maintains more or less the same width (exsag.) laterally. Lateral occipital lobes are absent, but a small, distinct median tubercle is developed. In longitudinal profile the occipital ring is bent down quite steeply to either side of the sagittal line, and in lateral profile is weakly convex.

The preglabellar field is between one quarter and one fifth the length (sag.) of the glabella. In lateral profile it is gently concave. On many specimens (e.g. Pl. 25, Figs. 10 and 14, Pl. 26, Figs. 1 and 2) there is a very slight depression, which runs parallel to the anterior margin and indicated by a darker area. On the posterolateral parts of the preglabellar field are a series of irregular raised tropidial ridges (see Pl. 25, Fig. 10 and Pl. 26, Figs. 1 and 5). The anterior border furrow is broad and rather shallow, and from it the inner part of the anterior border is inclined forwards at about 30°. The anterior border is about one third the total width (sag.) of the preglabellar area, and the outer part is declined forwards at about 30° and is nearly straight or slightly concave in lateral profile (see Pl. 25, Fig. 2).

The anterior branches of the facial sutures are quite strongly divergent, describing a strong, outwardly convex curve, with an exsagittal line drawn backwards from beta falling on, or a little outside the palpebral lobe. Gamma is quite close to the axial furrow. On the posterior branch, epsilon and zeta fall on one continuous curve, and the suture reaches close to the axial furrow, near the abaxial end of the occipital furrow. From this point the posterior branches diverge strongly on the posterior cephalic margin.

The palpebral lobe is posteriorly placed, between half and one third the sagittal length of the glabella, subcrescentic in outline, and rather narrow. It is inclined at an angle of about 30° from the axial furrow, flattening a little abaxially. The eye is rather large, crescentic with a strongly convex visual surface, and is mounted on a distinct eye socle, whose lower margin is defined by a distinct furrow, which diverges from the upper margin at either end (see Pl. 25, Figs. 11 and 15).

The free cheek has a rather narrow, convex field, gently declined from the eye region to the lateral border furrow. On the anterolateral part of the field, the tropidial ridges of the lateral part of the preglabellar field continue, running more or less parallel with the anterior border furrow. The lateral border is broad and flattened, widening towards the posterior. It is separated from the rest of the free cheek by the wide, shallow, lateral border furrow. The posterior border furrow is narrow and deep, and is abruptly truncated at the base of the genal spine where it meets the lateral border furrow. The posterior border is considerably narrower than the lateral, and widens slightly abaxially, and is gently inclined towards the posterior. The genal spine is broad and blade-like, tapering gradually backwards. The shallow median groove divides it into a wide outer band, anteriorly about as wide as the lateral border, and a narrow inner band. Both are inclined from the median groove, and the inner band rather more steeply.

The glabella, occipital ring and most of the free cheek have a sculpture of very fine raised ridges, arranged in a bertillon pattern on the glabella (see Pl. 25, Fig. 10). These ridges are finer than the tropidial ridges, which occur on the lateral parts of the preglabellar field and on the anterolateral parts of the free cheek.

The hypostomehas a very strongly convex median body, with ill-defined (on internal moulds) backwardly and inwardly directed median grooves, which divide it into a large anterior and small posterior lobe. The anterior wing is of moderate size and is directed upwards. The anterior border is rather narrow, separated from the median body by a distinct anterior border furrow. The conjoined lateral and posterior border furrows are rather wider and deeper than the anterior border furrow, separating off the narrow, upturned (ventrally) lateral and posterior borders. On the posterior margin there is a pair of broad-based spines (see Pl. 25, Fig. 3).

The number of thoracic segments is unknown, but is assumed to be 10, the normal retinue for Decoroproetus. A specimen from the Long Mountain (see Pl. 26, Fig. 3) shows parts of seven. The thoracic axis is fairly broad, convex in a longitudinal direction with the annulus slightly wider (sag.) than the articulating half ring. The articulating furrow is rather deep. In lateral profile the annulus is weakly convex, and inclined gently towards the posterior. The pleura has a deep pleural furrow, running more or less transversely, and very slightly backwards. Adaxially the posterior pleural band is wider, while abaxially the anterior one is slightly wider. In lateral profile the anterior pleural band is weakly convex, and the posterior pleural band is inclined gently towards the posterior. The pleural furrow becomes obsolete distally, and the posterolateral corner of the pleura is drawn out into a backwardly pointing spine, while the anterolateral corner is rounded.

The pygidium is subparabolic in outline, and is nearly twice as wide as long. (In laterally compressed specimens, the proportions may be considerably distorted - e.g. Pl. 25, Fig. 17). The axis is strongly convex in longitudinal profile, and at its anterior end occupies between a half and one third the total width (trans.) of the pygidium. It tapers quite strongly backwards, terminating in a rather ill-defined blunt posterior end, where there are traces of a poorly developed post-axial ridge. The axis consists of 7 to 9 rings, which are separated by shallow, indistinct interannular furrows, with the exception of the first, which is more distinctly defined. In lateral profile each ring is gently inclined towards the posterior.

The pleural areas have 5 or 6 pleural ribs, which curve quite strongly backwards abaxially, and also widen abaxially. The pleural furrows are deep and pronounced, with a steep anterior slope and rather shallower posterior slope. The interpleural furrows are indistinct, and usually only the first one or two pairs are distinguishable. They do not generally form a feature in the lateral profile of the pleurae. The pygidial doublure (see Pl. 25, Fig. 17) is broad, weakly convex ventrally and is ornamented with 6 or 7 prominent terrace lines, which run parallel to the margin. Between these, and running parallel to them are a series of faint secondary terrace lines.

DISCUSSION

Among the specimens from the type locality, collected by Dr. R.B. Rickards, are two early holaspid cranidia (Pl. 25, Figs. 4 and 7), and two early holaspid pygidia (Pl. 25, Fig. 9). The cranidia possess a proportionately longer preglabellar field, as well as deeper lateral glabellar furrows. lp appears to be entirely isolated from the axial furrow on both specimens, although it is difficult to ascertain its true extent on an internal mould. On the pygidium the interpleural furrows are clearly pronounced, in contrast to their inconspicuousness on larger specimens.

Decoroproetus sorobiculatus is clearly closely related to Decoroproetus decorus decorus (Barr.) from the Upper Wenlock of central Bohemia (see Pl. 45, Figs. 9-13, Pl. 46, Fig. 3), from which it differs principally in having a wider cephalic border, narrower field to the free cheek, shorter (sag.) preglabellar field and less tapering glabella. Decoroproetus sp. J from the Upper Llandovery of South Shropshire (see Pl. 26, Fig. 7) is also similar, and differences between it and D. sorobiculatus are indicated elsewhere (see below).

Decoroproetus sp. J.

Plate 26, Fig. 7.

MATERIAL

One cranidium (GSM 55472).

HORIZON AND LOCALITY

Upper Llandovery, limestone with Barrandella linguifer interbedded in the Purple Shales. Minsterley-Habberley lane, one sixth of a mile from the Shrewsbury main road.

DISCUSSION

Whittard (1938, p. 98) compared this specimen with Prionopeltis octaschistus Kegel, Phaetonides densistriatus Kegel, Warburgella rugulosa (Alth) and Proetus intermedius Barr. Examination of Whittard's specimen has shown it to belong to Decoroproetus, and it shows similarity to the later species D. scrobiculatus sp. nov. (see above). It differs from this species in not having impressed glabellar furrows or tropidial ridges, in having a less strongly upturned anterior border and in having a sculpture of coarser striations. Like D. scrobiculatus this species has a shallow depression running parallel to the ill-marked anterior border furrow, on the anterior part of the preglabellar field. The glabellar furrows are indicated by darker colouration on the glabellar surface, with lp very slightly impressed over part of its length. They show a similar arrangement to D. scrobiculatus.

Decoroproetus sp. K

Plate 26, Figs. 11 and 18

MATERIAL

External mould of a complete specimen (Coll. Dr. P.D. Lane) and an internal mould of parts of four thoracic segments and the pygidium, on the same slab as the external mould.

HORIZON AND LOCALITY

Upper Llandovery, C', Llandovery, Carmarthenshire.

DESCRIPTION

The cephalon is weakly vaulted, with a rather wide, flattened border. The glabella is about as long as broad, and about two thirds the total length (sag.) of the cranidium. From the posterolateral corners it tapers forwards gently to the bluntly rounded frontal lobe, and is weakly convex in lateral and longitudinal profiles. No lateral glabellar furrows can be discerned, but the preservation is bad. The glabella is defined by shallow conjoined axial and preglabellar furrows. The occipital furrow is apparently rather shallow, running more or less transversely. The occipital ring is fairly broad (sag.) and is about two thirds the sagittal length of the preglabellar area. Transversely it is about as wide as the glabella. In lateral profile it is flat, and nearly horizontal, and in longitudinal profile curves down gently at either end.

The preglabellar field is short (sag.), about equal in width (sag.) to the occipital ring, and merges insensibly into the flat, slightly up-turned anterior border. The anterior border furrow is indistinct. The anterior branches of the facial sutures are strongly divergent, with beta a well rounded outwardly convex curve. The path of the posterior branches is uncertain, but from the position of the eye it seems as if epsilon and zeta form a single curve. The palpebral lobe is crescentic, inclined at about 20° from the axial furrow and between half and one third the sagittal length of the glabella. The eye is badly preserved, but seems to be rather large and crescentic.

The field of the free cheek is weakly convex and rather narrow. The lateral border furrow is shallow and ill-defined, while the lateral border is broad and flat. The posterior border furrow is narrower and more distinct than the lateral, and from it the posterior border (which is narrower than the lateral border), is inclined towards the posterior. The genal spine is apparently broad-based, with a wide outer band and a narrower inner band divided by a shallow median furrow. It extends backwards at least as far as the sixth thoracic segment.

The thorax has at least 9 segments, and there may be 10. The axis is moderately convex in longitudinal profile, and tapers gently backwards. Each ring runs more or less straight (trans.), and in lateral profile is almost flat and gently inclined towards the posterior. The articulating furrow is narrow and prominent (see Pl. 26, Fig. 11), and the articulating half ring is about the same width (sag.) as the annulus. The pleurae curve gently backwards abaxially, and curve down gently at the fulcrum. The pleural furrow is moderately deep, runs parallel with the edge of the pleura and dies out abaxially. It divides the pleura into a narrower anterior and wider posterior pleural band. The posterolateral angle of the pleura is produced into a short, backwardly directed spine, while the anterolateral corner is rounded.

The pygidium is subparabolic in outline, about one and threequarter times as wide as long, without a border. At its anterior end, the axis occupies about one quarter of the total pygidial width. It tapers quite rapidly backwards to a blunt point, and is about four fifths the length (sag.) of the pygidium. In longitudinal profile the axis is quite strongly convex. Due to poor preservation, it is hard to estimate the number of axial rings. The pleural areas have five pairs of backwardly curving ribs, which widen abaxially. The interpleural furrows are very indistinct, and may be discerned only on the first two pairs of ribs. The pleural furrows are distinct, extending almost to the pygidial margin. These have a steep anterior slope, which becomes more pronounced abaxially. The interpleural furrows converge with the pleural furrows abaxially, and the part of the anterior pleural band between the two furrows abaxially is narrow and ridge like.

DISCUSSION

The broad lateral border of the cephalon of this species invites comparison with D. scrobiculatus (cf. Pl. 25 Fig. 11 and Pl. 26, Fig. 18). The two specimens described as Decoroproetus sp. K. originate from a similar horizon to D. sp. J (see above), and it is quite possible that only one species is represented. Meaningful comparison between D. sp. J and K must await better material of the latter. In all cases, D. sp. J, D. sp.

K and D. scrobiculatus form a closely related group.

Decoroproetus sp. L

Plate 26 Figs. 12, 15, 16

MATERIAL

Three pygidia and one free cheek.

HORIZON AND LOCALITY

Wenlock Shale, road cut near Martley, Abberley Hills.

DESCRIPTION

The free cheek has a rather narrow field. The eye is apparently rather large, probably mounted on a distinct eye socle. The lateral border furrow is wide and shallow, and the lateral border rather broad and weakly convex. The posterior border furrow is narrower and deeper than the lateral. Near the base of the genal spine the posterior border is as wide as the lateral border, but adaxially it narrows. The genal spine is fairly broad based, tapering gently backwards. The median groove is about as wide but a little shallower than the posterior border furrow. It divides the genal spine into a slightly wider outer band, and narrower inner band.

The pygidium is subparabolic in outline, without a border and three fifths as long as wide. Anteriorly the axis occupies about two fifths of the total width (trans.), and about five sevenths of its length (sag.). The axis is thus rather wide and short, tapering quite rapidly backwards to a bluntly rounded posterior end, which merges insensibly to the poorly developed postaxial ridge. In longitudinal profile the axis is strongly convex. In lateral profile it is gently convex, but slopes backwards progressively more steeply towards the posterior, and the area of the post-axial ridge and the postaxial area forms a gently concave curve. The axis consists of seven rings and a short terminal piece. In lateral profile most of the rings are nearly flat, but the last two and the terminal piece are gently convex. The interannular furrows between the first four rings are gently undulate, arching backwards sagittally and abaxially. The more posterior interannular furrows run more or less transversely. There are four pairs of pleural ribs, and traces of a fifth pair. They curve rather strongly backwards and broaden a little abaxially. The pleural furrows are deep, and deepen abaxially before becoming obsolete close to the margin. They have a steep anterior slope and shallower posterior slope. The interpleural furrows are rather fainter than the pleural, and only the first two pairs are easily discernible. They run close to, and parallel with the next pleural furrow behind, and are of more or less the same depth for their entire length. With the exception of the first pleural rib, where they are of more or less equal width (exsag.), the posterior pleural band is considerably broader than the anterior.

The whole of the free cheek and pygidium are covered with dense anastomising striations. On the free cheek they form a series of "V"s with the apex of each one on the lateral border furrow, or on the median furrow of the genal spine, pointing backwards. On the pleural areas of the pygidium the striations run forwards and outwards abaxially from the axial furrow, and on the axis are arched forwards sagittally.

The kink on the posterior margin behind the axis of the pygidium (Pl. 26, Fig. 15) is an artefact, and not an original morphological feature.

DISCUSSION

The specimens in the collections of the Institute of Geological Sciences appear to originate from limestone nodules interbedded in the shale. This is a similar mode of occurrence to Decoroproetus sp. J from the Upper Llandovery Purple Shales. Like Decoroproetus sp. K, Decoroproetus sp. L may belong to the same species as Decoroproetus sp. J, but the fine striations of Decoroproetus sp. L are in contrast to the coarser ones on D. sp. J, and may indicate a separate species. It is difficult, however, to compare different exoskeletal parts - a cranidium of D. sp. J and a free cheek and pygidia of D. sp. L.

Decoroproetus sp. M

Plate 27, Figs. 13, 14

MATERIAL

A free cheek - internal mould (OUM. C14141a) with counterpart external mould (OUM. C14141b).

HORIZON AND LOCALITY

Upper Llandovery.

DESCRIPTION

Anteriorly the field is narrower than the border. It is weakly convex and slopes down gently from the eye to the lateral border furrow. The eye is rather large, and mounted on a distinct eye socle, whose lower margin is defined by a furrow, which diverges from the upper margin, anteriorly and posteriorly. The anterior branch of the facial suture diverges strongly outwards abaxially, with beta a wide, outwardly convex curve. The posterior branch has epsilon and zeta as a single angle, and the suture cuts the posterior margin not far from the base of the genal spine. The lateral border furrow is wide and ill-defined, and the cast taken from the external mould (Pl. 27, Fig. 13) shows a ridge running along it and onto the posterior border. Comparison with the internal mould (Pl. 27, Fig. 14) shows that this is the inner edge of the doublure. The presence of a feature produced by it on the external surface may be a result of crushing or due to partial exfoliation of the exoskeleton. The lateral border is broad and weakly concave. The genal spine is short and rapidly tapering, and when the line of the lateral border furrow is produced backwards it falls on its inner margin. The median furrow of the genal spine broadens anteriorly, and divides the spine into convex inner and outer bands of approximately equal width. At its anterior end the median furrow curves adaxially to meet the lateral and posterior border furrows. The posterior border furrow is narrow and of comparable depth to the furrow at the lower margin of the eye socle. The posterior border is weakly convex, narrows adaxially and is inclined gently towards the posterior. The doublure is broad, gently convex ventrally and ornamented with 10-11 prominent terrace lines which run parallel to the margin. At the base of the genal spine there is a small panderian opening.

DISCUSSION

The broad lateral border again indicates some relationship to the *D. scrobiculatus* group, but the rather short genal spine with inner and outer bands of nearly equal width is in contrast to the other species.

Decoroproetus? sp. N

Plate 26, Figs. 13, 14, 17

MATERIAL

One cranidium (external mould) (SMC A 88902) and one pygidium (internal mould) (SMC A38833).

HORIZON AND LOCALITY

Upper Llandovery, Browgill Beds, *Phacops elegans* zone, Crummackdale, near Austwick, West Riding.

DESCRIPTION

The cranidium is about three fifths as wide (trans.) as it is long (sag.). The glabella is pyriform, distinctly constricted opposite gamma and is marginally longer (sag.) than it is wide (trans.). There is no indication of lateral glabellar furrows. The preglabellar field is about one third the length (sag.) of the glabella, and is convex in lateral profile (see Pl. 26, Fig. 14). The occipital ring appears to narrow abaxially. The palpebral lobe is narrow, crescentic, close to the glabella and backwardly placed. The anterior branches of the facial sutures are moderately divergent, and form a gently outwardly convex curve. The anterior border is narrow and convex.

The pygidium is subsemicircular in outline, about twice as wide (trans.) as it is long (sag.). The axis is short, rapidly tapering and anteriorly is three eighths the width (trans.) of the pygidium, and extends for about two thirds its length (sag.). It consists of 4 or 5 rings, but the exact number is difficult to ascertain. Because nearly all the dorsal surface of the pleural areas is missing, the number and nature of the pleural ribs is unknown. The pygidial doublure is very broad, underlying most of the pleural areas, and it narrows considerably behind the axis. It is ornamented by at least 8 prominent terrace lines which run parallel to the margin. These - particularly the inner ones - become bunched together behind the axis.

DISCUSSION

The single cranidium and pygidium, the only proetid remains known to the author from the Phacops elegans limestone are considered to belong to the same animal. The distinctly convex preglabellar field contrasts with the usual sigmoidal one characteristic of Decoroproetus, and this feature suggests that these specimens might not belong to that genus. Until further material comes to light, however, this species is included doubtfully in Decoroproetus, for it is this genus to which it most closely approaches in all other respects.

Genus ASTROPROETUS Begg, 1939

Type species Proetus (Astroproetus) reedi Begg, 1939

Astroproetus amplus sp. nov.

Plate 27, Figs. 1-4, 6-8

1904 Proetus pseudolatifrons sp. nov. pars Reed, Pl. 11, Fig. 9 (non Figs. 7-8).

1904 Proetus sp. ind. Reed, Pl. 11, Fig. 13.

HOLOTYPE

A nearly complete internal mould, with parts of the counterpart external mould (BM. In.58601).

MATERIAL

Besides the holotype, one additional almost complete internal mould, four cranidia and one pygidium.

TYPE STRATUM AND TYPE LOCALITY

Lower Llandovery, Mulloch Hill Group, Mulloch Hill, near Girvan, Ayrshire.

DERIVATION OF THE NAME

From the Latin amplus, large, because of the large size of this species.

DIAGNOSIS

This species is characterised by its large size, with the total sagittal length up to 37 mm; cephalic border rather narrow, convex; glabella broadly conical, with traces of three pairs of lateral glabellar furrows; lateral occipital lobes large, elongated in a transverse direction; palpebral lobe and eye small; pygidium of parabolic outline, axis with 6-7 rings, strongly convex in longitudinal view; pleural areas with 5-6 ribs (pairs); pleural furrows deep, extending nearly to the margin; interpleural furrows distinct, but considerably weaker than the pleural furrows.

DESCRIPTION

The cephalon has a parabolic outline, with a narrow, convex border. The glabella is nearly as broad as it is long, and is widest opposite the posterior end of the palpebral lobe. It tapers forwards rapidly and is well rounded anteriorly. Very faint traces of glabellar furrows are present. 1p is situated just posterior to the centre of the palpebral lobe. It is directed backwards at about 40° to an exsagittal line, and dies out well before reaching the occipital furrow. 2p is situated opposite gamma, and is of similar strength to 1p and bends backwards at about the same rate. 3p is faint, isolated from the axial furrow and situated about half way between 2p and the preglabellar furrow. The glabella is defined by distinct, conjoined axial and preglabellar furrows.

The occipital furrow is deeper than the axial furrow, and curves forwards at either end. It bends through a blunt angle opposite the inner end of the occipital lobe. The occipital ring is slightly wider (trans.) than the glabella. The lateral ends are flexed forwards weakly. The lateral occipital lobes are transversly elongated and are incompletely isolated.

The preglabellar field is between one fifth and one sixth the length of the glabella, and slopes down gently to the anterior border furrow. It is slightly flexed in lateral profile. The anterior branches of the facial suture run almost parallel for a short distance at gamma, and then diverge strongly. The posterior branches have epsilon and zeta as independent angles, and the length of the suture between these points runs close to and parallel with the axialfurrow. On the posterior border the sutures diverge strongly and cut the posterior margin nearly two thirds of the way from the lateral end of the occipital ring to the lateral margin.

The palpebral lobe is small, almost semicircular and is inclined from the axial furrow at about 20°, flattening off slightly abaxially. The eye is small, and situated posteriorly, close to the glabella and about one third its sagittal length. The free cheek is large, with the field weakly convex, with a slight flexure. The lateral border is rather narrow and convex. The genal spine is stout based and moderately long, extending backwards as far as the fourth or fifth thoracic segment. The posterior border is narrow and upturned, separated from the remainder of the cheek by a distinct posterior border furrow.

The thorax probably consists of ten segments, but the most complete specimens are disarticulated and slightly longitudinally compressed. The axis is convex in longitudinal profile and tapers backwards so that the last ring is three quarters the width (sag.) of the first. The pleurae are wider than the axis for the entire length of the thorax, and bend down fairly strongly at the fulcrum. Each pleura has a wide, shallow pleural furrow which dies out before reaching the abaxial end. The anterior and posterior bands of the pleura are of approximately the same width (exsag.), and the posterolateral angle of the pleura is pointed.

The pygidium isnearly twice as wide as long, parabolic in outline and without a border. The axis tapers gently to a blunt point, and is rather narrow (trans.). It does not reach the posterior margin, and consists of six or seven rings, of which the anterior ones are more distinctly separated from one another tham the posterior. The pleural areas have four to five pairs of ribs, which curve gently backwards. The pleural furrows are much stronger than the interpleural furrows, and extend further towards the margin. The furrow separating the first pleural rib from the articulating surface is much deeper than the remainder. The doublure of the pygidium is fairly wide, extending as far inwards as the posterior end of the pygidial axis. It is ornamented with strong, sub-parallel terrace lines.

DISCUSSION

Astroproetus amplus sp. nov. differs from the type species of *Astroproetus*, *A. reedi* Begg, from the Upper Ordovician (see Pl. 23, Figs. 21-23) in its greater number of pygidial axial rings and pleural ribs, its wider pleural fields on the pygidium, its shorter preglabellar field, smaller eyes and in the presence of distinct lateral glabellar furrows. *A. amplus* is more similar to other Llandovery species of *Astroproetus*, including undescribed species from Norway and eastern Canada, and *A. bellus* (Maximova) and *A. tertius* (Maximova) from the Siberian Platform (see Maximova, 1962). The two last named species were included by their author in *Pseudoproetus* Poulsen, but the author has examined casts of Maximova's original material, and considers them to belong to *Astroproetus*.

Astroproetus pseudolatifrons (Reed, 1904)

Plate 27, Figs. 5, 9-12

1904 *Proetus pseudolatifrons* sp. nov. *pars* Reed, p. 78, Pl. 11, Figs. 7-8 (*non* Fig. 9).

1931 *Proetus (Prionopeltis?) pseudolatifrons* Reed (*pars*), Reed, p. 14.

LECTOTYPE (here selected)

Internal mould of a cranidium (BM.In.21946). Original of Reed Pl. 11, Fig. 7, refigured herein as Pl. 27, Figs. 10-11.

MATERIAL

Two pygidia (oneon the same slab as the lectotype) and one free cheek - all internal moulds.

TYPE STRATUM AND TYPE LOCALITY

Upper Llandovery, Camregan Group, Camregan Wood, Girvan, Ayrshire.

OCCURRENCE

Only at the type locality.

DIAGNOSIS

Glabella tapers gently forwards, with a bluntly rounded frontal lobe; lateral occipital lobes poorly developed, elongated in a transverse direction; preglabellar field convex in lateral profile; pygidium with narrow, tapering axis, which is rather weakly convex in longitudinal profile, and consisting of at least 8 rings. Pleural fields wide, with at least 6 pairs of ribs.

DESCRIPTION

The cephalon has a rather narrow, convex border. The cranidium is about five sevenths as wide across the palpebral lobes as it is long (sag.). The glabella is slightly longer (sag.) than it is wide (trans.), and is defined by distinct, conjoined axial and preglabellar furrows. It is widest at the posterolateral corners and tapers forwards constantly and rather gently, being weakly constricted opposite gamma. The antero-lateral angles are bluntly rounded, and the frontal lobe terminates in a blunt point. In longitudinal profile the glabella is quite strongly convex, and in lateral profile is gently convex as far as the frontal lobe, where it curves down quite steeply to the preglabellar furrow. On the lectotype cranidium traces of 2 pairs of lateral glabellar furrows are present. Both are backwardly and inwardly directed at about 45° to an exsagittal line. 1p is situated about half way between the lateral constriction of the glabella and the posterolateral corner, while 2p is situated at the lateral constriction.

The occipital furrow runs in a transverse direction for a short distance medianally, but bends forwards abaxially. It is rather shallow over most of its length, but deepens at the inner ends of the lateral occipital lobes. It becomes almost obsolete abaxially. The occipital ring is rather broad (sag. and exsag.) and maintains the same width along its entire length. It is a little wider than the glabella transversely. The lateral occipital lobes are rather indistinct and are elongated in a transverse direction. The preglabellar field is short (sag.), about a fifth of the sagittal length of the glabella. It is weakly convex in lateral profile and slopes fairly steeply down to the anterior border furrow. The anterior border furrow is wide and shallow, but distinct, while the anterior border is convex, rather narrow and about three fifths the length (sag.) of the preglabellar field. The anterior branches of the facial sutures diverge strongly in front of gamma, with beta an angular, abaxially convex curve. The posterior branches diverge weakly from the axial furrows, then strongly on the posterior border, and cut the posterior margin of the cephalon about a third of the way between the abaxial ends of the occipital ring and the lateral margin. The eye and palpebral lobe are not preserved on the available material.

The free cheek has a broad, gently convex field. The lateral border furrow, at least posteriorly, is a little broader and shallower than the anterior. The lateral border, like the anterior, is rather narrow and convex. The posterior border furrow is similar in breadth and depth to the anterior. The genal spine is evidently fairly long, with a broad, shallow median groove. The cephalic doublure is ventrally convex, and is of comparable width to the border.

The pygidium is subparabolic in outline, without a border and about one and a half times as wide as long. Anteriorly the axis occupies about a quarter of the total pygidial width, and is narrow and weakly convex in longitudinal profile. It consists of at least 8 rings, and tapers backwards gently to a blunt point, not reaching the posterior margin. The pleural areas are broad, weakly convex, with at least 6 pairs of ribs. The pleural furrows are rather shallow, and run straight outwards and gently backwards from the axial furrow. They reach close to the pygidial margin. The interpleural furrows are indistinguishable on all the available specimens. The doublure is rather narrow, and does not reach quite as far inwards as the posterior end of the axis. It is weakly convex ventrally, and ornamented with terrace lines.

DISCUSSION

Reed (1904, pp. 78-79), noticing Salter's misinterpretation of M'Coy's species *Proetus latifrons*,originally intended his new species, *pseudolatifrons* to incorporate the Ludlovian specimens figured and described by Salter (1848, p. 337, Pl. 6, Figs. 1, 1a) as *P. latifrons*, as well as Upper Llandovery material from Girvan. Later he (1931, p. 14) evidently restricted *pseudolatifrons* to the Girvan material, and clearly stated that he had based the species on it, but made no further mention of Salter's specimens. The latter are specifically (and generically) distinct from the Girvan specimens, and are described elsewhere (see Chapter 5) as *Proetus (Proetus) bravonii*, while a new diagnosis and description for *pseudolatifrons* is given above.

Reed (1931, p. 14) compared *pseudolatifrons* with a species of *Prionopeltis*, *P. octaschistus*, Kegel. While there may be a superficial resemblance in the cranidium, the pygidium is entirely different. Reed's suggestion that the cranidium and pygidia he earlier included in the same species (pseudolatifrons) may belong to different species, seem untenable, particularly as both are associated together on the same piece of rock. Moreover, no spinose pygidia of the Prionopeltis type have ever been recorded from the Camregan Group, and the genus is unknown in pre-Ludlovian rocks.

The overall morphology of A. pseudolatifrons (Reed) is comparable with that of A. amplus sp. nov. (see Pl. 27), with the principle differences being manifested in glabellar shape, degree of isolation of lateral occipital lobes and in the degree of longitudinal convexity of the pygidial axis.

Astroproetus interjectus (Reed, 1935)
Plate 28, Figs. 3, 4, 7

1935 Proetus interjectus sp. nov. Reed, p. 40, Pl. 3, Figs. 23.

HOLOTYPE

Internal mould of a small cranidium (HM A.1031).

MATERIAL

Besides the type, one additional internal mould of a cranidium (BM. In.42699).

TYPE STRATUM AND TYPE LOCALITY

Middle Llandovery, Saugh Hill Group, Newlands, near Girvan, Ayrshire,

OCCURRENCE

Only known from the type locality.

DIAGNOSIS

Glabella marginally wider than long, with a well rounded frontal lobe; preglabellar field about a fifth of the sagittal length of the glabella, and distinctly convex in lateral profile; occipital ring with small, ovate lateral occipital lobes.

DESCRIPTION

The cranidium is moderately vaulted and slightly longer (sag.) than it is wide across the palpebral lobes. The glabella is a little wider than it is long, and is defined by deep, distinct conjoined axial and preglabellar furrows which shallow in the palpebral region. The glabella is moderately convex in both lateral and longitudinal profiles. From the well rounded posterolateral corners the glabella widens forwards very slightly as far as the palpebral region, in front of which it narrows gently and constantly to the well rounded frontal lobe. On the holotype it is hard to discern any trace of lateral glabellar furrows (although Reed (1935, Pl. 3, Fig. 23) figures quite well defined basal lobes), but on the additional cranidium (Pl. 28, Fig. 7) there are poorly defined 1p furrows. 1p lies opposite the anterior part of the palpebral region, and runs inwards almost transversely, before turning abruptly backwards through almost 90°. It is hard to ascertain if 2p are present.

The occipital furrow is deep, with the anterior and posterior slopes both rising from it at about 45°. The median section runs nearly transversely, but abaxially it turns backwards for a short distance before curving forwards behind the posterolateral corner of the glabella. The occipital ring is a little narrower (sag.) than the preglabellar field, and maintains more or less the same width along its length (sag. and exsag.). Transversely it is marginally wider than the glabella. In lateral profile it is gently convex. Laterally there are small, ovate rather poorly defined lateral occipital lobes.

The preglabellar field is about a fifth of the sagittal length of the glabella, and in lateral profile is distinctly convex, bending down steeply to the broad, shallow anterior border furrow. The anterior border is about half as wide (sag.) as the preglabellar field, and is moderately convex in lateral profile. In front of gamma the anterior branches of the facial sutures are quite strongly divergent, and describe a wide, abaxially convex curve. The palpebral lobe is not preserved in either of the specimens. The posterior branches of the facial sutures run close to the axial furrow, with epsilon and zeta as independent angles, before diverging strongly on the posterior border.

DISCUSSION

Reed (1935, p. 41) compared this species with certain species from Estonia and North America, figured by Schmidt (1894, Pl. 4, Fig. 23) and Foerste (1919, Pl. 19, Figs. 13-14). These species (*Proetus* aff *distans* Lindström from Estonia, and *P. princeps* Savage and *P. determinatus* Foerste from Ohio) seem from the figures to belong to *Astroproetus*, but a meaningful comparison with *A. interjectus* cannot be made without reference to the original specimens. From the Girvan district, *A. interjectus* shows greatest similarity to *A. subtriangularis*, described below, but which differs in having a more elongate, coniform glabella.

Astroproetus scoticus (Reed, 1941)

Plate 28, Figs. ~~2~~ 5, 6, 9

1941 Proetus scoticus sp. nov. Reed, p. 271, Pl. 5, Fig. 3

1960 Proetus scoticus Reed, Kielan, p. 183.

HOLOTYPE

Internal mould of a cranidium (HM. A 1109). The only specimen known.

TYPE STRATUM AND TYPE LOCALITY

Lower Llandovery, Mulloch Hill Group, Graigens, near Girvan.

DIAGNOSIS

Similar to Astroproetus amplus sp. nov., from which it differs in the following ways: glabella with more bluntly rounded frontal lobe, which bends more steeply downwards to the preglabellar furrow; preglabellar field shorter (sag.); palpebral lobe larger.

DISCUSSION

Astroproetus scoticus is not dissimilar to A. amplus (see above), but is only known from the holotype. More material may demonstrate that it belongs to a continuously variable series with that species, at an extreme end. Kielan (1960, p. 183) incorrectly states that A. scoticus comes from the Ordovician, and compares it with her Upper Ordovician "Proetus" sp. C. Kielan's "Proetus" sp. C. probably belongs to Decoroproetus, and is thus not directly comparable with A. scoticus.

Astroproetus subtriangularis (Begg, 1950)

Plate 28, Fig.s 1-2.

?1904 Proetus cf. obconicus Lindström, Reed, p. 81, Pl. 11, Fig. 12.

1950 Proetus subtriangularis sp. nov. Begg, p. 287, Pl. 14, Fig. 6.

HOLOTYPE

Internal mould of a cranidium (HM. A.3822).

MATERIAL

The cranidium figured by Reed (1904, Pl. 11, Fig. 12), and refigured herein as Pl. 28, Fig. 8, may belong to this species.

TYPE STRATUM AND TYPE LOCALITY

Middle Llandovery, Saugh Hill Group, Newlands, near Girvan.

DIAGNOSIS

Glabella conical, about sixth sevenths as wide (trans.) as it is long; preglabellar field about one quarter the sagittal length of the glabella, sigmoidal in lateral profile; anterior branches of facial sutures strongly divergent; lateral occipital lobes small, poorly developed.

DESCRIPTION

The cranidium is about two thirds as wide (trans.) across the palpebral lobes as it is long (sag.). The glabella is distinctly conical, about sixth sevenths as wide (trans.) as it is long (sag.). It tapers forwards evenly and fairly rapidly from the posterolateral corners to the bluntly pointed frontal lobe. It is defined by wide, shallow, conjoined axial and preglabellar furrows, which become shallower in the palpebral region. It is moderately convex in longitudinal profile and weakly convex in lateral profile, sloping down almost vertically to the preglabellar furrow at the anterior end of the frontal lobe. No distinct lateral glabellar furrows are apparent on the internal mould, although there do appear to be obscure traces of 1p, situated about one third of the way forwards from the posterior end of the glabella, with their adaxial ends turned strongly backwards.

The occipital furrow is broad and shallow, with anterior and posterior slopes inclined at about 45° and 30° respectively from it. It runs more or less transversely except abaxially, where it turns forwards. The occipital ring is a little narrower (sag.) than the preglabellar field, and maintains the same width (sag. and exsag.). Transversely it is of about the same width as the glabella. In lateral profile it is weakly convex. The lateral occipital lobes are small, rounded and obscure.

The preglabellar field is about one quarter the sagittal length of the glabella, and is sigmoidal in lateral profile. The anterior border furrow is broad and shallow, while the anterior border is rather narrow, convex and upturned. The anterior branches of the facial sutures are strongly divergent, with gamma-beta more or less straight. Beta is bluntly angular. The palpebral lobe and posterior branches of the facial sutures are not preserved on the holotype.

DISCUSSION

Besides the holotype, one additional cranidium from the same horizon may belong to this species. It was figured by Reed (1904, Pl. 11, Fig. 12) as Proetus cf. obconicus Lindström. Proetus obconicus (see Pl. 36, Figs. 6-8, 12-14), however, differs in lacking the preglabellar field, in having larger palpebral lobes and in having more strongly divergent anterior branches of the facial sutures. Reed's specimen differs from the holotype of A. subtriangularis in having a shorter preglabellar field.

It does, however, retain much of the original exoskeleton, and the length of the preglabellar field and width and depth of furrows is always exaggerated on internal moulds.

Astroproetus sp. A

Plate 28, Figs. 10-11.

MATERIAL

External mould of a cranidium of which a silicone cast is figured, and an internal mould of a pygidium, both on the same piece of rock.

HORIZON AND LOCALITY

Upper Llandovery (C'), Llandovery.

DESCRIPTION

The cranidium is moderately vaulted, with the sagittal length slightly greater than the palpebral width. The glabella is coniform, with bluntly angular posterolateral angles and is about as long (sag.) as it is wide (trans.). It is defined by distinct, narrow conjoined axial and preglabellar furrows, and occupies about five sevenths of the total cranidial length (sag.). In lateral profile the glabella is weakly convex, and slopes down quite steeply at the frontal lobe to the preglabellar furrow. In longitudinal profile it is quite strongly convex. Two pairs of inconspicuous lateral glabellar furrows are apparent. 1p is situated near the middle of the palpebral lobe, and runs inwards and backwards at about 45° to an exsagittal line, and does not reach the occipital furrow. 2p is very obscure, situated more or less opposite gamma, is shorter than 1p and is directed inwards and backwards at a slightly greater angle.

The occipital furrow is deeper and wider than the axial and preglabellar furrows, and curves forwards weakly abaxially. The anterior and posterior slopes are both inclined at about 45°. The occipital ring is about as wide (sag.) as the preglabellar field, and maintains a constant width abaxially (sag. and exsag.). Transversely it is a little wider than the glabella. Behind the short anterior slope, the occipital ring is weakly convex in lateral profile, achieving its greatest elevation in the region of the small median tubercle. The lateral occipital lobes are ovate, transversely elongated and separated from the rest of the occipital ring by weak furrows. They extend about half way towards the sagittal line.

The preglabellar field is about one fifth the length of the glabella (sag.), is weakly convex in lateral profile and slopes down quite steeply to the anterior border furrow. The latter is wide and shallow, and the anterior border is weakly convex, slightly upturned and is somewhat narrower (sag.) than the occipital ring. The anterior branches of the facial sutures are moderately divergent, with beta a wide, rounded angle. An exsagittal line drawn backwards from beta falls on the abaxial part of the palpebral lobe. The posterior branches of the facial sutures have epsilon and zeta as independent angles, and the stretch between them is straight, and diverges weakly backwards from the axial furrow. From zeta, the posterior branches diverge strongly on the posterior border. The posterior border furrow is shallow, and meets the axial furrow opposite the posterior end of the lateral occipital lobe.

The palpebral lobe is semielliptical in outline, posteriorly placed and about two fifths the sagittal length of the glabella. It is inclined at a shallow angle from the axial furrow, and flattens and is bent slightly downwards abaxially.

The pygidium is semicircular in outline, without a border and about twice as wide as long. The anterior margin curves gently backwards abaxially from the axial furrow. The axis anteriorly occupies about a quarter of the total pygidial width (trans.) and tapers backwards constantly and quite strongly to a bluntly pointed posterior end. It occupies about four fifths of the total pygidial length, and is defined by shallow, distinct axial furrows. In longitudinal profile the axis is semicylindrical, and in lateral profile slopes down gently towards the posterior, and slopes down steeply at the extreme posterior end. This and the postaxial area form a concave profile. The axis consists of seven, possibly eight axial rings and a short end piece. The inter-annular furrows are arched forwards weakly sagittally. The first three rings are distinctly convex in lateral profile, the first being elevated distinctly higher than the others, and separated by a deep furrow from the second.

The pleural areas are moderately convex, with at least four pairs of ribs which curve gently backwards and widen slightly abaxially. The pleural furrows are considerably deeper than the interpleural furrows, and extend close to the margin, with the first rather deeper than the remainder. The interpleural furrows are shallow, run nearly parallel with the pleural furrows, and deepen abaxially. The anterior and posterior pleural bands are of about the same width and are weakly convex. The doublure is moderately wide, extending almost as far inwards as the posterior end of

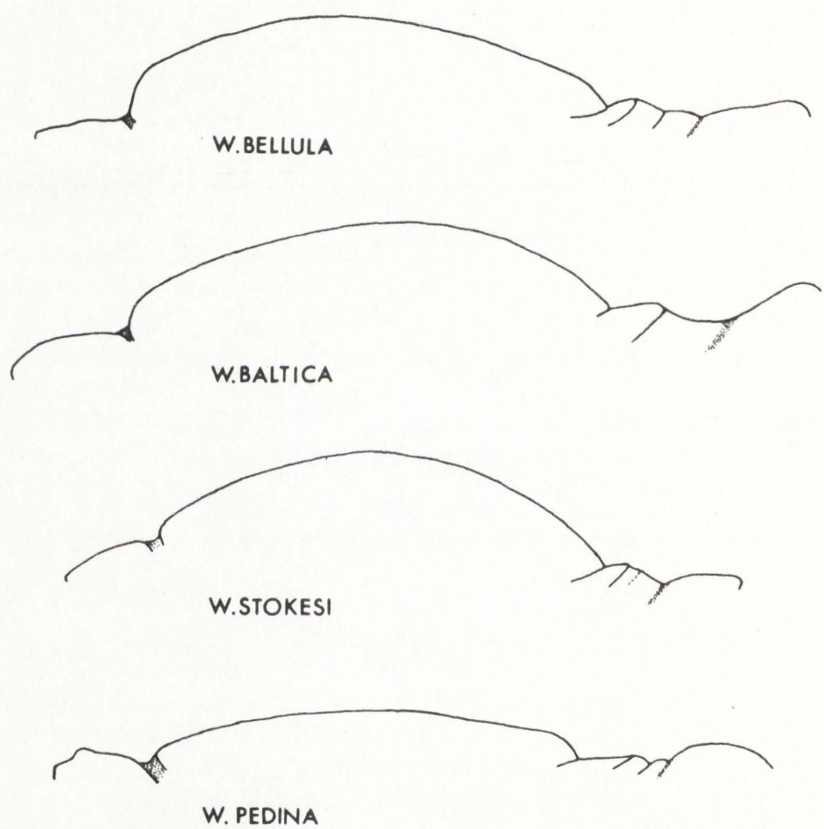


Fig. 4.2. Comparative lateral glabellar profiles of Warburgella species.

the axis. It is ventrally convex and bears between 10 and 12 terrace lines which run parallel to the margin.

DISCUSSION

Astroproetus sp. A approaches A. bellus (Maximova, 1962) from the Llandovery of the Siberian platform. This species differs in having distinct pitting on the preglabellar field, in having more clearly defined lateral glabellar furrows and in having a proportionately shorter (sag.) pygidium. Astroproetus sp. A is also close to A. amplus sp. nov., but differs from this earlier species in having more pointed ends to the lateral occipital lobes, a narrower border and beta as a more rounded angle.

Genus WARBURGELLA Reed, 1931

Type species Asaphus stokesii Murchison 1839

DIAGNOSIS

Preglabellar field moderately long (sag.) to short. Tropidium well developed. Glabellar outline trapezoidal, slightly constricted at 2p furrow, characteristically blunt anteriorly, broadest in line with mid-point of palpebral lobes. Two or three pairs of lateral glabellar furrows. 1p deep, strongly backwardly directed and partially isolating basal glabellar lobes. 2p and 3p shallow, short, with 2p backwardly directed, but less strongly than 1p, and 3p (when present) transversely directed. Occipital lobes distinct to incompletely isolated. Anterior branch of facial suture a smooth, outwardly convex curve.

Thorax of 8-10 segments. Pygidial border well-defined to absent. Pydidial axis extends nearly to border, short postaxial ridge present. Up to 11 axial rings present, 5 or 6 broad (exsag.) pleural ribs, with narrow, distinct pleural furrows.

SPECIES

W. stokesii (Murchison, 1839); W. baltica Alberti, 1963; W. bellula (Reed, 1917); W. pedina sp. nov.; W. rugulosa (Alth, 1874 (including 4 subspecies - rugulosa (Alth, 1874); rugusa (Boucek, 1934); maura Alberti, 1963; canadensis Ormiston, 1967); W. sp. A. The following species may also belong to Warburgella: glaber (Kummerow , 1927); waigatschensis (Tschern and Yak); parvula (Pompecki, 1890); yassensis (Etheridge and Mitchell, 1892).

GEOLOGICAL RANGE

Upper Llandovery to Lower Devonian (Gedinnian)

DISCUSSION

Ormiston (1967, p. 61) recently gave a new diagnosis for *Warburgella*, and commented on various aspects of the history and relationships of the genus. The diagnosis given above is essentially that of Ormiston, but revisionary work on British species has necessitated a few amendments. Out of the species which Ormiston considered to belong to *Warburgella*, *W. binodosa* Whittard is excluded, and is considered to belong to *Cyphoproetus*. Ormiston also doubtfully assigned to *Warburgella*, ?*W. rotundata* Begg 1939, ?*W. newlandensis* (Begg, 1950) and ?*W. reedi* (Begg, 1939). Revision of these species has revealed that none of them belong to *Warburgella*, and belong to the genera *Cyphoproetus*, *Otarion* and *Astroproetus* respectively. Ormiston considered that the last named genus may be a synonym of *Warburgella*, but the discovery of extra specimens of its type species has enabled a reappraisal of it, and has shown it to be generically distinct from *Warburgella*.

Although *Warburgella* appears in many faunal lists from the Upper Ordovician, all specimens identified as such have been found to belong to the morphologically similar genus *Cyphoproetus*. Ormiston (1967, p. 62) pointed out the differences between *Warburgella* and *Cyphoproetus*, and these, with some amendations, are summarised here:

	Warburgella	*Cyphoproetus*
Tropidium	Present	*Absent
Preglabellar field	Always present - stepped profile	Sometimes present - straight or convex profile
Glabellar outline	Trapezoidal	Parallel sided to weakly tapering forwards
Anterior border	Never broadened medianally	May be broadened medianally
Median tubercle on occipital ring	Lies on a transverse median line	Lies anterior to a transverse median line
Preannulus	Absent	Present on at least some species
Pygidial axis, and no. of rings	Long and narrow, barely tapering with 9-11 rings	Short, blunt, distinctly tapering, with 5-8 rings
Pygidial pleural ribs	Narrow, sharp pleural furrows, much deeper than interpleural furrows	Broad, shallow pleural furrows, a little deeper than interpleural furrows

**Cyphoproetus* aff. *binodosus* (see Pl. 30, Fig. 11), while possessing other characters of *Cyphoproetus*, has the tropidium.

While *Warburgella* and *Cyphoproetus* do have similar morphological features, they do not seem to be closely related. The presence of the preannulus, and the type of pygidium possessed by *Cyphoproetus* suggest some relationship with the Proetinae, while *Warburgella* seems to have its origins in *Astroproetus*. The Silurian genera *Prantlia*, *Rutellum* and *Ogmocybe* are probably related to *Warburgella*. All these genera have well developed basal glabellar lobes, a trapezoidal glabella, a preglabellar field, a long, narrow pygidial axis and narrow pygidial pleural furrows which are more distinct than the interpleural furrows. *Astroproetus* shows most of these features, but does not have well developed basal glabellar lobes, as its lp glabellar furrows are shallow and non-incised. The genera *Warburgella*, *Astroproetus*, *Prantlia*, *Rutellum* and *Ogmocybe* form a well defined group within the Proetidellinae. Their range of common features make them distinct from other Proetidellinae, and it may eventually be worth according them the status of a subfamily. Within these genera, the rostral plate is only known in two. In *Astroproetus* (e.g. Pl. 23, Figs. 20-22) it is the normal trapezoidal type, with the connective sutures converging backwards. In *Rutellum*, however, the connective sutures diverge backwards (e.g. Pl. 32, Fig. 13). The course of the connective sutures has not been clearly observed in *Warburgella*, but one very worn venral surface (SMC. A.28264) seems to indicate that like *Rutellum*, they diverge backwards. This may merely be an artefact, and better preserved material is required to confirm the true course. Thus the rostral plate may add extra weight to separating these genera from the Proetidellinae. *Astroproetus*, with its primitive rostral plate and lack of basal glabellar lobes could thus be either regarded as a primitive root stock, or the branch of the Proetidellinae leading to *Warburgella* and its allies.

Warburgella stokesi (Murchison, 1839)

Plate 29, Figs. 1-11

1839 *Asaphus stokesii* Murchison, p. 656, Pl. 14, Fig. 6.

1845 *Proetus stokesi* Murchison: Loven, p. 50, Pl. 1, Fig. 3.

1854 *Phaëtonides stokesi* Murchison: Angelin, p. 22, Pl. 17, Fig. 4.

1854 *Proetus stokesii* Murchison: Murchison, pl. 17, Fig. 7.

1854 *Forbesia stokesii* Murchison: M'Coy, p. 174.

1854 *Proëtus stokesii* Murchison: Morris, p. 114.

1873 Proetus stokesii Murchison: Salter, p. 134.

1877 Proetus stokesii Murchison: Woodward, p. 56.

1885 Phaëtonides stokesi Murchison: Lindström, p. 75.

non 1899 Proetus stokesi Murchison: Mem. Geol. Surv., p. 550, p. 673.

non 1904 Proetus stokesi (Murchison): Reed, p. 79, Pl. 11, Figs. 10,11.

1925 "Phaëtonides" stokesi Murchison: Warburg, p. 184.

1927 Proetus stokesi Murchison: Kegel, p. 637.

1931 Proetus (Warburgella) stokesi (Murchison): Reed, p. 14.

1935 Proetus stokesi Murchison: Reed, p. 42.

1938 Warburgella stokesi (Murchison): Whittard, p. 95, Pl. 3, Fig. 1 (non Figs. 2-3).

1967 Warburgella stokesi (Murchison): Ormiston, p. 62.

1969 Warburgella stokesii (Murchison): Alberti, p. 354.

NEOTYPE

(See Whittard, 1938, p. 95) - a nearly complete specimen (BU.176), figd. Whittard 1938, Pl. 3, Fig. 1 and refigured herein as Pl. 29, Figs. 1, 2, 4, 5.

MATERIAL

Many complete specimens and detatched exoskeletal remains.

TYPE STRATUM AND TYPE LOCALITY

Wenlock limestone, Dudley, Worcestershire.

OCCURRENCE

Wenlock limestone, Dudley and Welsh Borders.

DIAGNOSIS

Glabella broad, trapezoidal, a little wider (trans.) than it is long (sag.), with the frontal lobe bluntly rounded; preglabellar ridge present, but not conspicuous; pretropidial field slopes forwards rather steeply; genal spine broad based, blade-like and extending backwards as far as the ninth thoracic segment; thorax of 10 segments; pygidial axis with 8-9 rings, pleural areas with 5 pairs of ribs; abaxial ends of interpleural furrows fairly deep, adaxial part shallow, non-incised; no pygidial border; sculpture of fine striations, present on the glabella, palpebral lobe and cephalic margin.

DESCRIPTION

The cephalon is quite strongly vaulted, parabolic in outline and approximately twice as wide (trans.) as long (sag.), with a moderately wide, weakly convex border. The cranidium has the sagittal length somewhat greater than the palpebral width. The glabella has a trapezoidal outline and is moderately convex in longitudinal and lateral profiles. In lateral profile the posterior end of the glabella is slightly elevated above the occipital ring, and from here the glabellar contour is weakly convex until a position in front of the eye is reached. From here it curves down quite strongly to the anterior border furrow. The glabella is defined by shallow, distinct conjoined axial and preglabellar furrows. The axial furrow becomes very shallow in the region of the palpebral lobe. From the rounded posterolateral corners, the glabella widens forwards slowly to a position about half way up the basal lobes, and then narrows forwards moderately rapidly to the bluntly rounded frontal lobe, being constricted just in front of the 1p lobes. The 1p furrow is deep and prominent and weakly adaxially convex, directed backwards at an angle of 45° to an exsagittal line. Its anterior end is very shallow and situated opposite the anterior part of the palpebral lobe, but it rapidly deepens backwards and shallows slightly just before running into the occipital furrow. The 1p furrow thereby partially isolates the prominent, ovate basal lobe, which has an independent convexity from the rest of the glabella. The basal lobe is about one third of the sagittal length of the glabella and a quarter of its width (trans.). The remainder of the glabella, excluding the basal lobes is pyriform in outline. The 2p furrow is shallow, directed inwards and weakly backwards. It is situated opposite the anterior end of the palpebral lobe, and extends inwards about three quarters of the way to the sagittal line. The 3p furrow is a short distance in front of 2p, is very short and directed slightly backwards. Both 2p and 3p furrows are represented merely by interruptions in the fine striated sculpture of the glabellar surface, and are not impressed.

The occipital furrow is rather shallow, running more or less straight (trans.). The posterior slope rises up at about 45°, while the anterior is a little less steep. The occipital ring is about the same width (sag.) as the anterior border, and maintains more or less the same width laterally, where small, distinct ovate lateral occipital lobes are present. In lateral profile the occipital ring is weakly convex, reaching its greatest height in the region of the small, distinct median tubercle. Transversely it is about the same width as the widest part of the glabella. In longitudinal profile the posterior margin and the inner part of the anterior margin curve down steeply from the sagittal line, but on the lateral parts of the anterior margin the contour of the lateral occipital lobes forms a distinct change in slope and curves down rather gently.

The preglabellar field is between one fifth and one sixth the sagittal length of the glabella. A short distance in front of the glabella it is traversed by the tropidium, and in front of this is the pretropidial ridge. This is developed better in some specimens than in others. In lateral profile the post tropidial field slopes down gently from the preglabellar furrow to the tropidium. In front of the tropidium the pretropidial field slopes down rather steeply to the anterior border furrow, there being a break in slope at the posterior edge of the pre-tropidial ridge. The post tropidial field has a more or less straight profile, but the pretropidial field behind the pretropidial ridge, and the pretropidial ridge itself have a weakly convex profile.

The anterior border furrow is rather wide and shallow, but distinct. The anterior border is moderately wide, and is weakly convex in lateral profile. The anterior branches of the facial sutures are strongly divergent, and form a wide, outwardly convex curve. The posterior branches of the facial sutures have epsilon and zeta forming one broad curve, lying close to the axial furrow, and just before reaching the posterior border furrow they diverge strongly to cut the posterior margin between a third and half the distance from the lateral end of the occipital ring to the lateral border.

The palpebral lobe is large, semielliptical in outline and situated posteriorly, opposite the basal glabellar lobe. In longitudinal profile it is inclined at a shallow angle from the axial furrow, so that its abaxial part is elevated almost to the height of the lp lobe. The eye is large, and reniform, with a convex visual surface, consisting of a large number of small facets. The eye socle is poorly developed. The free cheek is large, with the weakly convex field sloping down quite steeply to the lateral border furrow. The slope is interrupted by the tropidium, whose distance from the lateral border furrow increases gradually towards the posterior. It dies out just before reaching the posterior border furrow. The posterior border furrow is rather deeper and narrower than the lateral border furrow, meeting the axial furrow about half way up the lateral occipital lobe. The posterior border is somewhat narrower and slightly more convex than the lateral border. The genal spine is long and broad-based extending backwards as far as the 9th thoracic segment. It has a distinct, deep, median groove dividing the spine into two bands of more or less equal width (trans.), and which dies out before reaching its posterior extremity. The anterior adaxial part of the genal spine overlaps the abaxial ends of the anterior segments of the thorax.

The cephalic doublure is about the same width as the border, and is quite strongly convex and bears fine, parallel terrace lines. The thorax has ten segments, with the axis tapering slowly backwards so that the last segment is about two thirds the width (trans.) of the first. The axis is moderately convex in longitudinal profile and is defined by distinct, but non-incised axial furrows. Each axial ring is arched forwards weakly sagittally. In lateral profile the annulus is weakly convex, gently inclined from anterior to posterior. The thoracic pleurae run more or less straight outwards (trans.), only curving backwards very weakly abaxially, and they are bent down weakly at the fulcrum. The posterolateral angles are produced into short backwardly and outwardly directed spines. Each pleura bears a rather strong pleural furrow which runs more or less parallel with the interpleural furrow, dividing it into an anterior and posterior pleural band of about the same width. In lateral profile both bands are weakly convex. The pleural furrow dies out a short distance from the distal end of the pleura.

The pygidium is more or less semicircular in outline, without a border. It is about twice as broad (trans.) as long (sag.). The anterior margin runs more or less straight outwards from the axial furrow, and is bent backwards at the anterolateral corners in the region of the articulating facet. Two or three terrace lines run along the posterior edge of the articulating facet. The axis is quite strongly convex in longitudinal profile, tapering backwards rather slowly to the bluntly rounded posterior end. Anteriorly the axis occupies about one quarter of the total pygidial width. It consists of 8-9 rings and is defined by distinct, but non-incised axial furrows. In lateral profile each ring is rather weakly convex, with the first being more strongly convex and elevated somewhat above thr remainder. In lateral profile the axis curves down gently from anterior to posterior, with the end of the axis suddenly sloping down steeply to the postaxial area. There is a slight break in slope between the end of the axis and the steeply sloping postaxial area, which is weakly convex. The pleural areas are quite strongly convex with 5 pairs of pleural ribs, which curve gently backwards, widening slightly abaxially. The pleural furrows are narrow, distinct and extending almost to the margin. The first interpleural furrow is discernible for its whole length, and is hardly impressed, except at the extreme abaxial end. The other interpleural furrows are usually only discernible abaxially, where like the first they turn backwards more strongly than the pleural furrow. Adaxially the anterior and posterior pleural bands are about the same width, but distally the posterior pleural band is somewhat wider, due to the course of the interpleural furrow. In lateral profile the anterior and posterior pleural bands appear as a single weakly convex rib, between each successive pleural furrow. The pygidial doublure is weakly convex, moderately wide and narrowing at the posterior end of the axis.

The sculpture consists of fine striations, localised to the glabella, palpebral lobe, cephalic border and probably the pygidial axis. The sculpture is more prominent on some specimens (e.g. Pl. 29, Fig. 7) than on others (e.g. Pl. 29, Fig. 12).

DISCUSSION

Whittard (1938, p. 96) included certain specimens from the Upper Llandovery of Shropshire in W. stokesi. These specimens, however, do not possess the tropidium, nor do they have a preglabellar field. The course of the cephalic doublure in front of the glabella indicates a sagittally broadened anterior border - a feature characteristic of Cyphoproetus. The pygidium of these specimens is also of the Cyphoproetus type, and hence they are described elsewhere (see below) as Cyphoproetus nasiger sp. nov.

Warburgella stokesi appears to be restricted to the Wenlock of the British Isles, but may be present in the Mulde Marl (Wenlock) of Gotland. Over most of Scandinavia, however, Warburgella is represented by W. baltica Alberti, 1963, a species which lacks the glabellar ridge. In the British Isles two additional species of Warburgella, W. pedina sp. nov., and W. bellula (Reed) are present in the Wenlock, and are described below. Alberti (1969, p. 355) incorrectly states W. stokesi as having 9 thoracic segments. The neotype, which only shows 9 (see Pl. 29, Figs. 1, 2), has, as Whittard suspects, the cephalon overlapping the anterior part of the thorax, and all other specimens (e.g. Pl. 29, Figs. 3, 6, 7) clearly show 10.

Warburgella bellula (Reed 1917)
Plate 30, Figs. 1-10, 12, 13, 17.

1917 Proetus stokesi Murchison, var. nov., bellula Reed, p. 165, Pl. 8, Figs. 5-10 (non Fig. 11).

LECTOTYPE (here selected)

A cranidium (SMC. A.16596), figd. Reed, Pl. 8, Fig. 6, and refigured herein as Pl. 30, Figs. 1-2.

MATERIAL

Besides the lectotype, 3 cranidia, 3 free cheeks, 3 pygidia, 1 hypostome.

TYPE STRATUM AND TYPE LOCALITY

Wenlock limestone, stream by quarry, 300 yards NE of Greenpool Farm, Usk Inlier.

OCCURRENCE

Wenlock limestone, Usk, Ledbury-Eastnor district, Wren's Nest, Dudley.

DIAGNOSIS

Closely related to Warburgella stokesi, from which it differs in the following ways: glabellar furrows 2p and 3p more distinct; pretropidial field slopes forwards less steeply; preglabellar ridge more conspicuous; genal spine more slender; pygidium with 6 pairs of pleural ribs; sculpture of short, coarse striations on the posterior part of the glabella and palpebral lobe and short coarse striations or granules on the pygidial axis and pleural areas.

DISCUSSION

Within the material included in this species, some variation in the surface sculpture is present. On the lectotype and at least one other specimen (Pl. 30, Fig. 12) the anterior part of the glabella is pitted and devoid of coarse striations, while on other specimens (e.g. Pl. 30, Fig. 3) the anteior part of the glabella is granular. On the pygidium, the interpleural furrows are either very weakly defined, with associated granules (e.g. Pl. 30, Fig. 7) or are almost detiorated into lines of very fine striations (e.g. Pl. 30, Fig. 9). In both cases the abaxial ends of the interpleural furrows are quite strongly impressed, as in W. stokesi.

For the present purposes, the variation of surface sculpture of W. bellula is taken to be intraspecific, and is possibly of sexual significance. W. stokesi also shows some variation in surface sculpture, as some specimens show distinct, continuous striations on the glabella (e.g. Pl. 29, Fig. 7), whileothers have an apparently almost smooth glabella (e.g. Pl. 29, Fig. 12). These differences may be due to preservation, or to intraspecific or sexual variation.

Warburgella pedina sp. nov.
Plate 28, Figs. 12-14, Text fig. 4.2.

HOLOTYPE

A complete specimen (BM.I.4520). The only specimen known.

TYPE STRATUM AND TYPE LOCALITY

Wenlock Shale, Wenlock Edge.

DERIVATION OF THE NAME

From the Greek pedinos, flat, alluding to the flat glabella.

DIAGNOSIS

Glabella tapers forwards strongly in front of the basal lobes, and is almost flat in lateral and longitudinal profiles, with a short, steep slope at the anterior end; 1p furrow narrow; thorax of 10 segments; pygidium with 8 axial rings and 5 pleural ribs; entire exoskeleton smooth apart from a few striations on the extreme anterior end of the glabella and on the outer part of the cephalic border; short, irregular raised ridges occur on the palpebral lobe, lateral occipital lobe and pygidial axis.

DESCRIPTION

The cephalon is parabolic in outline, with a moderately wide border. The glabella is distinctly wider (trans.) than it is long (sag.), at its widest point occupying about one third of the total cephalic width. It is very weakly inflated, and is nearly flat in longitudinal and lateral profiles sloping down steeply at the perimeter to the axial and pre-glabellar furrows. These are rather narrow, with the former shallowing and becoming wider in the palpebral region. From the bluntly rounded posterolateral corners, the glabella widens to a position opposite the anterior part of the palpebral lobe, from which it tapers forwards rapidly to the well rounded frontal lobe. It is slightly constricted opposite gamma. Three pairs of lateral glabellar furrows are present. 1p does not run into the axial furrow, and its anterior end is situated opposite the anterior part of the palpebral lobe. From this position 1p runs inwards and backwards in an inwardly convex curve at an angle of about 40° to an exsagittal line. 1p is narrow and deepest anteriorly, and shallows backwards and runs into the occipital furrow. The ovate basal glabellar lobes are incompletely isolated and very weakly convex. It is between a third and a quarter of the basal width of the glabella, and between a third and a half its length. 2p is situated at the lateral constriction of the glabella and is very inconspicuous, short and nearly transversely directed. It is represented by a very slightly impressed smooth area. 3p is a short distance in front of 2p, and is of similar nature and length.

On the extreme anterior part of the glabella there are a few prominent striations which run more or less parallel with the preglabellar furrow.

The occipital furrow is rather wide and shallow, flexed forwards weakly sagittally and laterally. The posterior slope is inclined backwards at about 45°, while the anterior slope is rather shallower. The occipital ring is rather narrow (sag.), being slightly narrower than the anterior border. Transversely it is about the same width as the glabella. In lateral profile it is convex, achieving its greatest elevation at the small median tubercle. In longitudinal profile, excepting the lateral occipital lobes, it forms a strongly convex curve. The lateral occipital lobes are small, ovoid and strongly convex, separated from the rest of the occipital ring by a wide, shallow furrow.

The preglabellar field is approximately the same width (sag.) as the anterior border. The tropidium, which runs parallel to the anterior border is two thirds of the way from the preglabellar furrow to the anterior border furrow. A short distance behind the tropidium, running nearly parallel with it is a single prominent raised striation. The preglabellar ridge is rather inconspicuous. In lateral profile (see Pl. 28, Fig. 13 and Text Fig. 4.2), the preglabellar field is stepped.

The anterior border furrow is narrow, and the anterior border is weakly convex with parallel raised striations on the outer part. The anterior branches of the facial sutures converge for a short distance in front of the palpebral lobes, running nearly parallel with the axial furrow as far as gamma. From here they diverge in a strong outwardly convex curve. The posterior branches run close to the axial furrow before diverging onto the posterior border. The palpebral lobe is rather small, posteriorly situated close to the glabella with a parabolic outline. In longitudinal profile it is inclined at a low angle from the axial furrow, and forms a continuously convex curve with the visual surface of the eye. On the abaxial part of the palpebral lobe there is a weak furrow, running parallel with the outer margin. The inner part of the palpebral lobe is traversed by four or five irregular raised ridges, some of which bifurcate. The eye is prominent and reniform, with a strongly convex visual surface which consists of a large number of small facets.

The field of the free cheek is steeply declined from the narrow, ill defined eye socle to the tropidium, which forms a distinct break in slope. Between the tropidium and the lateral border furrow, the field of the free cheek is even more steeply declined. The lateral border furrow is narrow, and shallower than the anterior. The lateral border is very weakly convex, and is declined as steeply as the inner part of the free cheek. On its outer margin parallel raised striations occur. The posterior border furrow and the posterior border are not preserved. The genal spine is fairly broad based, with a narrow median groove. Its length is unknown.

The thorax consists of 10 segments. The axis is strongly convex in longitudinal profile, tapering gently backwards so that the last ring is two thirds the width (trans.) of the first. In lateral profile the annulus is inclined backwards at a low angle from the distinct articulating furrow, and flattens posteriorly. The articulating half ring is gently convex in lateral profile, and a little shorter (sag.) than the annulus. The pleura is flat in lateral profile, and bends down quite strongly at the fulcrum. The pleural furrow is narrow and distinct, and runs very slightly backwards abaxially. The posterior pleural band is a little wider (sag.) than the anterior. In lateral profile the anterior and posterior pleural bands are gently inclined from the pleural furrow. The posterolateral corner of the pleura is bluntly pointed.

The pygidium is subparabolic in outline, without a border. The axis is narrow, and strongly convex in longitudinal profile, while in lateral profile it is inclined gently backwards. At its anterior end it is about a quarter of the total pygidial width (trans.), and it tapers very gently backwards to the bluntly rounded posterior end. The axis is about three quarters of the length (sag.) of the pygidium, and consists of 8 rings. In lateral profile, the first four are distinctly convex, with the intervening furrows fairly deep. The convexity of the rings, and the depth of the intervening furrows decreases backwards. Towards the axial furrow, all the interannular furrows become subdued. At the posterior end of the axis there is a short, poorly developed postaxial ridge. The pleural areas are weakly convex, and bear 5 pairs of ribs, which curve gently backwards and widen abaxially. The pleural furrows are narrow and distinct. The interpleural furrows do not run so strongly backwards as the pleural furrows adaxially, but abaxially run backwards much more strongly, nearly exsagittally. The interpleural furrows are shallower than the pleural furrows, and not incised. They deepen near their abaxial extremities. Neither the pleural nor the interpleural furrows reach the pygidial margin. In lateral profile the pygidial pleural ribs are only weakly convex. The postaxial area forms a distinctly concave curve. Most of the pygidium is smooth, but the sagittal part of the axis bears short, irregular transverse raised ridges, and there are similar, finer ridges on the posterior margin of the articulating facet.

DISCUSSION

While only one specimen of this species is known, it is particularly distinct in having a very flat glabella, and as the specimen is well preserved it is certain that this feature is not an artefact. Kummerow (1927, p. 38, Pl. 2, Figs. 11-12) described and figured *Phaetonides* (= *Warburgella*) *glaber* from the glacial erratics of the north German plain. He states that the glabella is very flatly vaulted, and that the exoskeleton is almost entirely smooth - both features of *Warburgella pedina*. However, other features, such as the concave outer part of the preglabellar field and the presence of a distinct pygidial border are in contrast with *W. pedina*. It seems, however, that a close relationship exists between *W. pedina* and the German species.

Warburgella sp. A

Plate 29, Fig. 10

MATERIAL

An internal mould of a cranidium (OUM.

HORIZON AND LOCALITY

Middle Llandovery, Venusbank Formation, Josey's Wood B, Minsterley.

DISCUSSION

This single, ill-preserved cranidium is the earliest known representative of *Warburgella*. That the specimen belongs to this genus is shown by the tropidium crossing the preglabellar field, and the presence of incompletely isolated basal glabellar lobes. The specimen is too poorly preserved to demonstrate its specific affinities, but it does demonstrate the presence of *Warburgella* in the Llandovery.

Genus OGMOCYBE gen. nov.

Type species *Ogmocybe pharangis* gen. et sp. nov.

DERIVATION OF THE NAME

From the Greek *ogmos*, a furrow, and *kybe*, a head, from the deep lp furrows on the glabella. Gender: feminine.

DIAGNOSIS

Similar to *Warburgella*, from which it is distinguished by the following characteristics: a very short (sag.) preglabellar field; no tropidium; more completely isolated basal glabellar lobes; thorax of 8 segments; pygidial pleural ribs with subparallel, rather shallow, narrow, pleural and interpleural furrows, the latter only slightly shallower than the former.

SPECIES

O. pharangis sp. nov.; *O. trapeziceps* sp. nov.; *O. ludlowensis* (Alberti, 1967); *O*? sp. A.

GEOLOGICAL RANGE

Upper Silurian, Ludlovian, Leintwardinian.

DISCUSSION

The most important features which distinguish this genus from *Warburgella* are the lack of the tropidium and the different type of pleural ribs on the pygidium. The overall pygidial features and the number of thoracic segments distinguish *Ogmocybe* from the morphologically similar genus *Cyphoproetus*. In the latter, the pygidium is much shorter, with a shorter, blunter axis with less rings, the pygidial pleural and interpleural furrows are wider and shallower, and the thorax has 10 segments. The pygidial structure of *Ogmocybe* infers a close association with *Warburgella*, and the presence of a ridge inside the anterior border of *O. trapeziceps* suggests analogy with the pretropidial ridge found in many *Warburgella* species.

Ogmocybe pharangis sp. nov.

Plate 31, Figs. 4, 6, 7.

HOLOTYPE

A nearly complete external mould (GSM.36747) of which a silicone rubber cast is figured herein as Plate 31, Fig. 4.

TYPE STRATUM AND TYPE LOCALITY

Ludlovian, Leintwardine (probably higher Lower Leintwardine channel deposits).

MATERIAL

Besides the holotype, three more or less complete specimens.

OCCURRENCE

Leintwardinian, Leintwardine area.

DERIVATION OF THE NAME

From Greek pharanx, a gully. This species is found in probable higher Lower Leintwardine channel deposits.

DIAGNOSIS

Glabella tapers weakly forwards, with 1p furrows nearly completely isolating basal glabellar lobes; pygidium with 9-10 axial rings and 6 pleural ribs; border weakly developed.

DESCRIPTION

The exoskeleton is elongated, and moderately vaulted. The cephalon is semioval in outline. The cranidium is about four fifths as wide across the palpebral lobes as it is long (sag.). The glabella is defined by narrow, distinct, conjoined axial and preglabellar furrows, is about as wide as long, and is weakly convex in lateral and longitudinal profiles. From the bluntly angular posterolateral corners it is nearly parallel sided as far as the middle of the palpebral lobes, and then narrows forwards gently to the bluntly rounded frontal lobe. 1p is deep, and is directed backwards at an average of about 40° to an exsagittal line, and is distinctly inwardly convex. The ovoid basal glabellar lobe is nearly completely isolated from the remainder of the glabella, and has independent convexity. It is between a half and a third as wide (trans.) as it is long (exsag.), and is about a third of the glabellar length and between a quarter and a third of its base width. 2p is very shallow, narrow, inconspicuous and runs transversely about half way towards the sagittal line, and is situated opposite the anterior end of the eye. The occipital furrow is deep, of comparable depth to the 1p furrows, and is flexed forwards sagittally and laterally. The anterior and posterior slopes are both steep. The occipital ring is moderately broad, and maintains more or less the same width exsagittally. In a median position there is a small, distinct tubercle. Abaxially there is a well isolated, ovate lateral occipital lobe. The furrow defining it deepends adaxially, and runs into the occipital furrow a little abaxially from the posterior end of the 1p glabellar furrow.

The preglabellar field is not well preserved on any of the available material, but is apparently of comparable width (sag.) to the occipital ring. Likewise the anterior border furrow and anterior border are badly preserved, but the former seems to be shallow and ill defined, and the latter perhaps weakly convex. The anterior branches of the facial sutures are strongly divergent from gamma, which lies close to the axial furrow. Beta is a rounded, outwardly convex angle, and an exsagittal line drawn backwards from it falls on the abaxial part of the eye. The posterior branches have epsilon and zeta as independent angles, with the stretch epsilon-zeta running close to and parallel with the axial furrow. Zeta is situated about half way along the lateral occipital lobe (exsag.), and from it the posterior branches diverge strongly, to cut the posterior margin about a third of the way from the axial furrow to the lateral margin.

The palpebral lobe is narrow, subcrescentic in outline, backwardly placed and close to the glabella, with its posterior end about a third of the way forward (exsag.) from the posterolateral corner of the basal glabellar lobe. It is about a third of the sagittal length of the glabella. The eye is reniform, about half the sagittal length of the glabella and supported by a low, indistinct eye socle. The field of the free cheek is broad and weakly convex. The lateral border furrow is ill-preserved on all the available material, but seems to be broad and shallow. The lateral border is also ill-preserved. The posterior border furrow is narrow and distinct, and is abruptly truncated at the base of the genal spine. The posterior border is about half the width (exsag.) of the occipital ring, is weakly convex and is gently inclined towards the posterior. The genal spine is narrow, with a distinct, narrow median groove, and extends backwards as far as the seventh thoracic ring.

The thorax consists of 8 segments, and the axis tapers backwards gently so that the last ring is between two thirds and four fifths the width (trans.) of the first. The axis is wider (trans.) than the pleurae along its entire length, except in small specimens (e.g. Pl. 31, Fig. 6). The axial rings are arched forwards weakly sagittally and laterally, and in lateral profile are very weakly convex and gently inclined towards the posterior. The articulating furrow is rather shallow. The pleura has a narrow pleural furrow which is directed obliquely outwards, converging with the posterior margin of the pleura abaxially. The pleural furrow is truncated abaxially by the posterior edge of the articulating facet. The latter meets the anterior margin of the pleura at an angle of about 130° adaxially. At this point there is a slight kink in the posterior margin of the preceeding pleura. The posterolateral corner of the pleura is bluntly angular, and the pleura is bent down at the fulcrum.

The pygidium is between half and two thirds as wide (trans.) as it is long (sag.), and is parabolic in outline with a poorly defined border. Anteriorly the axis occupies about a third of the total pygidial width, and is rather narrow and tapers backwards quite strongly. There are about 9-10 axial rings, of which the first 6 or 7 are separated by distinct interannular furrows, of which the anterior are arched weakly forwards sagittally. In lateral profile the axis slopes down gently from anterior to posterior, and each axial ring is weakly convex. Behind the axis there is a poorly developed postaxial ridge. The pleural areas are weakly convex, and bear 6 pairs of gently backwardly curving ribs which widen abaxially. The first pleural furrow is sharper and narrower than the remainder, which are narrow and rather shallow. The interpleural furrows are only a little shallower than the pleural, and each converges with the preceeding pleural furrow abaxially. The first pair of pleural and interpleural furrows reach the pygidial margin, but the remainder terminate on the inner edge of the poorly defined border. The anterior and posterior pleural bands are of more or less the same width (exsag.).

From the available material, the exoskeleton appears for the most part to be more or less smooth. The field of the free cheek of the holotype (see Pl. 31, Fig. 4) appears to be pitted with what is perhaps the dorsal expression of genal caecae.

DISCUSSION

All the material which has been identified as this species originates from old collections, and comes from the Leintwardine area. Dr. Whitaker has examined the matrix in which the specimens are preserved, and notes that the lithology is similar to that of the higher Lower Leintwardine channel deposits (see Whitaker, 1962, p. 327 etc.), and he suggests that it is probable that these specimens have originated from such deposits. Thus it seems as if this species is restricted to the channels, and it would be desirable to find well localised material to confirm this. Ogmocybe trapeziceps and O. ludlowensis, closely related species, occur in the Leintwardinian, but in the normal shelf facies.

<u>Ogmocybe trapeziceps</u> sp. nov.

Plate 30, Figs. 14-16.

HOLOTYPE

A cranidium (BM.It 8817), Pl. 30, Figs. 14 and 16.

MATERIAL

Besides the type, five cranidia.

TYPE STRATUM AND TYPE LOCALITY

Upper Leintwardine Beds, Quarry on the Diddlebury-Middlehope road, 220 yards NE of Fernhall Mill, Wenlock Edge district.

OCCURRENCE

Lower and Upper Leintwardinian, Wenlock Edge, Ludlow and Usk districts.

DERIVATION OF THE NAME

From the Latin <u>trapezium</u>, trapezium, and <u>ceps</u>, head, due to the trapezoidal glabella.

DIAGNOSIS

Glabella distinctly trapezoidal, blunt anteriorly; 2p and 3p furrows both fairly distinct; preglabellar field short (sag.), about a twelfth of the sagittal length of the glabella; a transverse ridge is developed on the posterior edge of the anterior border.

DESCRIPTION

The cranidium is rather weakly vaulted, with the palpebral width five sixths of the sagittal length. The glabella is as long (sag.) as it is wide (trans.). It is defined by narrow, but distinct conjoined axial and preglabellar furrows, and is weakly convex in lateral and longitudinal profiles. From the bluntly angular posterolateral corners the glabella widens gently forwards as far as a transverse line joining the mid points of the palpebral lobes, and from this position narrows ratherrapidly forwards, being weakly constricted at 2p. The 1p furrow is deep, and shallows at either end where it runs into the axial and occipital furrows. The anterior end is situated opposite the anterior part of thepalpebral lobe, and the furrow is directed backwards at an angle of about 40° to an exsagittal line, and is distinctly inwardly convex. The partially isolated basal glabellar lobe is ovate, and about two thirds as wide (trans.) at its widest as it is long (exsag.). It is about three eighths of the sagittal length of the glabella, and about a quarter of its basal width. It has independent convexity from the remainder of the glabella. 2p is situated a little posterior to gamma, and is directed backwards at about 70° to an exsagittal line. It is narrow and smooth, and extends adaxially betweem half and two thirds of the way towards the sagittal line. 3p is of similar nature to 2p, and is situated a little anterior to gamma, a short distance in front of 2p, and is directed weakly forwards and extends adaxially between a third and half way towards the sagittal line. The frontal lobe in front of 3p occupies about a third of the sagittal length of the glabella.

The occipital furrow is deep and broad, with the median section running more or less transversely, and the lateral parts behind the basal glabellar furrows running weakly forwards. This part of the occipital ring is narrower than the median section. The anterior and posterior slopes are quite steeply inclined. The occipital ring is about as wide (sag.) as the anterior border plus the preglabellar ridge, and maintains the same width laterally (exsag.). It is weakly convex in lateral profile, with a small, distinct tubercle in a median position. The lateral glabellar lobes are ovate, and partially separated from the rest of the occipital ring by furrows which quickly widen and shallow towards their inner ends where they run into the occipital furrow a little abaxially from the posterior ends of the 1p furrows. Transversely the occipital ring is marginally wider than the glabella.

The preglabellar field is very short (sag.), about a twelfth the sagittal length of the glabella. Immediately in front of it is the weakly convex, transversely elongated preglabellar ridge, which is defined by shallow, weak furrows. Abaxially from either end of the preglabellar ridge the anterior border furrow is narrow and distinct. The anterior border minus the preglabellar furrow is a little narrower (sag.) than the occipital ring, and is weakly convex in lateral profile. The anterior branches of the facial sutures form an abaxially convex curve, with beta bluntly angular. An exsagittal line drawn backwards from beta falls on the outer part of the palpebral lobe. The posterior branches have epsilon and zeta as a single angle, situated close to the lateral end of the occipital ring. From this position they diverge strongly onto the posterior margin, defining a minute triangular posterior portion of the fixed cheek. The posterior border furrow meets the axial furrow about half way along (exsag.) the lateral occipital lobe. The palpebral lobe is subparabolic in outline, posteriorly placed and nearly half the sagittal length of the glabella. In longitudinal profile it is inclined at a shallow angle from the axial furrow, and flattens abaxially.

The basal glabellar lobes, the palpebral lobes and parts of the occipital ring have a sculpture of very fine granules, while the remainder of the glabella and the entire preglabellar area are very finely pitted.

DISCUSSION

All but one of the cranidia belonging to this species originate from the Upper Leintwardinian, where it occurs in small numbers. The other cranidium is from the Lower Leintwardinian. The cranidium, except the lacking tropidium is extremely similar to that of Warburgella, and the preglabellar ridge of Ogmocybe trapeziceps may be analogous to the pre tropidial ridge in Warburgella. The material of Ogmocybe pharangis does not have the preglabellar area suitably preserved to indicate whether it too possesses the preglabellar ridge. Alberti (1967, p. 483, Pl. 1, Fig. 2) described and figured Proetus (sg.?) ludlowensis from the Lower Leintwardinian of the Ludlow district. He distinguished this species from Warburgella and Cyphoproetus by similar characters to those which distinguish Ogmocybe from these genera (see above). Alberti's species clearly belongs to Ogmocybe. It differs from O. pharangis in having a more strongly forwardly tapering glabella and from O. trapeziceps in having a more rounded frontal margin to the glabella. Like the latter it has a distinct preglabellar ridge.

?Ogmocybe sp. A

Plate 31, Fig. 16

MATERIAL

The anterior part of a cranidium, the only specimen known.

HORIZON AND LOCALITY

Higher Lower Leintwardine, channel deposits.

DISCUSSION

The single, incomplete cranidium has features which suggest that it may belong to Ogmocybe. The anterior border is distinctly widened sagittally, and the posterior part may be the preglabellar ridge found on O. trapeziceps, only seeming to merge with the anterior border on the internal mould. Two pairs of backwardly directed lateral glabellar furrows are present, the posterior pair probably being the anterior part of 1p. The glabella tapers rather strongly forwards, a feature which suggests that it does not belong to Cyphoproetus, as the sagittally widened anterior border might.

Genus RUTELLUM gen. nov.

Type species Rutellum malvernense gen. et sp. nov.

DERIVATION OF THE NAME

From the Latin rutellum, a little shovel, alluding to the shape of the cephalon. Gender - neuter.

DIAGNOSIS

Exoskeleton depressed; glabella trapezoidal with distinct basal lobes; preglabellar area long (sag.), about three quarters of the sagittal length of the glabella; cephalic border furrow duplicated; anterior branch of facial suture forms a wide, abaxially convex curve; rostral plate trapezoidal, with the connective sutures diverging backwards; cephalic doublure broad; thorax of ten segments; pygidium without border, axis narrow, tapering rapidly backwards; pleural areas with strong pleural furrows and interpleural furrows which become distinct abaxially.

SPECIES

Rutellum malvernense gen. et sp. nov.

GEOLOGICAL RANGE

Late Llandovery and Wenlock Shale.

DISCUSSION

The most distinctive feature of Rutellum is the rostral plate, whose connective sutures diverge backwards, a state of affairs which is unique in the Proetidae, unless the same happens in Warburgella (see above). The dorsal exoskeleton is broadly similar to that of Warburgella, but there are important differences, notably the lack of the tropidium, the duplicated, shallow cephalic border furrow, the long preglabellar area and the structure of the pygidial pleural ribs. The cephalon of Prantlia (see Pl. 46, Figs. 4, 8) is similar to that of Rutellum, but does not have the duplicated cephalic border furrow. Prantlia further differs in having only 9 thoracic segments, narrower thoracic and pygidial axes and a distinct pygidial border. Unfortunately the rostral plate of Prantlia is unknown. With its similarities to Warburgella and Prantlia, Rutellum seems to belong to the 'Warburgella branch' of the Proetidellinae. Outside this group, Rutellum shows similarities to Tropidocoryphe, particularly in the long preglabellar area, the glabellar outline and the broad cephalic doublure. It is quite possible that Rutellum and Tropidocoryphe have a common origin. The earliest Tropidocoryphe species occur in the Ludlovian of Australia (T. rattei (Etheridge and Mitchell, 1892)) and Bohemia (T. heothina sp. nov), both a little later than Rutellum. It would be of great interest to have knowledge of the rostral plate of Tropidocoryphe for further comparison with Rutellum.

Rutellum malvernense sp. nov.

Plate 32, Figs. 9, 13, 14, 15

HOLOTYPE

A complete exoskeleton (GSM 3303), Pl. 32, Fig. 15.

MATERIAL

About 12 more or less complete exoskeletons

TYPE STRATUM AND TYPE LOCALITY

Wenlock Shale, Malvern

OCCURRENCE

Woolhope Shales (top of Llandovery) and Wenlock Shale, Malvern.

DERIVATION OF THE NAME

From the occurrence of this species at Malvern.

DIAGNOSIS

Glabella with bluntly rounded frontal lobe; preglabellar area about three quarters of the length of the glabella (sag.); occipital furrow very shallow; pygidium with 6-7 axial rings and 4-5 pleural ribs. Connective sutures adaxially convex.

DESCRIPTION

The cephalon is parabolic in outline, and the anterior and lateral border furrows are duplicated, with the cephalic border indistinctly defined. The glabella is trapezoidal, about a quarter of the total cephalic width (trans.) at its base and defined by shallow, but distinct conjoined axial and preglabellar furrows. From the rounded posterolateral corners it widens as far as the middle of the palpebral lobes, then narrows forwards quite strongly to the bluntly rounded frontal lobe. It is distinctly constricted at the anterior end of the basal lobe. The glabella is weakly convex in lateral and longitudinal profiles, the convexity being weaker in lateral profile, where it slopes down gently from the occipital ring to the preglabellar furrow. 1p is situated about half way along the glabella, opposite the anterior end of the palpebral lobe, and runs backwards at about 30° to an exsagittal line. It deepens distally, but shallows again posteriorly, where it runs into the occipital furrow. The resultant basal glabellar lobe has independent convexity from the rest of the glabella. It is nearly half the length of the glabella and about a quarter of its basal width. 2p is short, incised, extends transversely adaxially about a third of the way to the sagittal line and is situated a short distance behind gamma. 3p is not far in front of 2p, a short distance in front of gamma. It is shorter than 2p, and runs slightly forwards.

The occipital furrow is very shallow and runs almost transversely. The anterior slope is inclined from it at about 40°, and the posterior slope at about half this angle. At the median part of the occipital furrow is narrow, but behind the basal glabellar lobe it widens. The occipital ring is rather wide (sag.) and maintains about the same width exsagittally. Transversely it is distinctly wider than the glabella. In lateral profile the anterior two thirds slopes down very gently to the occipital furrow, while the posterior third is almost horizontal. The lateral occipital lobes are poorly developed, and are separated from the rest of the occipital ring by very shallow, oblique furrows, whose inner ends meet the occipital furrow opposite the posterior end of 1p. There is a small median tubercle, situated a little closer to the posterior margin than to the occipital furrow.

The preglabellar area is long (sag.), about three quarters the sagittal length of the glabella. In lateral profile it is almost flat as far as the outer anterior border furrow, and the inner anterior border furrow is sometimes indicated as a slight depression. The cephalic border furrow is duplicated, with the inner furrow apparently indicating the position of the inner edge of the doublure. Both furrows are very wide and shallow, with the inner being narrower. On the preglabellar area the inner anterior border furrow runs more or less transversely, and sagittally approaches quite close to the preglabellar furrow. The outer anterior border furrow in this region runs close to and parallel with the slightly upturned, weakly convex anterior border.

From gamma the anterior branches of the facial sutures diverge in a strong, rounded, abaxially convex curve. Gamma is close to the axial furrow, and an exsagittal line drawn backwards from beta falls just abaxially to the eye lobe. The posterior branches have epsilon and zeta as a single angle, close to the axial furrow opposite the lateral occipital lobe. From this position they diverge strongly onto the posterior border, and cut the posterior margin about half way between the axial furrow and the lateral margin. The palpebral lobe is situated posteriorly, close to the basal glabellar lobe, and is crescentic in outline and rather steeply inclined from the axial furrow. The eye is large and crescentic, with a strongly convex visual surface and is about two thirds the sagittal length of the glabella. The eye is elevated a little higher than the highest point of the glabella. The eye socle is narrow, with the lower margin running more or less parallel with the upper margin. The former is defined by a weak, narrow furrow.

The inner part of the field of the free cheek, as far as the inner lateral border furrow, is weakly convex, but the stretch between the inner and outer lateral border furrows is concave. On the free cheek the inner and outer lateral border furrows both run parallel to the margin. The lateral border is rather narrow, inclined and weakly convex. The posterior border furrow is deep and narrow, and is truncated abaxially at the base of the genal spine. The posterior border is about two thirds the width (exsag.) of the occipital ring, and is gently inclined towards the posterior. The genal spine is broad based and blade like. It has a wide shallow median groove, which divides the spine into inner and outer bands of about the same width (trans.), and dies out before reaching the posterior end. The genal spine extends backwards as far as the anterior edge of the pygidium, and the posterior end is slightly upturned.

The cephalic doublure is very wide, and weakly ventrally convex. On the outer part there ~~are~~ prominent, parallel terrace lines, but the inner part is devoid of these. The rostral plate is large, trapezoidal in outline, with the connective sutures diverging backwards. These are abaxially convex. The posterior end of each connective suture reaches the inner margin of the doublure at a position below where the facial suture crosses the inner anterior border furrow (see Pl. 32, Fig. 13).

The thorax consists of ten segments. The first six axial rings maintain more or less the same width (trans.), but the remaining part of the axis tapers quite strongly backwards. In lateral profile each axial ring is inclined quite strongly towards the posterior, and is very weakly convex. Each is arched forwards gently sagittally, and the articulating furrow is narrow and distinct, with the articulating half ring weakly convex and about two thirds the length (sag.) of the annulus. The pleura is adaxially nearly horizontal, and bends down quite strongly at the fulcrum. The pleural furrow is narrow and distinct, and from it the anterior and posterior pleural bands are gently inclined, with the latter a little wider (exsag.) than the former. The pleural furrow dies out before reaching the abaxial end of the pleura, where it is truncated by the articulating facet. The posterolateral corner of the pleura is angular. Anteriorly the axis is wider (trans.) than the pleural area, but posteriorly the pleural area is wider.

The pygidium is subparabolic in outline, without a border and about twice as wide (trans.) as it is long (sag.). Anteriorly the axis is about a quarter of the total pygidial width (trans.), and tapers rapidly backwards to a blunt point, not reaching the pygidial margin. Six to seven axial rings are present, separated by poorly defined furrows which arch weakly backwards sagittally. The pleural areas are weakly convex, with 4-5 pairs of backwardly curving pleural ribs. The pleural furrows are narrow and distinct and maintain more or less the same depth along their entire length, and reach close to the pygidial margin. Abaxially each pleural furrow arches gently forwards before curving backwards again. The interpleural furrows deepen abaxially so that their abaxial parts are about as deep as the pleural furrows, and run almost parallel with the next pleural furrow behind. The anterior pleural band is rather wider (exsag.) than the posterior, and is elevated a little higher. Behind the pygidial axis there is poorly defined postaxial ridge. Like the cephalic doublure, the pygidial one is very broad, and seems to be entirely covered by parallel terrace lines.

The entire exoskeleton appears to be smooth, except for a few parallel terrace lines on the extreme margin of the cephalon, and on the posterior end of the genal spine.

DISCUSSION

This species is based on about a dozen more or less complete exoskeletons, all from the Malvern area, and all, except one, from the Wenlock shales. The exception comes from the Woolhope shales. All the material originates from old collections, and is usually labelled '*Proetus grindrodianus*', a manuscript name which has never appeared in print. Most of the material was probably collected during the building of the Malvern tunnel, and thus the section from which it came is no longer accessible.

Rutellum malvernense possesses a duplicated cephalic border furrow. Whether or not this feature is generic or specific is unknown, as *Rutellum* is monotypic. A similar feature has been noted in certain species of

Cornuproetus (Lepidoproetus) (see Alberti 1969, p. 196, Fig. 28), but here only the anterior border furrow is duplicated. The inner cephalic border furrow of Rutellum malvernense is clearly a dorsal expression of the inner edge of the doublure, and is likely to be a primary rather than a secondary feature.

?SUBFAMILY PROETINAE Salter, 1864

Genus CYPHOPROETUS Kegel, 1927

Type species Cyphaspis depressa Barrande, 1846

Cyphoproetus depressus (Barrande, 1846)

Plate 32, Figs. 8, 10-12

MATERIAL

About 10 more or less complete exoskeletons.

HORIZON AND LOCALITIES

Wenlock Shale, shaly facies of Wenlock limestone, Dudley and Malvern.

DISCUSSION

Cyphoproetus depressus occurs rarely in the British Silurian, either in the Wenlock Shale or in the shaly facies of the Wenlock limestone. Most of the specimens come from Malvern, probably from the Malvern tunnel at more or less the same horizon as Rutellum malvernense. Several specimens are sufficiently preserved to show the presence of the pre-annulus (see Pl. 32, Figs. 8 and 11), a feature of special significance in Cyphoproetus (see also Chapter 8), suggesting some relationship with Proetus. The presence of Cyphoproetus depressus in Britain seems to be complementary to that of Warburgella stokesi and W. bellula, the former occurring in muddy deposits and the latter in calcareous deposits. The two are not known to occur together.

Cyphoproetus strabismus Owens

Plate 31, Fig. 15, Plate 32, Figs. 1-7

MATERIAL

One cephalon, 3 cranidia, 1 pygidium with parts of 6 attached thoracic segments, 2 isolated pygidia.

HORIZON AND LOCALITY

Upper Wenlock, Inndgreni zone, stream near Court House, Kingswood, ?
Long Mountain.

DISCUSSION

The Long Mountain specimens are sufficiently similar to those of C. strabismus from Bohemia to be considered conspecific; small differences do exist, for example in the number of pygidial axial rings and pleural ribs and in the width of the thoracic axis. The last feature has been exaggerated by vertical compression (see Pl. 46, Fig. 14) and by lateral compression (see Pl. 32, Fig. 7) in the specimens illustrated. C. strabismus occurs in dark shales in the Long Mountain, while it occurs in more or less contemporaneous dark muddy limestone in Bohemia. The controlling environmental factor for this species may have been depth.

Cyphoproetus externus Reed 1935

Plate 31, Figs. 8, 11, 12, 14

1904 Proetus stokesi (Murchison), 1839: Reed, p. 79, Pl. 11, Figs. 10, 11.

1935 Proetus (Cyphoproetus) externus sp. nov.: Reed, p. 42, Pl. 11, Fig. 15.

HOLOTYPE

A cranidium (HM. A.1032), figd. Reed 1935 Pl. 11, Fig. 15, and refigured herein as Pl. 31, Figs. 11 and 14.

MATERIAL

Four more or less complete internal moulds, and a number of isolated cranidia, free cheeks and pygidia.

TYPE STRATUM AND TYPE LOCALITY

Middle Llandovery, Saugh Hill Group, Newlands, near Girvan.

OCCURRENCE

Lower and Middle Llandovery, Mulloch Hill and Newlands, Girvan district.

DIAGNOSIS

Glabella distinctly constricted laterally; basal glabellar lobes incompletely isolated and elongated exsagittally; preglabellar field very short (sag.); anterior border not widened sagittally.

DESCRIPTION

The cranidium has the palpebral width about four fifths of the sagittal length, and the glabella is a little longer (sag.) than wide, or as wide as long. The glabella is defined by distinct, shallow conjoined axial and preglabellar furrows and is weakly convex in lateral and longitudinal profiles. From the bluntly rounded posterolateral angles the glabella widens forwards as far as the anterior part of the basal lobe, and from here narrows forwards rather gently, being weakly constricted at the anterior end of the basal lobe. The frontal lobe is bluntly rounded. 1p glabellar furrow is shallow at its anterior end, but rapidly deepens before shallowing again where it runs into the occipital furrow. It thereby partially isolates an exsagittally elongated basal lobe. At its base, the basal lobe is about a quarter of the basal glabellar width, and exsagittally is about a third of the sagittal length of the glabella. It has independent convexity from the remainder of the glabella. 2p is situated at the constriction in the glabella, and is faint, short and directed almost transversely adaxially, 3p, when apparent is situated a short distance in front of 2p, and is of a similar nature.

The occipital furrow is rather narrow and runs nearly transversely, but is deflected backwards behind the basal lobe. The anterior slope is nearly vertical, while the posterior slope is inclined at about 45°. The occipital ring is wide (sag.) and is nearly flat in lateral profile. It is rather wider than the glabella transversely, and maintains more or less the same width (exsag.), Small, very poorly defined lateral occipital lobes are present, and only the inner end of the furrow that defines them is discernible. It is wide and shallow, and runs into the occipital furrow a little abaxially from the 1p furrow. In a median position there is a small median tubercle.

The preglabellar field is extremely short (sag.), and it is difficult to separate it from the anterior border furrow. As all the specimens examined are internal moulds, it is quite possible that no preglabellar field exists on the original dorsal surface. The anterior border is rather narrow, steeply upturned and convex. The anterior branches of the facial sutures are rather weakly divergent. Gamma is a long, wide angle close to the axial furrow, and beta is a narrower, abaxially convex curve, and an exsagittal line drawn backwards from it falls on the abaxial part of the palpebral lobe. The posterior branches have epsilon and zeta as a single angle, close to the abaxial end of the occipital furrow. From this position they diverge strongly onto the posterior border, and cut the posterior margin about a third of the way from the axial furrow to the lateral margin.

The palpebral lobe is narrow, crescentic in outline and placed opposite the basal glabellar lobe. It is inclined steeply from the axial furrow, and flattens abaxially. The eye is about half the length of the glabella, and is crescentic in outline. There is apparently no distinct eye socle. The field of the free cheek is convex and slopes down quite steeply from the eye region. The lateral border furrow is apparently rather shallow, but is not well preserved on any of the material examined. The lateral border is apparently similar to the anterior border. The posterior border furrow is narrow and deep, and is abruptly truncated at the base of the genal spine. It runs into the axial furrow about half way along (exsag.) the abaxial end of the occipital ring. The posterior border is rather narrow and inclined towards the posterior. The genal spine is rather long, extending as far back as the sixth thoracic segment, and is narrow. There is a slight inward flexure of the lateral margin at the base of the genal spine.

The cephalic doublure is rather narrow, ventrally convex and bears distinct, parallel terrace lines.

The thorax consists of 10 segments. The axis tapers quite rapidly backwards so that the last ring is about two thirds the width (trans.) of the first. At the anterior end, the axis is as wide as the pleural areas, but at the posterior the latter are wider. The axial ring is arched forwards sagittally and laterally, and is weakly convex in lateral profile. The pleura bears a prominent, oblique pleural furrow, which runs gently backwards abaxially, dying out before reaching the abaxial extremity of the pleura. The anterior and posterior pleural bands are both of more or less the same width (exsag.). The pleura is bent down quite strongly at the fulcrum, and the posterolateral corner is pointed.

The pygidium is subparabolic in outline, and is nearly twice as wide (trans.) as it is long (sag.). Anteriorly the axis occupies about a quarter of the total pygidial width, and tapers gently backwards to the bluntly rounded posterior end, not reaching the posterior margin. In longitudinal profile it is strongly convex. At least four axial rings are present, separated by wide, forwardly arched interannular furrows. The pleural areas are gently convex, with 3 pairs of ribs, and possibly a fourth. The pleural ribs curve gently and evenly outwards and backwards, and widen slightly abaxially. The pleural furrows are only marginally deeper than the interpleural furrows, and both extend close to the pygidial margin and run almost parallel. The resultant anterior and posterior pleural bands are therefore of about the same width (exsag.), and both are weakly convex. Behind the axis there is a very poorly developed postaxial ridge, and there is no pygidial border. The pygidial doublure is fairly wide, and bears fine, subparallel terrace lines.

DISCUSSION

When Reed (1935, p. 42) described his new species Cyphoproetus externus he based it on a single cranidium, and stated that it was allied to Proetus (= Warburgella) stokesi, but did not directly compare it with specimens from the Girvan area which he had previously described (1904, p. 79, Pl. 11, Figs. 10-11) as the latter. Comparison of these, and additional specimens with the type of C. externus has shown that they belong to this species rather than to W. stokesi, which is unknown before the Wenlock. The type of C. externus does differ from the other specimens in possessing a wider occipital ring (cf. Pl. 31, Fig. 11, and Figs. 8 and 12), but it is likely that it is damaged on the latter, so that the differences are probably apparent rather than real.

C. externus is rather similar to an undescribed species of Cyphoproetus from the Llandovery (Stage 6) of the Oslo Region, Norway, and is one of several Girvan proetid species which are comparable with Norwegian ones. Fuller comparison must await description of the Norwegian species.

Cyphoproetus binodosus (Whittard, 1938)
Plate 31, Figs. 5, 9, 10, 13

1938 Warburgella binodosa sp. nov.: Whittard, p. 97, Pl. 3, Fig. 4.
1967 Warburgella binodosa Whittard, 1938: Ormiston, p. 62.

HOLOTYPE

A cranidium (GSM 36000), figd. Whittard Pl. 3, Fig. 4, and refigured herein as Pl. 31, Fig. 13.

MATERIAL

Besides the holotype, one cranidium (Pl. 31, Fig. 9); a free cheek (Pl. 31, Fig. 5), and a cephalon with parts of 6 thoracic segments (Pl. 30, Fig. 11), may belong to this species.

TYPE STRATUM AND TYPE LOCALITY

Upper Llandovery, Purple Shales, Onny River section, near Cheney Longville.

OCCURRENCE

Upper Llandovery and Lower Wenlock, South Shropshire.

DIAGNOSIS

Glabella tapers rather strongly forwards, frontal lobe truncated; basal glabellar lobes incompletely isolated; anterior border very wide

wide (sag.), about half of the sagittal length of the glabella; occipital ring considerably wider (trans.) than the glabella.

DESCRIPTION

The cranidium is weakly vaulted. The glabella is a little wider (trans.) than it is long (sag.) and is weakly convex in lateral and longitudinal profiles. It is defined by wide, deep conjoined axial and preglabellar furrows and is trapezoidal in outline. From the rounded posterolateral angles the glabella widens forwards weakly for a short distance, as far as a position half way up the basal lobes, and from here narrows rapidly to the bluntly truncated frontal lobe. 1p is deep but shallow anteriorly and posteriorly and is directed backwards at about 35° to an exsagittal line. The basal lobe is ovate, with independent convexity from the remainder of the glabella, and are about half its length and between a third and a quarter of its basal width. A little anterior to gamma there is a short, shallow 2p furrow, which is directed forwards.

The median portion of the occipital furrow is about the same depth as the preglabellar furrow, and runs transversely. The abaxial portions are weakly deflected backwards behind the basal lobes. The anterior and posterior slopes are both rather steep. The occipital ring is about half the width (sag.) of the anterior border, and transversely it is distinctly wider than the glabella. In lateral profile the anterior part slopes down to the occipital furrow, while the posterior part is nearly horizontal. There is a small tubercle situated about two thirds of the way from the posterior margin to the occipital furrow. The moderate sized lateral occipital lobes are ovate, and partially isolated from the rest of the occipital ring by an oblique furrow which widens and deepens towards the occipital furrow, which it runs into a little abaxially from the posterior end of the 1p furrow.

The anterior border is very wide (sag.), about half the sagittal length of the glabella, and is weakly convex in lateral profile. It occupies the entire preglabellar area, there being no preglabellar field. The anterior border furrow is wide and shallow. The anterior portion of the fixed cheek is distinctly convex. The anterior branches of the facial sutures are strongly divergent from gamma, which lies close to the axial furrow. Beta is a wide, abaxially convex curve. The posterior branch has epsilon and zeta as a single angle, which lies close to the axial furrow, and from here runs outwards and backwards to define a small triangular posterior portion of the fixed cheek. The posterior border furrow meets the axial furrow close to the posterior end of the occipital lobe. The posterior border is rather narrow. The palpebral lobe is not preserved on any of the available material.

The surface of the glabella and occipital ring at least has a sculpture of fine granules.

Associated with the cranidium from the lower Wenlock of Buttington Brick Works (Pl. 31, Fig. 9), there is a free cheek (Pl. 31, Fig. 5) which shows a similar surface sculpture. This specimen may belong to *C. binodosus* but the lateral border at the facial suture is rather narrow, and separated from the field of the free cheek by a deep lateral border furrow, which is in contrast to the wide anterior border and shallow lateral part of the anterior border furrow.

DISCUSSION

Whittard (1938, p. 97) placed this species in *Warburgella*, but the presence of the sagittally widened anterior border, the anterior position of the median occipital tubercle, and the lack of both preglabellar field and tropidium suggest that it should be placed in *Cyphoproetus*. Whittard (p. 97) supposed the widened anterior border to constitute the tropidium, but he evidently misunderstood this feature in its present conception, and did not mention it in *Warburgella stokesi* which he described in the same paper.

A specimen from the Upper Llandovery Purple Shales near Church Stretton figured as Pl. 30, Fig. 11, is similar to *C. binodosus*, but has a distinct tropidium. The cranidium also differs in other features, such as the presence of a short (sag.) preglabellar field, the shallower 1p furrows and the length-breadth proportions of the glabella. Despite the tropidium, this specimen has distinct *Cyphoproetus* features - the very broad anterior border, the forwardly placed median occipital tubercle, and possibly the preannulus (there is some indication of this feature on the third thoracic axial ring). Because of these features, this specimen is considered to belong to *Cyphoproetus* - the only representative of that genus with the tropidium. Until more information is available on *C. binodosus*, this specimen is figured as *C.* aff. *binodosus*. Information on the pygidium would be highly desirable.

Cyphoproetus nasiger sp. nov.

Plate 31, Figs. 1-3 ; text-fig 1.

1878 Proetus nasiger Edgell MS; Newton and Etheridge, p. 72.

1927 Proetus sp. undescr.: Whittard, p. 751.

1938 Warburgella stokesi (Murchison) pars.: Whittard, p. 95, Pl. 3, Figs. 2, 2a, 3 (non Fig. 1).

HOLOTYPE

A nearly complete internal mould (GSM.35999) figd. Whittard 1938, Pl. 3, Fig. 3, and refigured herein as Pl. 31, Fig. 1.

TYPE STRATUM AND TYPE LOCALITY

Upper Llandovery Purple Shales, Onny River section, near Cheney Longville.

MATERIAL

Besides tye type, 1 internal mould with counterpart external mould, and 1 additional poorly preserved internal mould.

OCCURRENCE

Upper Llandovery, Pentamerus Beds and Purple Shales, South Shropshire.

DERIVATION OF THE NAME

Wyatt Edgell's old manuscript name nasiger is revived for this species.

DIAGNOSIS

Glabella hardly tapering forwards; no preglabellar field; anterior border widened sagittally; occipital ring only marginally wider (trans.) than the glabella; lateral border of cephalon not incurved at the base of the genal spine.

DESCRIPTION

The cephalon is roughly semicircular in outline. The glabella is as wide, or a little wider than long (sag.), and is moderately convex in lateral and longitudinal profiles. The glabella is subquadrate in outline, and is defined by narrow, distinct conjoined axial and preglabellar furrows. From the bluntly angular posterolateral corners it widens very gradually forwards until about half way up the basal lobes, from where it tapers forwards very gradually to the bluntly rounded frontal lobe, being weakly constricted opposite gamma. 1p glabellar furrow is deep in its median portion, and shallows at either end, and is directed backwards at about 45° to an exsagittal line. The resultant partially isolated 1p lobe is ovate, elongated in an exsagittal direction with independent convexity from the remainder of the glabella. It is about two fifths of the sagittal length of the glabella, and a quarter of its basal width.

Short, faint, transversely directed 2p is present at about the lateral constriction of the glabella.

The occipital furrow is deep and rather narrow. The median portion runs more or less transversely, with the abaxial portions deflected backwards behind the basal glabellar lobes. The occipital ring is apparently narrower (sag.) than the anterior border. It is weakly convex in lateral profile and gently inclined towards the posterior. Small, ovate, inconspicuous lateral occipital lobes are developed, separated from the remainder of the occipital ring by shallow furrows, which run into the occipital furrow a little abaxially from the posterior ends of the lp furrows. The anterior border is distinctly widened sagittally, and there is no preglabellar field.

The anterior branches of the facial sutures are moderately divergent in a rounded, abaxially convex curve. An exsagittal line drawn backwards from beta falls on the outer part of the eye. Gamma is close to the axial furrow, opposite the lateral constriction of the glabella. The posterior branches have epsilon and zeta as a single angle, situated close to the axial furrow, opposite the lateral occipital lobe. From this point the sutures diverge onto the posterior border to cut the posterior cephalic margin about half way between the axial furrow and the lateral margin.

The palpebral lobe is rather narrow, crescentic and backwardly placed, opposite the basal glabellar lobe. It is inclined at about 30° to the axial furrow, and is not elevated as high as the sagittal region of the glabella. The eye is rather large and reniform, supported on a low, indistinct eye socle. The field of the free cheek is convex, and slopes down gently to the lateral border furrow, which is broad and shallow. The lateral border is broad and weakly convex. The posterior border furrow is narrow and deeper than the lateral, and meets the axial furrow about half way along the abaxial end of the occipital ring (exsag.). The posterior border is narrower than the lateral, and is inclined towards the posterior. The genal spine is rather narrow based, and extends backwards as far as the seventh thoracic segment.

The thorax consists of 10 segments. Anteriorly the axis is wider (trans.) than the pleural areas, but posteriorly the latter are wider. The axis tapers gently backwards so that the last ring is about three quarters of the width of the first (trans.). In longitudinal profile the axis is quite strongly convex. Each ring is arched gently forwards sagittally, and in lateral profile is gently convex and inclined towards the posterior. The pleura bears a prominent pleural furrow which runs obliquely outwards and is truncated abaxially by the articulating facet. The posterior pleural band is a little wider than the anterior (exsag.), and the posterolateral corner of the pleura is angular. The pleurae bend down gently at the fulcrum.

The pygidium is subparabolic in outline, and about twice as wide (trans.) as it is long (sag.). Anteriorly the axis occupies about a quarter of the total pygidial width, and tapers gently backwards to the bluntly rounded posterior end. It consists of about 5 rings, separated by shallow interannular furrows. In lateral profile each ring is weakly convex and gently inclined towards the posterior. The pleural areas are rather broad, weakly convex and bear about 4 pairs of rather indistinct ribs. Both pleural and interpleural furrows are shallow, and run more or less parallel and extend close to the pygidial margin. The anterior and posterior pleural bands are of about the same width (exsag.). There is a poorly defined postaxial ridge, and there is no pygidial border.

The cephalic doublure is ventrally rather strongly convex, and bears strong, parallel terrace lines. On the holotype (Pl. 31, Fig. 1) the trapezoidal rostral plate is clearly seen, and this has the rostral suture about twice the length (trans.) of the hypostomal suture. The connective sutures converge backwards. The pygidial doublure is narrower and the cephalic, but like it is ventrally convex and bears strong, parallel terrace lines.

DISCUSSION

This species occurs rarely in the Upper Llandovery of South Shropshire, and it was considered by Whittard (1938, p. 97) to belong to Warburgella stokesi. However, the Upper Llandovery specimens have the sagittally widened anterior border, and lack the preglabellar field and the tropidium - features of Cyphoproetus and not Warburgella. One specimen (Pl. 31, Fig. 2) shows a suggestion of a tropidium on the posterolateral part of the free cheek, and the pygidium, while not like that typical for Warburgella seems to have abaxially deepened interpleural furrows, a feature found on Warburgella, but not Cyphoproetus. It is thus possible that this specimen is an early Warburgella species, and it is with some doubt that it is included in Cyphoproetus nasiger.

CHAPTER 5

BRITISH SILURIAN PROETINAE, AND RELATED FORMS FROM SCANDINAVIA

ABSTRACT

All known members of the Proetinae from the British Isles are revised and closely related species from Gotland are compared and figured. The types of the old species Proetus latifrons (M'Coy) and Proetus fletcheri Salter are illustrated by photographs for the first time. Comparison of British material with the type and other specimens of Proetus concinnus Dalman) has shown that this species is present in the British Silurian. The new Proetus species P. astringens, P. bravonii, P. confossus, P. dudleyensis, P. falcatus and P. haverfordensis are defined. A new species of Schizoproetus, S. tiro is the earliest known representative of that genus, hitherto only known from the Devonian. An attempt is made to relate the Silurian Proetus species to later Devonian ones, and 5 groups of Proetus species in the Silurian are recognised.

INTRODUCTION

In the nineteenth century, Murchison (1839, 1854), M'Coy (1846), and Salter (1848, 1873) figured Proetus species from the Silurian of the British Isles, and in the present century Reed (1901, 1904, 1916) and Curtis (1958) figured additional species. Most of the figures are inadequate by modern standards, and it has hence been necessary to refigure all the old species. There has been considerable confusion in the interpretation of certain species, particularly Proetus latifrons (M'Coy). Salter (1848) misinterpreted M'Coy's species, and many later workers followed his interpretation of the species until Reed (1904) noticed the mistake.

RELATIONSHIP OF SILURIAN PROETINAE

Whittington and Campbell (1967, p. 456) and Campbell (1967, p. 15) have suggested that the subgenus Proetus (Proetus) might be confined to a group of Middle and Late Silurian species centred on Proetus (Proetus) concinnus (Dalman). They noted a range of common characters present in this group, including:

glabellar shape and outline of the muscle areas

fine pitting on the field of the free cheek

lack of a distinct pygidial border

incurving of marginal terrace lines onto the pleural regions of

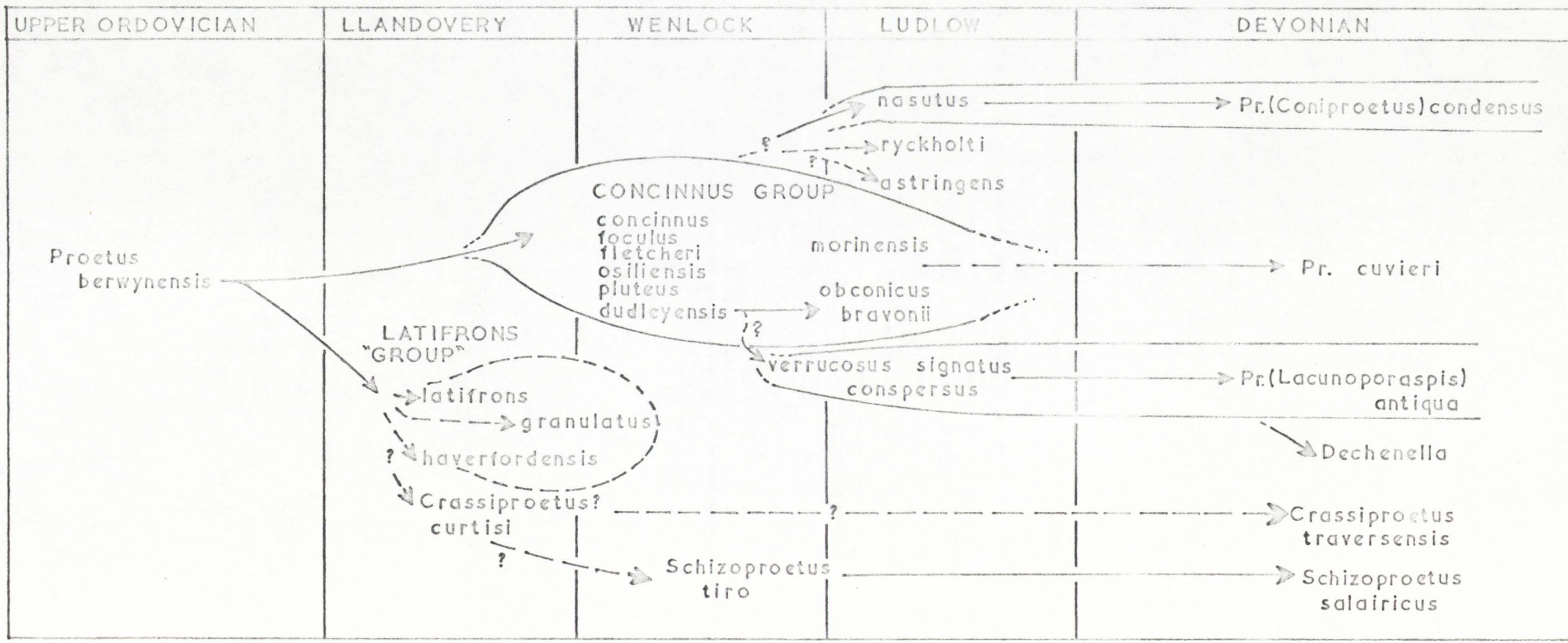


Fig.5.1. Possible relationships between Silurian Proetus species and closely related Ordovician and Devonian taxa.

the pygidium
prominent genal spines
fine granulation on the glabella
position of the eye lobe.

Whittington and Campbell (1967, p. 457) also noted a similarity between the Proetus (Proetus) concinnus group and the Middle Devonian species, Proetus cuvieri. They indicated that only minor differences exist between cuvieri and the concinnus group, including the proportions of the glabella, the length of the genal spine, presence of strong tubercles on the surface of some specimens of cuvieri and the lack of incurved terrace lines on the pygidium of cuvieri, and considered that these differences did not warrant a subgeneric distinction. Examination of further Devonian species such as P. myops Barrande, P. micropthalmus Pribyl and P. bohemicus Hawle and Corda has shown that these, together with cuvieri share some or all of the following characters:

genal spine very short, or lacking
small eye lobe
distinct eye platform
no incurved marginal terrace lines on the pygidium.

On the basis of these characters there is an argument in favour of separating the Devonian species subgenerically from the concinnus group. Out of the Devonian species mentioned above, P. bohemicus differs from the others in having a distinct pygidial border, while P. myops lacks a distinct eye platform. If these species are to be separated subgenerically from Proetus (Proetus), it is thus likely that more than one subgenus is represented. Until a full revision of these Devonian forms is undertaken, it is perhaps wise to merely refer them to Proetus. Thus, for the present purposes Proetus (Proetus) is only used for the Silurian concinnus group of species, and the following are considered to belong:

P. (P.) bravonii sp. nov.
P. (P.) concinnus (Dalman)
P. (P.) confossus sp. nov.
P. (P.) dudleyensis sp. nov.
P. (P.) fletcheri Salter
P. (P.) foculus Campbell
P. (P.) morinensis Pribyl
P. (P.) obconicus Lindström
P. (P.) osiliensis Schmidt
P. (P.) pluteus Whittington and Campbell

The geological range of this group of species is from the Wenlock to the Leintwardinian stage of the Ludlow.

Two Ludlovian species, P. ryckholti Barrande and P. astringens sp. nov. show similarities to members of the concinnus group. P. ryckholti is quite similar to P. (P.) obconicus (cf. Pl. 36, Figs. 6-8, 12-14 and Pl. 42 Figs. 1-3), but differs in having a wider, flatter anterior border and a short (sag.) preglabellar field, and it seems to lack the distinct pitting on the free cheek and on the anterior portion of the fixed cheek. P. astringens approaches P. (P.) dudleyensis, but its glabella tapers more strongly forwards and the genal spine is longer. P. ryckholti has been included in Proetus (Coniproetus) by Alberti (1966, 1969), and shares the glabellar shape and rather broad flattened anterior border with its sub-genotype, P. (C.) condensus Pribyl, 1965 (cf. Pl. 42, Figs. 1-3 and 4). P. ryckholti lacks the distinct pygidial border which seems to be a characteristic of P. (coniproetus) as well as the rather coarse, granular sculpture, but it, and possibly P. astringens, are descendents of the line leading to P. (Coniproetus). A true representative of P. (Coniproetus), P. (C.) nasutus sp. nov. is already present in the early Ludlovian of Bohemia. P. ryckholti and P. astringens are not presently assigned to any subgenus, but at a later date it may be possible to assign the former to P. (Coniproetus) and the latter to P. (Proetus).

Proetus (Proetus) obconicus and P. (P.) bravonii show some tendency in their morphology towards a group centred on Proetus signatus Lindström and may be descendents of the branch leading to the latter. Tendencies towards the signatus group shown by these species include reduction in the size of the eyes, a comparative narrowing of the pygidial axis and a broadening of the pleural areas, together with an increase in the number and depth of the pygidial pleural and interpleural furrows. The group based on signatus includes P. signatus Lindström, P. verrucosus Lindström P. conspersus Lindström, P. pulcher Neiszkowski and P. barrangus Haas. It is possibly represented in the British Silurian, and occurs widely in Gotland, Estonia, the Harz (Germany) and N.W. Turkey. Haas (1968, p. 77) has pointed out common features of some of these species, including the elongated, pyriform glabella, weakly vaulted in lateral profile, the slender pygidial axis and the rather flat pygidial pleural areas. To these may be added the small eye (in most species), the large number of pygidial axial rings and pleural ribs and the distinct granular sculpture. Haas considered members of this group to be a species group within Proetus (Proetus) rather than a distinct subgenus. However, certain species, especially signatus are very similar to the early Devonian species

Lacunoporaspis antiqua Yolkin, 1966, and there is good reason to place species of the signatus group in Lacunoporaspis, with which they have far more in common than with Proetus (Proetus). Yolkin placed Lacunoporaspis in the Dechenellinae, and although it shows some tendencies towards members of that subfamily, the gross morphology shows greater affinity with the Proetinae, and Lacunoporaspis is here included as a subgenus of Proetus.

The remainder of the Silurian species of Proetus can be placed into two groups - a few species centred on P. latifrons (M'Coy) and the single species Proetus falcatus sp. nov. The former includes P. latifrons, P. granulatus Lindström and P. haverfordensis sp. nov. It is characterised by a broad, coniform glabella, rather small eyes and short or absent genal spines. The overall morphology is similar to that of P. berwynensis (Whittington) from the Ordovician of North Wales, so perhaps it represents the primitive Proetus stock from which later groups have arisen. The coniform glabella invites comparison with members of Proetus (Coniproetus), but other characters of this subgenus are not present. Proetus falcatus sp. nov. has a distinctive morphology which separates it from other Proetus species - strongly divergent anterior branches of the facial sutures, a narrow, elongated glabella and a distinct pygidial border. The last feature suggests some relationship with Proetus (Coniproetus). The P. latifrons group and P. falcatus may eventually form the basis for two new subgenera.

Specimens from the late Wenlock Halla beds of Gotland have been identified as a new species of Schizoproetus, S. tiro, and the same species is probably present in the Wenlock Limestone of Dudley. This is the earliest representative of that genus, on which Yolkin (1968) based a new subfamily, the Schizoproetinae. Schizoproetus was previously classified with the Dechenellinae. Yolkin (1968) has suggested that Dechenella may have its origins in Proetus (Lacunoporaspis), and this suggestion is considere here as to be the most plausible of those put forward. P. (Lacunoporaspis) is believed to have its origins in the P. (Proetus) concinnus group, but such an origin is unlikely for Schizoproetus. Rather it may be related to Crassiproetus? curtisi nom. nov. (see Pl. 39, Fig. 4) which occurs in the Upper Llandovery. C? curtisi may be linked to Proetus through such species as P. haverfordensis, which shares the rather large pygidium. Because Schizoproetus appears to have a separate origin from Dechenella, I prefer to place it in Yolkin's subfamily the Schizoproetinae, rather than classify it with the Dechenellinae.

DISTRIBUTION

The distribution of Silurian Proetus species seems to be largely controlled by lithofacies. In the Llandovery Proetus is poorly represented in the British Isles, and species of the "latifrons group" (see above) occur sporadically in South Wales and Eire. In the Wenlock Shales of the Mendip Hills, personal collecting has shown P. latifrons to be the commonest trilobite, but the species is not known from the Wenlock Shales elsewhere. In the Wenlock Shales and in shaly intercalations of the Wenlock Limestone, P. falcatus, P. (P.) fletcheri and P. (P.) dudleyensis predominate. The last named is very similar to the North American species P. (P.) pluteus and P. (P.) foculus, and such a similarity supports a similar Wenlock age for the deposits in which they occur, bearing out the suggestions made by Whittington and Campbell (1967, p. 449) and Campbell (1967, p. 11). Unfortunately, many of the specimens of P. (P.) dudleyensis and P. (P.) fletcheri from Dudley are poorly localised stratigraphically. A large number of shale bands intercalate the Dudley Wenlock limestone sequence (see Butler, 1939), and it is impossible to ascertain from which of these bands the specimens originate. Thus, it is not possible to estimate the precise stratigraphical range.

In the purer limestone facies of the Wenlock limestone Proetus (Proetus) concinnus predominates, and this species also occurs in the Mulde Marl of Gotland. In the Nodular Beds of Dudley P. (P.) confossus is common, accompanied by occasional P. (P.) concinnus. Schizoproetus ?tiro occurs very rarely in the Wenlock limestone at Dudley, but is exceedingly abundant in the Wenlock Halla Beds of Gotland.

From the above, it can be seen that different species of Proetus (Proetus) prefer different types of facies - dudleyensis and fletcheri dominating the more argillaceous beds and concinnus and confossus the more calcareous beds. P. (P.) concinnus, P. (P.) dudleyensis and P. falcatus linger on until the early Ludlovian, but they are quickly replaced by new species. In the Eltonian and Bringewoodian Proetus is not common, and is represented by P. astringens. This species is replaced in the later Bringewoodian by P. (P.) bravonii, which becomes abundant in the Leintwardinian. This species is extremely common at certain horizons, especially at the top of the Lower Leintwardine Beds. In the Kendal area, many specimens are complete, and a smaller proportion of complete specimens occur in the Ludlow and Usk areas. In the Channel-fill deposits near Leintwardine, e.g. at Marlow (see Whitaker, 1962) bands are crowded with disarticulated remains of this species, which have been washed in from the shelf. Another Proetus species occurs rarely in the channel deposits of the Leintwardinian. In the Ludlovian of Gotland the totally different facies is characterised by different species such as Proetus (Lacunoporaspis) signatus and P. (L.) conspersus.

SYSTEMATIC PART

Family PROETIDAE Salter 1864

Subfamily PROETINAE Salter 1864

Genus PROETUS Steininger 1831

Synonyms, Gerastos Goldfuss 1843; Aeonia Burmeister 1843; Forbesia M'Coy 1846

Type species Calymmene concinna Dalman, 1828

OCCURRENCE

Upper Ordovician to Upper Devonian, cosmopolitan.

DIAGNOSIS

Glabella parallel-sided, conical or pyriform; preglabellar field, when present, is minute; lateral glabellar furrows inconspicuous dark areas, sometimes interrupting glabellar sculpture or weakly impressed; one or more pairs of auxiliary impressions commonly developed; occipital ring not narrowed laterally, with or without distinct lateral occipital lobes; genal angles rounded or produced into genal spines; rostral plate triangular or trapezoidal, connective sutures converging backwards; panderian notch present on doublure at base of genal spine; hypostome with prominent anterior wings, with or without paired spines on posterior margin; thorax of 10 segments, preannulus present; pygidium with 6-9 axial rings, no distinct postaxial ridge; pleural areas with anterior and posterior pleural bands of equal width (exsag.) and convexity; pygidial border may or may not be present; exoskeleton smooth or granular, sometimes with localised pitting.

Subgenus PROETUS (PROETUS) Steininger 1831

Subgenotype Calymmene concinna Dalman, 1828

OCCURRENCE

Wenlock and Ludlow, Scandinavia, British Isles, Estonia, Bohemia, North America.

Locality	Proetus (Pr.) concinnus	Pr. (Pr.) confossus	Pr. (Pr.) bravonii	Pr. (Pr.) dudleyensis	Pr. (Pr.) fletcheri	Proetus latifrons	Pr. cf. latifrons	Pr. astringens	Pr. falcatus	Pr. haverfordensis	Pr. sp.A	Pr. sp.B	Pr. sp.C	Pr. sp.D	Crassiproetus? curtisi	Schizoproetus tiro?
Dudley	x	x		x	x				x							x
S. Shropshire & N. Herefordshire	x		x					x			x		x			
Malvern and Abberley Hills	x			x				x	x							
Inliers of S. Welsh Borders			x													
Builth			x													
S.W. Wales							x			x						
Tortworth												x			x	
E. Mendips						x										
Kendal			x													
Girvan														x		
N.W. Éire						x										

Series	Stage	Proetus (Pr.) concinnus	Pr. (Pr.) confossus	Pr. (Pr.) bravonii	Pr. (Pr.) dudleyensis	Pr. (Pr.) fletcheri	Proetus latifrons	Pr. cf. latifrons	Pr. astringens	Pr. falcatus	Pr. haverfordensis	Pr. sp.A	Pr. sp.B	Pr. sp.C	Pr. sp.D	Crassiproetus? curtisi	Schizoproetus tiro?
LUDLOW	Whitcliffian			?													
	Leintwardinian			x								x					
	Bringewoodian			?					x								
	Eltonian	x			x				x	x							
WEN.	Wenlock Limestone	x	x		x	x											x
	Wenlock Shale				x	x	x	x		x							
LLAND.	Upper						x				x		x	x		x	
	Middle														x		
	Lower																

Fig. 5.2. Stratigraphical and Geographical distribution of Proetinae in the British Isles.

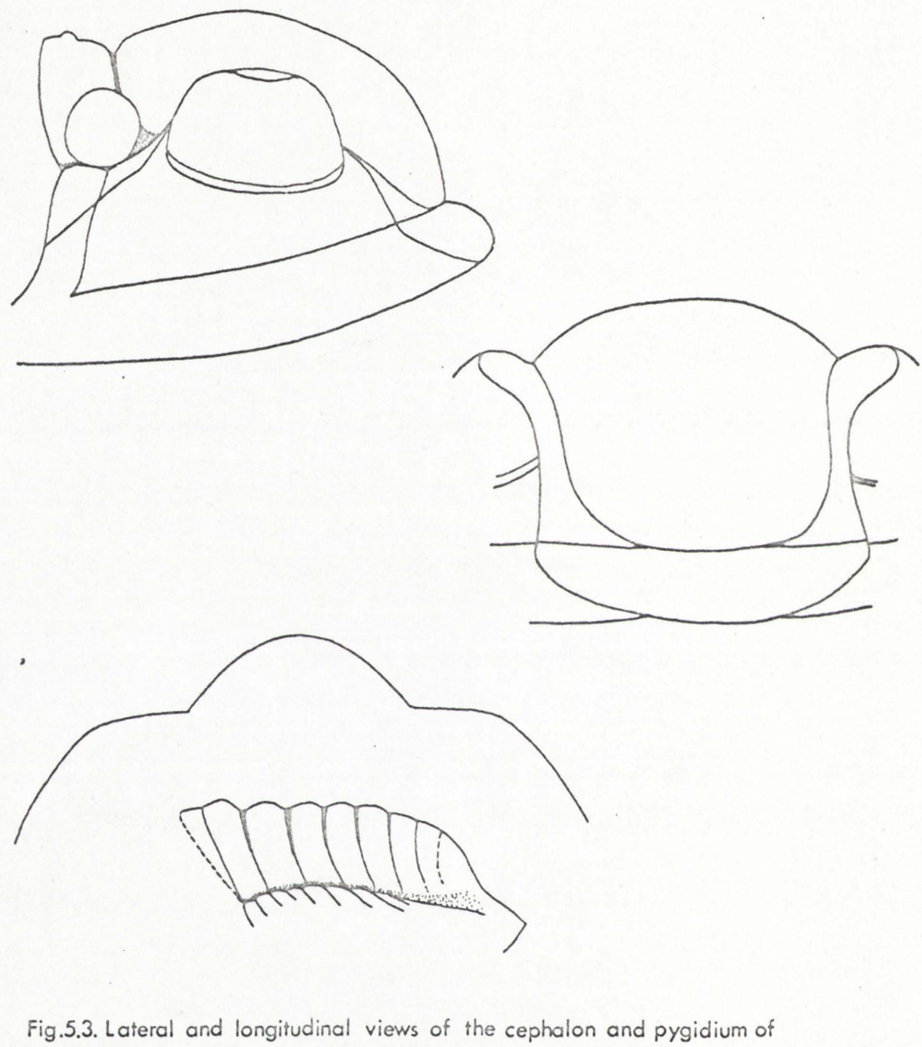


Fig.5.3. Lateral and longitudinal views of the cephalon and pygidium of Proetus (Pr.) concinnus.

DIAGNOSIS

Glabella usually with very weak lateral glabellar furrows; preglabellar field absent; occipital ring with well developed lateral lobes; prominent genal spines present; marginal terrace lines of pygidium incurved onto the pleural region of the pygidium; exoskeleton usually smooth, glabella may be finely granular; field of free cheek and anterior portion of fixed cheek with fine pitting.

DISCUSSION

Relationships of species of Proetus (Proetus) with other Proetus species are discussed fully above.

Proetus (Proetus) concinnus (Dalman, 1828)

Plate 34, Figs. 1-10, Plate 35, Figs. 1-7, 10, 11, Text. Fig. 5.3

1828 Calymmene concinna: Dalman, p. 234, Pl. 1, Figs. 5a-c.

non 1839 Asaphus concinnus Dalman: Emmrich, p.35.

1839 Calymene indeterminable: Murchison, Pl. 14, Fig. 5.

1843 Gerastos concinnus Dalman: Goldfuss, p. 538.

non 1843 Aeonia concinna Dalman: Burmeister, p. 40, Pl. 1, Fig. 5.

1845 Proetus concinnus Dalman: Loren, p. 49, Pl. 1, Figs. 2a-b.

non 1846 Proetus concinnus: Beyrich, Pl. 3, Figs. 8-10.

1846 Aeonia concinna Dalman: Burmeister, p. 100, Pl. 5, Fig. 8.

1848 Proetus sp.: Salter Pl. 6, Figs. 2-4.

1854 Proetus sp.: Murchison, Pl. 27, Fig. 8.

1854 Forbesia concinna Dalman: Angelin, p. 22, Pl. 17, Fig. 5.

non 1857 Proetus concinnus Dalman: Nieszkowski, p. 42.

1885 Proetus concinnus Dalman: Lindström, p. 78

1901 Proetus concinnus Dalman: Lindström, p. 67, Pl. 6, Figs. 19-23.

1923 Proetus concinnus (Dalman): R. and E. Richter, p. 240.

1946 Proetus (Proetus) concinnus (Dalman): Pribyl, p. 4.

1959 Proetus (Proetus) concinnus (Dalman): Richter, Richter and Struve, in Moore, p. 0.385, Fig. 293, 1a-e.

1967 Proetus concinnus (Dalman): Whittington and Campbell, p. 456, Pl. 3, Figs. 4, 5, 9, 11, 12.

1967 Proetus concinnus (Dalman): Campbell, p. 11.

1968 Proetus concinnus (Dalman): Martinsson, p. II, Fig. 1A-C.

1969 Proetus (Proetus) concinnus (Dalman): Alberti, p. 74.

HOLOTYPE

Incomplete, partially enrolled specimen (UM. G.733), figd. Dalman, Pl. 1, Figs. 5a-c, Whittington and Campbell Pl. 3, Figs. 4, 5, 9, 11, 12, Martinsson, Fig. 1A-C and refigured herein as Pl. 34, Figs. 5-7.

MATERIAL

Numerous complete specimens and detatched exoskeletal parts.

TYPE STRATUM AND TYPE LOCALITY

Wenlock Series, Mulde Beds, Djupvik, parish of Eksta, Gotland.

OCCURRENCE

Wenlock-Eltonian, Gotland and Anglo-Welsh area.

DIAGNOSIS

Glabella elongated, almost parallel sided and constricted laterally, slightly overhanging the anterior border; lateral glabellar furrows inconspicuous; eye large, nearly two thirds the sagittal length of the glabella; field of free cheek narrow, pitted; genal spine narrow, extending backwards as far as the fifth thoracic segment; pygidial axis wide, bluntly terminating, with 7-8 rings, of which the posterior are poorly defined; pleural areas with 5-6 pairs of ribs, with the pleural and interpleural furrows generally rather shallow; apart from the fine pitting in the free cheek, the exoskeleton is smooth.

DESCRIPTION

The cephalon is parabolic in outline, well valuted with a moderately wide, convex border. The glabella is elongated, longer than wide, almost parallel sided and very weakly constricted opposite gamma. The frontal margin is well rounded, and slightly overhangs the anterior border. In lateral and longitudinal profiles the glabella is rather strongly convex, more so in the latter. Three pairs of lateral glabellar furrows are present, but are very inconspicuous, and are represented by muscle areas which are a little darker than the rest of the glabellar surface. 1p is situated opposite the centre of the palpebral lobe, and runs transversely adaxially for a short distance before turning abruptly backwards. 2p is situated slightly posterior to gamma and runs very gently backwards. 3p is a short distance in front of 2p, and runs nearly transversely. Whittington and Campbell (1967, Pl. 3, Fig. 4) figure the holotype photographed under alcohol, and this shows the muscle areas as dark patches. The glabella is defined by the narrow, distinct conjoined axial and pre-glabellar furrows which widen and shallow in the region of the palpebral lobes. The occipital furrow is deeper and wider than the axial furrow, with the median section running nearly transversely, turning forwards at either end in front of the lateral occipital lobes. The anterior slope is very steeply inclined, while the posterior slope is inclined at about 45°. The occipital ring is about a fifth of the sagittal length of the glabella sagittally, and transversely is somewhat wider. In lateral profile it is quite steeply inclined as far as the median tubercle, which is placed towards the posterior margin, and behind this is gently declined towards the posterior. The distinct, ovoid lateral occipital lobes are incompletely isolated. The anterior branches of the facial sutures are parallel or very weakly divergent. Beta is a wide, abaxially convex curve, and an exsagittal line drawn backwards from it falls on the adaxial part of the palpebral lobe. Gamma is quite close to the axial furrow. The posterior branches have epsilon and zeta as independent angles, and the former lies close to the anterolateral corner of the lateral occipital lobe while the latter lies about half way along it (exsag.). From zeta the posterior branch turns strongly abaxially, and cuts the posterior margin close to the base of the genal spine, and is kinked just behind the posterior border furrow.

The palpebral lobe is subparabolic in outline and about half the sagittal length of the glabella. It is steeply inclined from the axial furrow and flattens abaxially. The eye is large, crescentic and about two thirds the sagittal length of the glabella with a broad, convex visual surface. The eye socle is narrow, and the lower margin is not defined by a furrow and runs parallel to the upper margin.

The field of the free cheek is rather narrow and gently convex, and is steeply declined from the eye to the lateral border furrow. The lateral and anterior border furrows are narrow and distinct. The cephalic border is broad and gently convex and is quite steeply declined. The anterior border appears narrower than the lateral due to the overhanging frontal lobe of the glabella. The posterior border furrow is a little wider than the lateral, and meets the axial furrow about half way along (exsag.) the lateral end of the occipital ring. Adaxially the posterior border is about half the width (exsag.) of the occipital ring, but widens abaxially to be almost as wide at the base of the genal spine. The genal spine is narrow, and tapers gently backwards, terminating opposite the fifth thoracic segment. There is a short median groove, deflected abaxially from the lateral border furrow, and it dies out a short distance along the genal spine.

The cephalic doublure is as wide as the border and is gently ventrally convex. On the doublure of the lateral border, close to the base of the genal spine is a small panderian notch (see Pl. 34, Fig. 8). The rostral plate is trapezoidal with the connective sutures converging backwards. The posterior margin is about a quarter the length of the rostral suture. The hypostome has a strongly convex median body which rises to a crest near the anterior end. The backwardly directed median furrows are rather distinct, and divide the median body into a large anterior lobe and small crescentic posterior lobe. The anterior face of the anterior lobe is triangular, and the remainder of the lobe has fine terrace lines which run in a series of concentric 'U's, opening towards the anterior. The lateral border is rather broad, and separated from the median body by a deep, distinct furrow. The posterior border furrow is like the lateral, and on the posterior border are two pairs of short backwardly directed spines. The anterior border furrow is deeper than the lateral, and the anterior border is narrow and upturned (ventrally). The anterior wing is prominent, trapezoidal and upturned, without a wing process. The posterior wing is rather small and triangulate.

The thorax consists of 10 segments. The axis tapers gently backwards and is rather strongly convex longitudinally. The interannular furrow divides each axial ring into the preannulus and postannulus, and is very shallow and bends forwards abaxially to meet the articulating furrow some distance in from the axial furrow. On the first few rings the preannulus and postannulus are of almost equal width (sag.), but on the more posterior ones the postannulus is distinctly wider (see Pl. 34, Fig. 3). The articulating furrow is narrow and deeply incised. The articulating half ring is about two-thirds the width (sag.) of the preannulus plus postannulus. The inner part of the pleura is nearly flat, while the outer part is steeply declined. There is an incised, narrow pleural furrow which runs obliquely backwards and outwards and is truncated by the posterior edge of the articulating facet about half way between the fulcrum and the abaxial end of the pleura. The posterior pleural band is always broader than the anterior pleural band (exsag.). Abaxially the pleura is bluntly truncated. The articulation between the thoracic segments, the cephalon and the pygidium seems to be the same as in P. (P.) pluteus, described by Whittington and Campbell (1967, p. 453), (cf. Pl. 34, Fig. 8 and Whittington and Campbell, Pl. 2, Figs. 23-25, 31).

The pygidium is subparabolic in outline, without a border. It is about one and a half times as wide (trans.) as it is long (sag.). The axis is two fifths the total pygidial width at its anterior end, and tapers gently backwards to the bluntly rounded posterior end. There is no postaxial ridge. The first ring is narrower and elevated higher than the remainder, and separated from them by a broad, deep furrow. The remaining 7-8 rings become progressively less distinctly defined towards the posterior. The pleural regions are rather strongly convex, with 5-6 pairs of ribs. The pleural and interpleural furrows are usually rather ill defined, and shallow, with the exception of the first pair of pleural furrows which are incised and distinct. All the pleural and interpleural furrows die out before reaching the pygidial margin. The pygidial doublure is weakly convex and a little wider than the cephalic doublure. It is slightly constricted sagittally at the end of the pygidial axis.

The field of the free cheek is pitted (see Pl. 34, Figs. 1a-b). The cephalic border, the genal spine and the cephalic and pygidial doublures bear fine, parallel terrace lines. On the pygidium some of the marginal terrace lines are incurved onto the pleural areas to run subparallel with the abaxial ends of the pleural and interpleural furrows (see Pl. 34, Fig. 4). The remainder of the exoskeleton is smooth.

DISCUSSION

Proetus (Proetus) concinnus is abundant in the Mulde Marl of Gotland, and occurs in smaller numbers in the British Wenlock and early Ludlow. In the British Wenlock the closely related P. (P.) dudleyensis and P. (P.) fletcheri occur, and differences between these species and concinnus are pointed out below. Also very closely related are P. (P.) pluteus Whittington and Campbell, from the Silurian of Maine, P.(P.) foculus Campbell from the Silurian of Oklahoma, P. (P.) morinensis Pribyl from the Ludlow of Bohemia and P. (P.) osiliensis Schmidt from the Silurian of Estonia. P. (P.) pluteus differs in not having the glabella overhanging the anterior border, in having a broader field of the free cheek, a shallower lateral border furrow, a shorter genal spine, a smaller eye and in having the posterior end of the pygidial axis poorly defined. P. (P.) foculus differs in having a flatter glabella, not overhanging the field of the free cheek, a less arched thoracic axis, greater postannulus to preannulus ratio and a greater number of incurved marginal terrace lines on the pygidium. P. (P.) morinensis differs in having a non-constricted glabella which does not overhang the anterior border and in having the pygidial pleural and interpleural furrows running closer to the pygidial margin. P. (P.) osiliensis differs in having a more tapering glabella, a smaller eye and a broader field of the free cheek.

Within the specimens of P. (P.) concinnus from Britain some variation can be seen, particularly in the eyes. Some specimens (e.g. Pl. 35, Figs. 4-7) have a longer visual surface (measured vertically) than others (e.g. Pl. 34, Figs. 1-7). Clarkson (1969) has postulated similar differences in eye height in Weberides stumnerensis to be of sexual significance, and the same may equally apply for P. (P.) concinnus.

Proetus (Proetus) dudleyensis sp. nov.

Plate 35, Figs. 8, 9, 12a-b

HOLOTYPE

A complete exoskeleton (B.U. Holcroft Coll. 21), figd. Pl. 35, Figs. 12a-b.

MATERIAL

Many complete specimens, and some detatched exoskeletal parts.

TYPE STRATUM AND TYPE LOCALITY

Wenlock Limestone, Dudley, Worcestershire.

OCCURRENCE

Wenlock Limestone and Lower Eltonian, Dudley and Welsh Borderland.

DERIVATION OF THE NAME

From Dudley, where this species is abundant.

DIAGNOSIS

Similar to P. (P.) concinnus from which it differs in the following ways: less inflated, pyriform glabella with rather distinct, incised lateral glabellar furrows and which does not overhang the anterior border; narrower palpebral lobe; more sigmoidal anterior branch of facial suture; posterior branch of facial suture not kinked near posterior border furrow; shorter genal spine; less arched thoracic axis; broader pleural areas of pygidium.

DISCUSSION

Within the Proetus (Proetus) concinnus group, P. (P.) dudleyensis shows greatest similarities to P. (P.) foculus Campbell and P. (P.) pluteus Whittington and Campbell. From the former it differs in having a more pyriform glabella with distinct lateral glabellar furrows, and has shallower pygidial pleural and interpleural furrows and less numerous incurved marginal terrace lines. From the latter it differs in having a narrower field of the free cheek, a deeper lateral border furrow, deeper glabellar furrows and a better defined posterior end of the pygidial axis. Plate 35, Fig. 9 shows the ventral surface of P. (P.) dudleyensis. The panderian openings seem to be wider than those of P. (P.) pluteus (see Whittington and Campbell, 1967, Pl. 2, Fig. 25). On P. (P.) dudleyensis it can be seen that the more anterior thoracic segments have angular posterolateral corners, while the posterior ones have rounded posterolateral corners - the same as in P. (P.) pluteus.

Proetus (Proetus) fletcheri Salter, 1873

Plate 36, Figs. 1a-b, 2, 9, 10, Text. Fig. 5.3.

1873 Proetus fletcheri: Salter, p. 134.
1877 Proetus fletcheri Salter: Woodward, p. 56.
1891 Proetus fletcheri Salter: Woods, p. 151.
1901 Proetus fletcheri Salter: Reed, p. 11, Pl. 1, Figs. 5-6.
1967 Proetus fletcheri Salter: Whittington and Campbell, p. 456.
1967 Proetus fletcheri Salter: Campbell, p. 15.

HOLOTYPE

An almost complete exoskeleton (SMC A.10248), figd. Salter, p. 134, Reed, Pl. 1, Figs. 5-6 and refigured herein as Pl. 36, Figs. 1a-b, 2, Text. Fig. 5.3.

MATERIAL

Several complete specimens.

TYPE STRATUM AND TYPE LOCALITY

Wenlock Limestone, Dudley, Worcestershire.

OCCURRENCE

Unknown outside type locality.

DIAGNOSIS

Similar to P. (P.) concinnus, from which it differs in the following ways: glabella ovate, wider (trans.) than long (sag.), laterally abaxially convex, with a distinct pair of posterior auxiliary impressions close to the occipital furrow; narrower palpebral lobe; posterior branch of facial suture not kinked near the posterior border furrow; shorter genal spine.

DISCUSSION

Specimens of P. (P.) fletcheri from Dudley are preserved in a similar matrix to P. (P.) dudleyensis sp. nov. Apart from the glabella, the two species are exceedingly similar, and it is possible that this difference is sexual.

The shape of the glabella of P. (P.) fletcheri is very similar to that of Proetus cuvieri Steininger, 1831 from the Middle Devonian of the Eifel district, (see Whittington and Campbell 1967, Pl. 3, Fig. 3) - in both species it is ovoid and laterally abaxially convex. There is a strong possibility that P. (P.) fletcheri is ancestral to P. cuvieri and its allies.

Proetus (Proetus) bravonii sp. nov.
Plate 33, Figs. 1-16

1848 Proetus latifrons M'Coy: Salter, p. 337, Pl. 6, Figs. 1, 1a-c.
1854 Forbesia latifrons M'Coy: M'Coy p. 174.
1854 Proetus latifrons M'Coy: Murchison, p. 235, Fass. 46, Fig. 7.
1873 Proetus latifrons M'Coy: Salter, p. 165
1877 Proetus latifrons M'Coy: Woodward, p. 56.
1899 Proetus latifrons M'Coy: Mem. Geol. Surv., pp. 524, 673.
1904 Proetus pseudolatifrons; pars: Reed, p. 78 (non Pl. 11, Figs. 7-9).
1916 Proetus signatus Lindström: Reed, p. 168, Pl. 8, Figs. 12.
1938. Proetus cf. signatus Lindström: Stubblefield, p. 32.

HOLOTYPE

A complete internal mould (GSM.36859), figd. Salter, Pl. 6, Figs. 1, 1a-c, figd. Murchison, p. 235 Fass. 46, Fig. 7, and refigured herein as Pl. 33, Figs. 1-3.

MATERIAL

About 10 complete or almost complete specimens, and numerous isolated exoskeletal parts.

TYPE STRATUM AND TYPE LOCALITY

Upper Ludlow, Usk 'above the castle', Monmouthshire.

OCCURRENCE

Leintwardinian (and possibly Bringewoodian), Welsh Borderland, Kendal district.

DERIVATION OF THE NAME

From Bravonium, the Roman name for Leintwardine. This species is abundant in the Leintwardinian, and occurs in the Leintwardine district.

DIAGNOSIS

Similar to Proetus (Proetus) obconicus Lindström, but differing from it in having a wider cephalic border, lacking the prominent granules at the posterior part of the glabella, and on the axial regions of the thorax and pygidium. Other features include the finely granular surface of the glabella, distinct pitting on the area between the anterior branches of the facial suture and the glabella and prominent, parallel terrace lines on the anterior part of the anterior border and on the outer part of the lateral border.

DESCRIPTION

Cephalon suboval, with a rather wide, weakly convex border. Cranidium with palpebral width about three quarters of the sagittal length. Glabella tapers gently forwards, with the frontal lobe well rounded, and slightly longer (sag.) than wide (trans.). In lateral and longitudinal profiles it is gently convex. The glabella is defined by narrow, but distinct axial and preglabellar furrows, which widen and shallow slightly opposite the palpebral lobe. In most specimens there is a minute preglabellar field, where the preglabellar furrow almost merges with the anterior border furrow. This preglabellar field appears considerably longer as internal moulds (cf. Pl. 33, Fig. 1 and Fig. 4). Three pairs of glabellar furrows are indicated, scarcely impressed onto the glabellar surface, and are seen as smooth, often slightly darker areas interrupting the minutely granular glabellar sculpture. 1p is situated opposite the middle of the palpebral lobe, and extends about half way towards the sagittal line, directed slightly backwards and then turns abruptly backwards to run more or less exsagittally about half way towards the occipital furrow. Between the anterior part of 1p and the sagittal line is a small, rounded auxiliary impression and there seems to be a second between the distal end and the occipital furrow, situated in a line joining the distal end of 1p and the occipital tubercle. 2p is situated a little posterior to gamma, and is directed backwards in the same direction as the proximal part of 1p. It is deepest at the distal end, which is a dark, elongated area, joined to the axial furrow by a lighter, rather indistinct section. 2p extends inwards further than 1p, and not quite as far inwards as the anterior auxiliary impression. 3p is represented by a small ovate one third of the way from 2p to the anterior end of the glabella. It is a little further out than the distal part of 2p.

The occipital furrow is deep and rather wide, with a steep anterior slope and a shallow posterior slope. It curves rather weakly forwards sagittally, and turns abruptly forwards at either end in front of the lateral occipital lobes, where it also narrows. The occipital ring is rather narrow (sag.), and is narrower than the anterior border. The posterior margin runs more or less transversely, curving forwards at the extreme lateral ends. The lateral occipital lobes are prominant and ovate, and incompletely isolated, fusing with the remainder of the occipital ring laterally. There is a small median occipital tubercle. In lateral profile the occipital ring is more or less flat, with the anterior part sloping down gently into the occipital furrow. It is not elevated as high as the posterior part of the glabella.

The anterior branches of the facial sutures are moderately divergent, with gamma a little distant from the axial furrow. An exsagittal line drawn backwards from beta falls on the outer part of the palpebral lobe. The posterior branches have epsilon and zeta as independent angles, with the intervening stretch running close to and parallel with the axial furrow. From zeta the sutures diverge strongly to cut the posterior margin about half way between the axial furrow and the inner margin of the genal spine. The palpebral lobe is broad with a crescentic outline, with its posterior end situated close to the posterolateral corner of the glabella. In longitudinal profile it hardly rises from the axial furrow, running outwards and inclined at a shallow angle. The eye is crescentic and between one third and half the length (sag.) of the glabella. There is a narrow eye socle, whose lower margin runs parallel with the base of the eye.

The cephalic border is fairly wide and weakly convex, and on the outer part has three or four terrace lines, running parallel with the margin. The anterior and lateral border furrows are narrow, shallow and fairly clearly defined. The posterior border furrow is wider and rather shallow.

The anterior portion of the fixed cheek shows a distinct pitting in well preserved specimens (e.g. Pl. 33, Fig. 16). This feature is presumably present on the free cheek, but no suitably preserved material is at hand to show if this is so. The field of the free cheek is rather broad outside the eye, and slopes down gently from it to the lateral and posterior border furrows. The genal spine is slender and rather long, stretching as far backwards as the fifth thoracic segment. It bears a distinct median furrow.

The cephalic doublure is ventrally concave, and bears a series of fine parallel terrace lines. On some complete internal moulds (e.g. Pl. 33, Figs. 1 and 6) the impression of the triangular rostral plate is distinct, with the connective sutures converging backwards. The hypostome is rather narrow and elongated, with a strongly vaulted median body. At the anterior end is a distinct triangular facet. The median furrows are situated well backwards, and directly behind them are well-defined maculae. The anterior, lateral and posterior parts of the hypostomal border are all narrow, and defined by a rather wide, deep border furrow. The anterior wings are not preserved on the single hypostome (an external mould) known from this species, and on the posterior margin there only appears to be one pair of spines. The borders are slightly pinched-in about half way up the hypostome. The hypostomal border has strong, sub-parallel terrace lines, while in the median body parallel terrace lines run in a U-shape, with the base of the U directed towards the posterior.

The thorax consists of 10 segments. The axis is rather narrow, and tapers gently backwards so that the last ring is about two thirds the width (trans.) of the first. Anteriorly the pleurae are about as wide as the axis, but posteriorly they are considerably profile. In longitudinal profile the axis is gently convex. Each ring is arched gently forwards (sag.), and in lateral profile slopes up steeply from anterior to posterior. The pleurae run more or less transversely, with the fulcrum about half way along the pleura anteriorly, but nearer its proximal end posteriorly. Each pleura has a broad, shallow pleural furrow, which dies out near the distal extremity. The anterior and posterior pleural bands are of more or less equal width (exsag.). The posterolateral corner of each pleura is pointed. Some internal moulds show the doublure, which bears parallel terrace lines running in an exsagittal direction.

The pygidium is of subparabolic outline, without a border and is about twice as wide (trans.) as long (sag.). The axis is rather narrow, tapering to a blunt point and is about four fifths the sagittal length of the pygidium. At its anterior end it is between one quarter and one third of the width (trans.) of the pygidium. In longitudinal profile the axis is rather weakly convex. It consists of seven to eight rings and a short end piece. On internal moulds these rings are not well defined, but external surfaces show each ring separated by a distinct furrow. The interannular furrows become progressively shallower and less conspicuous towards the posterior. In lateral profile the first ring is elevated considerably above the remainder. The pleural areas of the pygidium are broad and weakly convex. They bear 5-6 pairs of ribs which curve gently backwards, and widening slightly distally. The pleural furrows are a little deeper than the interpleural furrows, which run more or less parallel with them. The anterior pleural and interpleural furrows reach close to the margin, while the more posterior ones die out before reaching it. Occasional marginal terrace lines extend inwards from the pygidial margin and run into pleural or interpleural furrows. The pygidial doublure is of comparable width and convexity to the cephalic one, and like it, bears parallel terrace lines.

DISCUSSION

From field evidence this species appears to reach its acme near the top of the Lower Leintwardinian, where its remains are often very abundant (see above). The holotype originates from Usk, and is labelled "Upper Ludlow". The surrounding matrix suggests that it is highly likely to have originated from the Leintwardinian. In old collections in the Sedgwick and Geological Survey Museums there is a large number of complete specimens from the Kendal area. These are labelled as coming from "Lower Ludlow rock" or "Upper Ludlow", but the lithology of the surrounding matrix suggests that all these specimens originate from the Lower Underbarrow Flags, which are correlated with the Upper Leintwardinian.

Proetus (Proetus) bravonii shows greatest affinities with the Gotland species P. (P.) obconicus Lindström (see Pl. 36. Figs. 6-8, 12-14), but differs from it in a number of details indicated in the diagnosis. Both P. (P.) bravonii and P. (P.) obconicus show characters transitional between the P. (P.) concinnus group and the P. (Lacunoporaspis) signatus group, but the glabellar shape and the nature of the pygidium indicate closer affinities with the former. P. (P.) bravonii and P. (P.) obconicus may have their origins in species like P. (P.) dudleyensis.

Proetus (Proetus) confossus sp. nov.

Plate 36, Figs. 3-5, 11, Plate 37, Figs. 1, 4-5. 6

HOLOTYPE

A cranidium (BM. It. 8845), Pl. 36, Figs. 3-5.

MATERIAL

Several cranidia, one free cheek, two pygidia.

TYPE STRATUM AND TYPE LOCALITY

Wenlock Limestone, Nodular Beds, Wren's Nest (western side), Dudley, Worcestershire.

OCCURRENCE

Unknown, outside the type locality.

DERIVATION OF THE NAME

From Latin confossus, full of holes - the anterior portion of the fixed cheek is distinctly pitted.

DIAGNOSIS

Glabella conical, as wide as long; lateral glabellar furrows weak, represented as smooth areas interrupting the sculpture; palpebral lobe small, a little under a third of the sagittal length of the glabella; anterior border narrow, genal spine short, panderian notch on cephalic doublure wide; pygidial axis with 6 rings, pleural area with 4-5 pairs of rather weakly defined ribs; sculpture of fine granules, anterior portion of fixed cheek pitted.

DESCRIPTION

The cranidium is rather strongly vaulted, and is a little longer (sag.) than it is wide (trans.). The glabella is conical in outline, as long (sag.) as wide (trans.) and defined by narrow, incised conjoined axial and preglabellar furrows. In longitudinal profile the glabella is strongly arched from side to side, and in lateral profile is gently arched, bending down steeply at the frontal lobe (see Pl. 36, Figs. 4-5). Three pairs of lateral glabellar furrows are present, represented by smooth areas on the glabellar surface. The abaxial end of 1p is opposite the anterior part of the palpebral lobe, about one third of the way up the glabella and is directed backwards at 45° to an exsagittal line broadening adaxially to a lozenge shaped area, distally tapering to a point not far in front of the occipital furrow. The adaxial end of 1p is about half way between the axial furrow and the sagittal line. Associated with 1p are two auxiliary impressions, (these are clearly seen on Pl. 37, Fig. 4) and the anterior one is ovate situated forwards from and a little adaxially to, the distal end of 1p. The posterior one is very inconspicuous, and is situated between the distal end of 1p and the occipital furrow, a little abaxially from it. 2p is situated opposite gamma, and is directed backwards at about the same angle as 1p, and is about the same length. It is club-shaped, broadening a little abaxially. 3p is ovate, some distance back from the anterior end of the glabella, and isolated from the axial furrow.

The occipital ring is about a fifth of the sagittal length of the glabella sagittally. Transversely it is as wide or marginally wider than the glabella. In lateral profile it is gently convex and gently inclined towards the posterior. Laterally there is an ill defined, ovate occipital lobe. Medianally there is a small, distinct tubercle. The occipital furrow is broad, very weakly arched forwards sagittally and more strongly laterally. A depression runs backwards from it at the inner end of the occipital lobe, but quickly shallows. The anterior slope of the occipital furrow is rather steep, while the posterior slope is very shallow.

The anterior border is rather narrow, sagittaly about three fifths the width of the occipital ring. In lateral profile it is quite strongly convex. The anterior branches of the facial sutures are quite strongly divergent, abaxially sigmoidal. Beta is a wide, rounded angle, and an exsagittal line drawn backwards from it falls on the outer part of the palpebral lobe. Gamma is a very broad angle, a little distance out from the axial furrow. The posterior branch has epsilon and zeta as widely separated angles, and the stretch between them runs close to, and parallel with the axial furrow. Epsilon is opposite a position half way between the abaxial end of 1p and the posterolateral corner of the glabella. Zeta is about half way along (exsag.) the lateral end of the occipital ring. From zeta the posterior branch turns strongly outwards on the posterior border.

The palpebral lobe is a little under one third the sagittal length of the glabella and is subparabolic in outline. In longitudinal profile most of it is horizontal, but the inner part is quite steeply declined to the axial furrow. On the single free cheek available, only the ventral surface is seen (see Pl. 37, Fig. 1), but the eye is apparently rather small. The field of the free cheek is fairly wide. The doublure is moderately broad, and bears prominent terrace lines running parallel to the margin. There is a broad panderian notch near the base of the genal spine, which is very short and rapidly backwardly tapering.

The thorax is unknown.

The pygidium is subparabolic, without a border. The axis is broad, tapering quite rapidly backwards to the bluntly rounded posterior end. It is defined by weak axial furrows, and is gently convex longitudinally. There are 6 axial rings, defined by rather broad, shallow interannular furrows, which are arched gently backwards sagittally. The first ring is separated from the remainder by a deeper furrow, and is somewhat elevated above them. At the lateral end of each ring is a small, smooth ovate depression. The pleural areas are gently convex, and bear 4-5 pairs of rather weakly defined ribs, whose pleural and interpleural furrows are shallow, about the same depth, parallel and curved gently backwards. They die out a little distance from the pygidial margin.

The glabella, occipital ring and pygidium are finely granular. Small granules are seen on the anterior border of the holotype (see Pl. 36, Fig. 3), which intersperse the prominent, parallel raised striations. The anterior portion of the fixed cheek is distinctly pitted, and the field of the free cheek is probably also pitted in a similar fashion.

DISCUSSION

P. (P.) confossus seems to be most closely related to P. (P.) obconicus Lindström, whose cranidium is quite similar (cf. Pl. 36, Figs. 3, 11 and 13). The principal differences are length-breadth proportions of the glabella and the size of the palpebral lobe. The pygidia of these two species (cf. Pl. 36, Fig. 12 and Pl. 37, Fig. 5) differ in the width and length of the axis and in the distinctness and number of axial rings and pleural ribs. P. (P.) obconicus lacks the fine granular surface sculpture of P. (P.) confossus, and only has localised granules.

Proetus (Proetus) cf. obconicus (Lindström, 1885)
Plate 37, Figs. 2-3

MATERIAL

Two more or less complete, enrolled exoskeletons.

HORIZON AND LOCALITY

Wenlock Limestone, Dudley, Worcestershire.

DISCUSSION

The cephalon differs from that of P. (P.) obconicus (see Pl. 36, Fig. 6) in having a relatively broader glabella, a larger palpebral lobe, a broader occipital ring and seems to lack the distinctive pitting of the cheeks. The pygidium differs from that of P. (P.) obconicus (see Pl. 36 Fig. 12) in having less sharply defined pleural and interpleural furrows which run as far as the margin. From P. (P.) confossus sp. nov. (see Pl. 36, Figs. 3-5, 11, Pl. 37, Figs. 1, 4) P. (P.) cf. obconicus differs in having a larger palpebral lobe and a smooth exoskeleton. A new species close to P. (P.) obconicus and P. (P.) confossus is apparently represented.

Proetus astringens sp. nov.

Plate 37, Figs. 6, 8, 9, 12, ~~13~~

HOLOTYPE

A nearly complete internal mould (BM It.8849), Pl. 37, Figs. 12, ~~13~~.

MATERIAL

Three more or less complete specimens

TYPE STRATUM AND TYPE LOCALITY

Upper Eltonian, Oldcastle Farm, near Colwall Green, Herefordshire.

OCCURRENCE

Upper Eltonian to Lower Bringewoodian, Malvern, Abberley and Wenlock Edge districts.

DERIVATION OF THE NAME

From the Latin astringens, contracting - the glabella tapers rather strongly forwards.

DIAGNOSIS

Glabella pyriform, distinctly constricted opposite gamma; cephalic border broad, gently convex; genal spine broad, rather short; eye large; anterior branch of facial suture sigmoidal; pygidial axis short, blunt with 5-6 rings; pleural areas with ?4 pairs of weakly impressed ribs; no pygidial border.

DESCRIPTION

The cephalon is subparabolic in outline with a rather broad, weakly convex border. The glabella is pyriform, rather weakly vaulted, as wide or a little wider than long, distinctly constricted opposite gamma, widest at the centre of the palpebral lobes and with a rounded frontal margin. It is defined by apparently rather shallow conjoined axial and preglabellar furrows, the latter confluent with the anterior border furrow in front of the glabella. On none of the specimens is the dorsal surface of the glabella preserved, but the holotype has two pairs of weakly impressed lateral glabellar furrows, 1p opposite the centre of the palpebral lobe and 2p opposite gamma. Both run gently backwards, and 1p is forwardly convex.

The occipital furrow is wider and deeper than the axial furrows, and is arched weakly forwards sagittally. The occipital ring is as wide as the anterior border and laterally has prominent ovate lobes. Transversely it is as wide or wider than the glabella. The anterior branch of the facial suture is strongly sigmoidal, with beta an acute, rounded angle. An exsagittal line drawn backwards from beta falls on the outer part of the palpebral lobe. Gamma is close to the axial furrow. The posterior branch has epsilon and zeta as independent angles, the former near the posterolateral corner of the glabella and the latter opposite the lateral occipital lobe. The stretch between epsilon and zeta runs more or less parallel with the axial furrow. From zeta the posterior branch turns strongly abaxially on to the posterior border, and cuts the posterior margin about half way between the axial furrow and the lateral margin.

The palpebral lobe is rather narrow and crescentic, about half the sagittal length of the glabella, and backwardly placed. The eye is large and crescentic, about two thirds of the sagittal length of the glabella. The field of the free cheek is gently convex and rather narrow. The anterior and lateral border furrows are rather shallow, and define the broad, gently convex anterior and lateral borders. The posterior border furrow is apparently of a similar depth to the lateral, and meets the axial furrow near the posterior end of the lateral occipital lobe. The posterior border is narrower than the lateral, and broadens abaxially. The genal spine is broad based, extending backwards as far as the fifth thoracic segment. The median groove dies out near the posterior end of the genal spine, and at the anterior end turns inwards to meet posterior border furrow. The inner and outer bands of the genal spine are of about equal width.

The cephalic doublure is moderately broad, strongly ventrally convex and ornamented with fine, parallel terrace lines. One specimen (Pl. 37, Fig. 6) shows the impression of the triangular rostral plate very clearly.

The thorax consists of 10 segments, with the axis, which is quite strongly longitudinally convex, tapering gently backwards so that the last ring is about three quarters of the width (trans.) of the first. Each axial ring is arched gently forwards sagittally. The preannulus is not seen on any of the specimens. The doublure of the annulus is dorsally convex, and has fine, transverse terrace lines. The pleura at the adaxial end is nearly horizontal, and abaxially it is gently declined. It has a distinct, apparently narrow pleural furrow which seems to be truncated by the posterior edge of the articulating facet not far from the distal end of the pleura, which is bluntly truncated.

The pygidium is subparabolic in outline, nearly twice as wide (trans.) as it is long (sag.). Anteriorly the axis is nearly a third of the total pygidial width, and tapers gently backwards to the bluntly rounded posterior end. It consists of five, possibly six rings, separated by rather shallow interannular furrows which run nearly transversely on the holotype. The axis is defined by rather shallow, non-incised axial furrows. There is no postaxial ridge. The pleural areas are gently convex, and have possibly four pairs of rather weakly defined ribs. The pleural and interpleural furrows appear to be rather shallow and to extend almost to the margin (see Pl. 37, Fig. 8). The pygidial doublure is of similar width to the cephalic, and like it is distinctly ventrally convex and ornamented with fine parallel terrace lines.

The entire exoskeleton seems to be devoid of sculpture, but on the specimen which shows part of the external surface (Pl. 37, Fig. 8) it is not well preserved.

DISCUSSION

Only the internal surface of most of the exoskeleton is known from this species, and it is not presently possible to describe the details of the preannulus, surface sculpture etc. Relationships and distribution are discussed above.

Proetus falcatus sp. nov.

Plate 38, Figs. 8, 10-13

HOLOTYPE

A nearly complete exoskeleton (BM 59022), Pl. 38, Figs. 10-13.

MATERIAL

Several complete specimens.

TYPE STRATUM AND TYPE LOCALITY

Eltonian, Wren's Nest, Dudley, Worcestershire.

OCCURRENCE

Wenlock-Lower Ludlow, Dudley and Malvern districts.

DERIVATION OF THE NAME

From the Latin falcatus, curved like a sickle - from the path of the anterior branch of the facial suture.

DIAGNOSIS

Glabella elongated, finger-like with 2 pairs of weakly impressed lateral furrows; anterior branch of facial suture strongly abaxially convex; cephalic border broad, flattened; genal spine long, narrow; occipital ring with ill defined lateral occipital lobes; pygidium with 6 axial rings, posterior ones ill defined, and five pairs of pleural ribs with shallow pleural and interpleural furrows; poorly developed pygidial border present; exoskeleton smooth.

DESCRIPTION

The cephalon is moderately vaulted, parabolic in outline with a broad, flattened border. The glabella is elongated, finger-like and rather longer (sag.) than wide (trans.). It is defined by narrow conjoined axial and preglabellar furrows, the latter running into the anterior border furrow. The posterolateral corners are rounded, and from here the glabella tapers very gently forwards to the rounded frontal margin. The glabella is rather weakly convex in lateral and longitudinal profiles. 1p is opposite the anterior part of the palpebral lobe, weakly impressed and ruhs backwards at about 45° to an exsagittal line, dying out shortly before reaching the occipital furrow. It extends a little under half way towards the sagittal line, and narrows very gently backwards. It is gently adaxially convex. 2p is opposite gamma, and runs inwards and very slightly backwards, extending about two thirds of the way towards the sagittal line. Like 1p it is weakly impressed. No 3p furrows are seen on any of the specimens.

The occipital furrow is deep, and runs nearly transversely, and is deflected very weakly forwards at the lateral ends. The anterior slope is nearly vertical, while the posterior is inclined at about 60°. The occipital ring is two thirds of the sagittal width of the anterior border, and transversely is a little wider than the glabella. In lateral profile it is gently inclined towards the posterior. In a median position is a small, distinct tubercle, situated towards the posterior margin. The lateral occipital lobe is small and triangulate, separated from the occipital ring by a shallow furrow which deepens suddenly at the adaxial end where it runs into the occipital furrow.

The anterior branch of the facial suture is strongly abaxially convex, with beta an acute rounded angle. An exsagittal line drawn backwards from beta falls on the outer part of the visual surface of the eye. Gamma is close to the axial furrow. The posterior branch has epsilon and zeta as independent angles, separated only by a short distance. The former is opposite the posterolateral corner of the glabella, while the latter is opposite the lateral occipital lobe. The stretch of suture between runs close to and nearly parallel with the axial furrow.

From zeta the posterior branch turns strongly abaxially and runs backwards across the posterior border and cuts the posterior margin about half way between the axial furrow and the lateral margin. This stretch of the suture is weakly abaxially convex.

The palpebral lobe is subparabolic and a little under half the length of the glabella, and is posteriorly placed. It is inclined at about 35° from the axial furrow, and flattens abaxially. The abaxial edge is elevated almost to the height of the sagittal region of the glabella. The eye is large, crescentic, about half the sagittal length of the glabella, mounted on a narrow, curb-like eye socle whose lower margin is not defined by an incised furrow. The field of the free cheek is rather narrow, and convex. The anterior and lateral border furrows are deep and wide, defining the broad, gently convex anterior and lateral borders. The posterior border is considerably narrower than the anterior and lateral borders, and is a little narrower (exsag.) than the occipital ring. The posterior border furrow is narrower, but as deep as the lateral and anterior border furrows, and meets the axial furrow near the posterior end of the lateral occipital lobe. The genal spine is long, narrow and gradually tapering, extending backwards as far as the eighth thoracic segment. The median furrow is short, only apparent anteriorly and at the anterior end of the genal spine, turns abruptly adaxially and runs into the posterior border furrow.

The thorax consists of ten segments. The axis is moderately longitudinally convex and tapers backwards only very weakly. The non incised intra-annular furrow divides the annulus into the pre- and post-annulus, of which the latter is considerably longer (sag.). The intra-annular furrow curves gently forwards laterally, and meets the articulating furrow a short distance in from the axial furrow. The articulating furrow is narrow and incised. In lateral profile the post-annulus is gently convex. The inner part of the pleura is more or less horizontal, and abaxially from the fulcrum it is quite steeply declined. The pleural furrow is narrow and incised, and runs very gently backwards. It is truncated by the posterior edge of the broad articulating facet a short distance abaxially from the fulcrum. The posterior pleural band is somewhat wider than the anterior. The distal end of the pleura is bluntly truncated.

The pygidium is subparabolic in outline, nearly twice as wide as it is long. The axis is three tenths of the total pygidial width anteriorly, and tapers gently backwards to the bluntly rounded posterior end. The axial furrows are distinct, but non-incised, shallowing considerably at the posterior end of the axis. Six axial rings are present, becoming progressively less distinct towards the posterior. The first ring is elevated higher than the rest, and separated from them by a rather deep furrow. The pleural areas are gently convex, with five pairs of pleural ribs, which run quite strongly backwards. The first two pairs of pleural furrows and the first pair of interpleural furrows reach the pygidial margin, but the remainder are truncated before reaching it by a rather poorly developed pygidial border. The pleural furrows are narrow and incised, while the interpleural furrows are shallow and rather inconspicuous, only the first two pairs being clearly seen.

The exoskeleton is smooth, with the exception of the inner portion of the genal spine, which has distinct longitudinal raised striations.

DISCUSSION

This species does not particularly resemble any others, and comments on its relationships and distribution are given above.

Proetus latifrons (M'Coy 1846)

Plate 37, Figs. 10-11, Plate 38, Figs. 1-6, 9.

1846 *Forbesia latifrons* M'Coy, p. 49, Pl. 4, Fig. 11.

non 1848 *Proetus latifrons* M'Coy: Salter, p. 337, Pl. 6, Figs. 1, 1a-c.

non 1854 *Forbesia latifrons* M'Coy: M'Coy, p. 174.

non 1854 *Proetus latifrons* M'Coy: Morris, p. 114.

non 1854 *Proetus latifrons* M'Coy: Murchison, p. 235, Fossils 46, Fig. 7.

non 1857 *Proetus latifrons* M'Coy: Nieszkowski, p. 44.

non 1873 *Proetus latifrons* M'Coy: Salter, p. 165.

non 1871 *Proetus latifrons* M'Coy: Woodward, p. 56.

non 1879 *Proetus latifrons* M'Coy: Nicholson and Etheridge, p. 171.

non 1899 *Proetus latifrons* M'Coy: Mem. Geol. Surv. p. 524, 673.

non 1904 *Proetus latifrons* (M'Coy): Reed, p. 76, Pl. 11, Figs. 4, 4a.

HOLOTYPE

Complete, slightly damaged internal mould (NMI.G8: 1970), figd. M'Coy 1846, Pl. 4, Fig. 11 and refigured herein as Pl. 38, Figs. 1-3, 6.

MATERIAL

One topotype external mould of part of the thorax and pygidium, and about 20 cranidia, free cheeks, pygidia, 1 cephalon, 1 complete internal mould lacking the free cheeks.

TYPE STRATUM AND TYPE LOCALITY

?Upper Llandovery, Egool, Ballaghaderrean, Co. Roscommon, Eire.

OCCURRENCE

Apart from the type locality, in the Wenlock Shales of the Silurian inlier of the Eastern Mendips.

DIAGNOSIS

Glabella foreshortened, tapering rapidly forwards, about as long as wide; three pairs of indistinct lateral glabellar furrows; eye of moderate size, posterior branch of facial suture with epsilon and gamma as independent angles; anterior branches moderately divergent; no genal spine.

DESCRIPTION

The cephalon is roughly semicircular in outline, and is fairly strongly vaulted. The glabella is coniform in outline, of almost equal length and breadth and is weakly convex in longitudinal profile, and more strongly convex in lateral profile. At its widest point, near the posterior end of the palpebral lobe, it approaches half the total cephalic width. It tapers forwards rapidly in front of this point to the well rounded frontal lobe. The glabella of the holotype is badly preserved, but some of the Mendips specimens (e.g. Pl. 38, Figs. 4-5) show weakly impressed glabellar furrows. 1p is situated opposite the centre of the palpebral lobe, and is directed backwards at about 35° and gently curved, with the convex edge forwards. 2p is situated opposite gamma, is shorter than 1p and is directed backwards at a slightly smaller angle and is hardly curved. 3p directed backwards at a similar angle to 2p, is a short distance in front of it and does not appear to run into the axial furrow. The glabella is defined by conjoined axial and preglabellar furrows. The former shallows markedly at the palpebral lobe. In front of the glabella the preglabellar furrow merges with the anterior border furrow, and there is no preglabellar field.

The occipital furrow has a steep, almost vertical anterior slope and a rather shallow posterior slope. For most of its length the occipital furrow runs more or less transversely, and turns weakly forwards at either end. The occipital ring is not well preserved on any of the available material, but seems to be a little wider (sag.) than the anterior border, and not quite as wide (trans.) as the greatest width of the glabella. It seems likely that rather large, ill defined lateral occipital lobes are developed. In longitudinal profile the occipital ring plunges down quite steeply from the sagittal region to the lateral extremities.

The anterior branches of the facial sutures are moderately divergent, with the stretch gamma to beta more or less straight. An exsagittal line drawn backwards from beta falls on the palpebral lobe. Gamma is a little distance out from the axial furrow. The posterior branches of the facial sutures run parallel with and close to the axial furrow behind the palpebral lobe, with epsilon and zeta as independent angles. Zeta is opposite the lateral end of the occipital ring, and the sutures diverge strongly outwards on the posterior border from this point, and cut the posterior margin about one third of the way from the axial furrow to the lateral margin.

The palpebral lobe is of moderate size, subparabolic in outline and a little under half the sagittal length of the glabella. The eye is crescentiform, half the sagittal length of the glabella, and does not seem to be supported on an eye socle. The field of the free cheek is moderately convex, and slopes down quite steeply from the eye to the lateral border furrow. The lateral and anterior borders are not preserved on the holotype, but the Mendip material shows that they are moderately convex and separated from the rest of the cephalon by wide, shallow anterior and lateral border furrows. The posterior border furrow seems to be rather wider and deeper.

The genal angle is rounded, and there is no genal spine, as clearly shown on some of the Mendip specimens (e.g. Pl. 37, Fig. 11). The holotype (Pl. 38, Figs. 1-3, 6) shows what outwardly look like genal spines, especially on the right hand side, but close examination reveals that these are marks made by preparation.

The cephalic doublure is weakly convex ventrally, and is traversed by parallel terrace lines, which also occur on the outer part of the cephalic margin. The holotype shows the mould of the trapezoidal rostral plate in front of the glabella. The posterior margin of the rostral plate is one quarter the length (trans.) of the rostral suture.

The thorax consists of ten segments. The axis tapers gently backwards, so that the last axial ring is about three quarters the width (trans.) of the first. Anteriorly the axis is slightly wider than the pleurae, but at the tenth segment the reverse is the case. On only one specimen (see Pl. , Fig.) has it been possible to examine the external surface of a small part of the thorax. This indicates that on the axis the preannulus is present, probably reaching the same width (sag.) as the annulus at the sagittal line. Each pleura is traversed by a narrow, distinct pleural furrow, which seems to die out near the distal end. The pleura bends down quite steeply at the fulcrum, which is about half way along the pleura at the first segment, but nearer the inner end on the last. The distal end of the pleura seems to be bluntly truncated. The pygidium is of subparabolic outline, without a border. The axis consists of about six/seven clearly defined rings, and does not achieve the posterior margin. In longitudinal profile it is strongly arched. The pleural areas have three or four pairs of ribs with rather shallow, ill defined pleural and interpleural furrows. These die out before reaching the margin. On the extreme margin of the pygidium there are terrace lines, but no specimens are sufficiently well preserved to show if any of these turn inwards onto the pleural area. The pygidial doublure is similar to the cephalic doublure, and like it is characterised by parallel terrace lines.

DISCUSSION

The synonymy list for this species indicates the extent to which it has been misinterpreted. This was due to an original misinterpretation of the species by Salter (1848, p. 337), and later workers followed Salter's rather than M'Coy's conception of it. Reed (1904, p. 78-9) attempted to rectify the state of affairs, and his conclusions are fully discussed in connection with Astroproetus pseudolatifrons (Reed) (see Chapter 4).

The present interpretation of Proetus latifrons restricts this species to the probable Upper Llandovery of Eire and the Wenlock Shales of the Mendip Hills. P. latifrons is distinctive among Silurian Proetus species in lacking genal spines, a feature which is widespread in Devonian species. P. granulatus Lindström 1885 from the Silurian of Gotland (see Pl. 38, Fig. ~~7~~) also lacks genal spines, and the glabella is similar to that of 5 P. latifrons, although it differs in having a prominent granular sculpture. P. haverfordensis sp. nov. is like P. latifrons, but has short genal spines and a rather longer pygidium.

Proetus cf. latifrons (M'Coy)

Plate 39, Fig. 1

MATERIAL

An almost complete internal mould.

HORIZON AND LOCALITY

Upper Llandovery Coralliferous Series, 80 feet above the base, Marlves Bay, Pembrokeshire.

DISCUSSION

A distorted, though nearly complete internal mould has characters which are comparable with Proetus latifrons (M'Coy), particularly the coniform glabella and the pygidium with a rather narrow axis (cf. Pl. 39, Fig. 1, and Pl. 37, Fig. 10 and Pl. 38, Figs. 1-2, 4-5). The postero-lateral corners of the free cheeks are ill preserved, but the left hand one seems to indicate that they are rounded, and without spines. This character adds weight to a comparison with P. latifrons, which also possesses this feature, and further material from Pembrokeshire may demonstrate the presence of the species there with certainty.

Proetus haverfordensis sp. nov. ?

Plate 39, Figs. 2, 3, 7, 11, 15.

HOLOTYPE

A complete internal mould, with counterpart external mould (SMC A.32 743 a-b), the former figured as Pl. 39, Fig. 2, and a silicone cast from the latter as Pl. 39, Fig. 3.

MATERIAL

Besides the type an almost complete internal mould, a partially complete cephalon, with parts of five attached thoracic segments, and a pygidium.

TYPE STRATUM AND TYPE LOCALITY

Upper Llandovery, below the path SW of Uzmaston Farm, the Frolic, Haverfordwest, Pembrokeshire.

OCCURRENCE

Upper Llandovery, Pembrokeshire.

DERIVATION OF THE NAME

From Haverfordwest, a town in Pembrokeshire.

DIAGNOSIS

Cephalon semicircular with shallow border furrow; glabella conical; genal spine very short; thorax with 10 segments, axis narrow, pleural areas broad; pygidium large, a little longer (sag.) than the cephalon; without a border; axis about two thirds the total pygidial length (sag.), with 8-9 rings; pleural areas with at least 4 pairs of ribs, more posterior ones very ill defined; prominent incurving marginal terrace lines are seen on the anterior part of the pygidium; exoskeleton smooth.

DESCRIPTION

The cephalon is roughly semicircular in outline, with a moderately wide, weakly convex border, defined by shallow, non incised lateral (and anterior?) border furrows. (On the holotype internal mould (Pl. 39, Fig. 2) the depth of the lateral border furrow is greatly exaggerated by deformation (cf. right hand side of external surface, Pl. 39, Fig. 3)). The glabella is coniform, rather wider (trans.) than long (sag.) and apparently rather weakly inflated. It is defined by narrow, conjoined axial and preglabellar furrows. From the posterolateral corners to the anterior part of the palpebral lobe it is almost parallel sided, but anterior to this narrows rapidly forwards to the bluntly pointed frontal lobe. No lateral glabellar furrows are seen on the type, but two faint, non-incised pairs are present on another specimen (see Pl. 39, Fig. 11).

The occipital furrow is broad and deep, arched weakly forwards sagittaly. In lateral profile the anterior and posterior slopes are rather steeply inclined. The occipital ring is rather narrower (sag.) than the preglabellar area and has small, ovate poorly defined lateral occipital lobes. In lateral profile it is inclined quite steeply towards the posterior. There is a very short (sag.) preglabellar field.

The anterior branch of the facial suture is rather strongly abaxially sigmoidal, and an exsagittal line drawn backwards from beta falls on the visual surface of the eye. The posterior branch runs close to the axial furrow behind the eye, and epsilon and zeta are independent angles. Zeta lies close to the anterolateral corner of the occipital lobe, and from here the posterior branch turns strongly abaxially into the posterior border to cut the posterior margin apparently about one third of the way down the axial furrow to the lateral margin.

The palpebral lobe is semielliptical in outline, backwardly placed and inclined at a low angle from the axial furrow. It is about a third of the sagittal length of the glabella. The eye is crescentiform and about half the sagittal length of the glabella. The nature of the eye socle is not seen on any of the specimens.

The field of the free cheek is broad and gently convex, gently declined from the eye region. The posterior edge is steeply declined to the posterior border furrow, which is considerably deeper than the lateral. It runs into the axial furrow at the lateral end of the lateral occipital lobe. Abaxially the posterior border furrow is truncated abruptly at the base of the genal spine. The latter is short, triangular and posteriorly pointed, and has a shallow median furrow.

The cephalic doublure is rather broad, and is ventrally convex. The holotype internal mould (Pl. 39, Fig. 2) shows the impression of the triangular rostral plate, and the same specimen and an additional one (Pl. 39, Fig. 11) shows the broad panderian notch close to the base of the genal spine, which appears as a constriction in the doublure. There are fine, parallel terrace lines on the doublure.

The thorax consists of 10 segments. Anteriorly one axis is as wide (trans.) as the pleurae, but posteriorly the latter are considerably wider. The axis is rather narrow, and tapers gently backwards. It is moderately convex longitudinally. Each ring is arched gently forwards sagittally. The preservation of the thoracic axis is poor on the specimens examined, but the last ring on the external mould of the holotype (Pl. 39, Fig. 3) shows the preannulus which appears to be about a third of the sagittal width of the postannulus. The intra-annular furrow is shallow and non-incised, and seems to run into the articulating furrow before reaching the axial furrow. The articulating furrow is deep and incised.

The pleura runs almost horizontally and transversely as far as the fulcrum, at which it is gently declined and turned gently backwards. The pleural furrow is narrow and incised, and is abruptly truncated by the posterior edge of the broad facet about half way between the fulcrum and the distal end of the pleura. The pleural furrow divides the pleura into a wider posterior band and a narrower anterior band. The distal end of the pleura is bluntly truncated. In lateral profile the anterior pleural band is gently convex, while the posterior is gently inclined towards the posterior.

The pygidium is large, subparabolic, without a border and about twice as wide (trans.) as it is long (sag.). It is a little longer (sag.) than the cephalon, and as long (sag.) as the thorax. Anteriorly the axis is about a quarter the width (trans.) of the pygidium, and tapers gently backwards to the bluntly rounded posterior end. It extends for about two thirds of the total pygidial length. It is defined by rather deep axial furrows which shallow markedly at the posterior end. Eight to 9 axial rings are present, which become progressively more ill defined towards the posterior. The axial rings run nearly transversely, and the first is not noticeably elevated above the remainder as in some Proetus species. In lateral profile each ring is flat and gently inclined towards the posterior.

The pleural areas are strongly convex, their adaxial parts being quite strongly inclined from the axial furrow. At least 4 pairs of pleural ribs are developed, which curve gently backwards. The first two or three pairs of pleural furrows are narrow, incised and extend to the margin. The first two or three pairs of interpleural furrows are very shallow and inconspicuous, deepening a little distally and extending to the margin. Succeeding pleural and interpleural furrows are very inconspicuous and hardly apparent. On the anterior parts of the pleural areas, marginal terrace lines are incurved and run subparallel to the pleural and interpleural furrows.

The pygidial doublure is broad, gently ventrally convex and ornamented with fine, parallel terrace lines. The doublure is distinctly constricted behind the axis, where the inner terrace lines are bunched together.

The entire exoskeleton is apparently smooth.

DISCUSSION

Proetus haverfordensis sp. nov. is included above in the Proetus latifrons group because of the general cephalic morphology. It differs from other members in having short genal spines and a larger pygidium. The last feature suggests a possible relationship with another Upper Llandovery species Crassiproetus? curtisi (see below and Plate 39, Fig. 4), but the latter seems to have a more rounded glabella and has a much shallower occipital furrow. Because of the parabolic elongated pygidium, combined with the ovate glabella, curtisi is doubtfully assigned to Crassiproetus, while the incurving terrace lines on the shorter, subparabolic pygidium show that haverfordensis should be assigned to Proetus.

Proetus sp. A

Plate 39, Figs. 5, 9, Text Fig. 5.4

MATERIAL

One internal mould of a cranidium, with counterpart external mould (M. Jones Coll.).

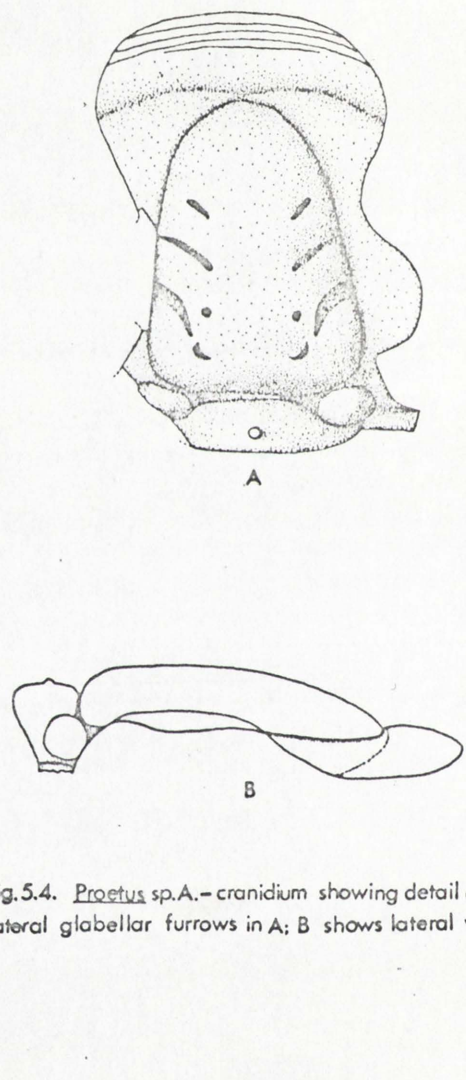


Fig. 5.4. Proetus sp. A.– cranidium showing detail of the lateral glabellar furrows in A; B shows lateral view.

HORIZON AND LOCALITY

Lower Leintwardine Beds (channel fill deposits), Church Hill, Leintwardine.

DESCRIPTION

The cranidium is weakly vaulted, with the sagittal length about one and a quarter times the palpebral width. The glabella is coniform and elongated, about two thirds as wide (trans.) as it is long (sag.). From the rounded posterolateral angles it narrows forwards constantly and gradually to the bluntly rounded frontal margin. The glabella is defined by distinct, non-incised conjoined axial and preglabellar furrows, the axial furrows shallowing at the palpebral lobes. In lateral and longitudinal profiles the glabella is weakly convex, and the posterior end of the glabella is elevated somewhat above the occipital ring. There are three pairs of weakly impressed lateral glabellar furrows. 1p is opposite the centre of the middle of the palpebral lobe and is crescentic, with the convex side anterior. It extends about two fifths of the way towards the sagittal line. Associated with 1p are two auxiliary impressions, which lie between 1p and the sagittal line, close to the furrow. The anterior one is ovate, while the posterior one is larger and crescentiform, with the convex side towards the posterolateral corner of the glabella. On the right hand side of the specimen, the posterior auxiliary impression appears to be divided into two, with a small ovate depression behind the crescentic one. 2p is situated a little behind gamma, and expands adaxially and is more or less club shaped, extending a little over half way towards the sagittal line. It is directed backwards at about 45° to an exsagittal line. 3p is a weakly impressed elongated ovate depression, isolated from the axial furrow and directed backwards at about the same angle as 2p. It is about a third of the way from 2p to the frontal margin of the glabella, therefore leaving a fairly long frontal lobe in front of it.

The occipital furrow is deep, arched very weakly forwards sagittally and more strongly laterally. The anterior slope is nearly vertical, while the posterior slope is inclined at about 45°. The occipital ring is a little narrower (sag.) than the anterior border. Transversely it is a little wider than the glabella. In lateral profile it is inclined at 45° from the occipital furrow, and flattens towards the posterior. In longitudinal profile it bends down strongly from the sagittal region to the lateral ends. Ovate lateral occipital lobes are developed, separated from the rest of the occipital ring by shallow, non-incised furrows. There is a small median tubercle, placed towards the posterior margin.

The preglabellar field is minute, about a seventh of the width (sag.) of the anterior border. The anterior border furrow is weak and non-incised. The anterior border is broad (sag.) about a quarter of the sagittal length of the glabella. It is weakly convex in lateral profile, and has fine, parallel raised striations on the outer part. The anterior branch of the facial suture describes a gentle, abaxially convex sigmoidal curve, and an exsagittal line drawn backwards from beta falls on the outer part of the palpebral lobe. Gamma is a wide angle, a little distance out from the axial furrow. The posterior branch of the facial suture has epsilon and zeta as independent angles. Epsilon is close to the postero-lateral corner of the glabella, while zeta is opposite the occipital lobe. The stretch between runs close to and parallel with the axial furrow. From zeta the posterior branch turns strongly abaxially onto the posterior border.

The palpebral lobe is large, nearly half the sagittal length of the glabella and semielliptical in outline. It is inclined at a low angle from the axial furrow, and flattens distally.

The cranidium appears to be smooth.

Remainder of the exoskeleton is unknown.

DISCUSSION

The species which is closest to Proetus sp. A is P. pulcher Neiszkowski 1857, but this species differs in having a more triangular, pointed glabella. P. pulcher is considered above to belong to a group of Proetus species included in the subgenus Lacunoporaspis, and because of the similarity between P. pulcher and P. sp. A, the latter is also likely to belong to the same subgenus. Before it is definitely included, more information on other parts of the exoskeleton are required, particularly the pygidium.

Proetus sp. B

Plate 39, Figs. 8, 10

1958 Proetus sp. Curtis, p. 141, Pl. 29, Fig. 3.

MATERIAL

Two pygidia

HORIZON AND LOCALITY

Upper Llandovery, Damery Beds, Damery Bridge near Tortworth.

DESCRIPTION

See Curtis, p. 141.

DISCUSSION

The two pygidia from Tortworth are similar to that of a specimen from the Wenlock of Pembrokeshire (see above and Pl. 39, Fig. 7) described as Proetus cf. latifrons (M'Coy), and are likely to be conspecific. There is a likelihood that the Pembrokeshire specimen belongs to P. latifrons, and consequently the Tortworth specimens also probably belong to this species. Until more information is available, the Tortworth specimens are designated Proetus sp. B.

Proetus sp. C

Plate 39 Figs. 6, 12

MATERIAL

Two cranidia.

HORIZON AND LOCALITIES

Upper Llandovery, Pentamerus Beds, Marshbrook, Shropshire; Huntley Hill Beds, east side of Nottswood Hill, near Longhope, Gloucestershire.

DISCUSSION

Two cranidia from south Shropshire have a coniform glabella and apparently rather weakly isolated lateral occipital lobes which invite comparison with Proetus haverfordensis sp. nov., which occurs in approximately contemporaneous beds in Pembrokeshire. They differ from P. latifrons in having a narrower, more elongated glabella and less distinct lateral occipital lobes.

Proetus sp. D.

Plate 39, Figs. 13-14

1904 Proetus latifrons (M'Coy): Reed p. 76, Pl. 11, Figs. 4, 4a.

MATERIAL

A poorly preserved internal mould of a cranidium, with a partially complete external mould.

HORIZON AND LOCALITY

Middle Llandovery, Saugh Hill Group, Newlands, near Girvan, Ayrshire.

DESCRIPTION

The glabella is as long as wide, coniform and defined by deep conjoined axial and preglabellar furrows. From the bluntly rounded postero-lateral corners it tapers forwards gently as far as the anterior ends of the palpebral lobes, and then tapers rapidly to the bluntly pointed frontal lobe. The glabella is weakly inflated in lateral and longitudinal profiles. Three pairs of glabellar furrows are present. 1p is opposite the anterior part of the palpebral lobe, and broadens and runs adaxially for about two fifths of the way towards the sagittal line, and then turns abruptly backwards almost in a right angle, and narrows apparently to a point not far in front of the occipital furrow. It is weakly impressed deepest at the abrupt turn. 2p is a little anterior to gamma, and is narrow and runs for about two thirds of the way towards the sagittal line. Proximally it is almost incised, but distally it shallows and widens a little. It is weakly convex towards the anterior and runs backwards at about 75° to an exsagittal line. 3p is a short distance in front of 2p and is obscured and isolated from the axial furrow. It extends as far inwards as 2p, and is directed backwards at a similar angle.

The occipital furrow is broader and deeper than the axial furrow, and is almost transverse medianally, turning strongly forwards laterally. The anterior slope is nearly vertical. The occipital ring is poorly preserved, but seems to be as wide (sag.) as the preglabellar area and marginally wider (trans.) than the glabella. It is inclined at about 45° from the occipital furrow and flattens towards the posterior. A rather small, poorly isolated, ovate lateral occipital lobe is developed.

The short, convex preglabellar field is marginally narrower (sag.) than the anterior border. The anterior border furrow is deep, narrow and distinct. The anterior border is rather narrow and rolled, and appears to have fine raised striations on its outer part. The anterior branches of the facial sutures are nearly parallel. The palpebral lobe is about a third of the sagittal length of the glabella, subparabolic in outline and backwardly placed. The posterior branches of the facial sutures are not preserved.

DISCUSSION

Reed considered that this specimen belonged to the "true" Proetus latifrons of M'Coy, but a number of differences are seen - notably the presence of the preglabellar field and the parallel anterior branches of

SPECIES	Glabellar shape.	No. of lateral glabellar furrows.	Depth of lateral glabellar furrows	Lateral occipital lobes	Epsilon and zeta	Flexure on free and fixed cheeks	Preglabellar field	No. of rings on pygidial axis.	Posterior end of axis	No. of pygidial pleural ribs	Sculpture
celechovicensis	pyriform	4	deep	separated from glabella	separate angles	present	absent	13-14	touches border	7-9	granular
salairicus	pyriform	3	deep	separated from glabella	separate angles	present	present	11-13	does not touch border	8-9	granular
tiro	pointed trapezoidal	3	shallow	Laterally fused with glabellar in adult. Separated in immature.	separate angles	present	present	10-12	does not touch border	7-8	pitted in adult, granular in immature

Fig. 5.5 Comparison of certain characters of <u>Schizoproetus celechovicensis</u>, <u>Schizoproetus salairicus</u> and <u>Schizoproetus tiro</u>.

the facial sutures in P. sp. D, not characters of P. latifrons (see Pl. 38, Figs. 1-6, 9). Proetus sp. D is perhaps closest to the Ashgill species P. berwynensis (Whittington, 1966) (see Chapter 3), sharing with it the short preglabellar field and parallel anterior branches of the facial sutures.

Subfamily SCHIZOPROETINAE Yolkin 1968

Genus SCHIZOPROETUS R. Richter 1912

Type species Proetus celechovicensis Smycka, 1895

DISCUSSION

Species of Schizoproetus have hitherto only been recorded from the Middle Devonian, and Ormiston (1967, p. 69) stated that "possibly the origin of Schizoproetus is to be traced to some Lower Devonian Proetus". The new Silurian species assigned to Schizoproetus here takes the genus back as far as the late Wenlock, and it is suggested above that it may have its origins in the Llandovery species Crassiproetus? curtisi.

Although the shape of the glabella and the non-impressed lateral glabellar furrows distinguish the Silurian species Schizoproetus tiro from the type species, certain features, especially the pygidium are very similar to it and other Devonian species, especially S. salairicus (Tchernysheva, 1951 (see Yolkin 1968, Pl. 9, Figs. 9-11). This species and S. tiro also agree in certain cephalic features, notably the marked flexure on the lateral parts of the frontal area and on the free cheek (cf. Pl. 40, Figs. 1-3, 10, 14 and Yolkin 1968, Pl. 9, Figs. 5-8, 12-13). The glabellar outline of the smallest cranidium of S. salairicus figured by Yolkin (Pl. 9, Fig. 8) is not dissimilar to that of S. tiro, although with increase in size S. salairicus becomes more elongated and pyriform. The shape of the occipital ring in S. tiro, S. salairicus and S. celechovicensis is similar in all three, but the latter two differ from the first in not having the lateral occipital lobes fused with the glabella. It is of interest to note that a small cranidium of S. tiro (Pl. 40, Fig. 13) has lateral occipital lobes distinctly isolated from the glabella, as well as somewhat deeper lateral glabellar furrows.

Despite the morphological differences, it is not difficult to imagine S. tiro as representing an ancestral stock from which other Schizoproetus species arose, and a succession of species through S. tiro, S. salairicus and S. celechovicensis can be seen, showing deepening of lateral glabellar furrows and elongation of the glabella.

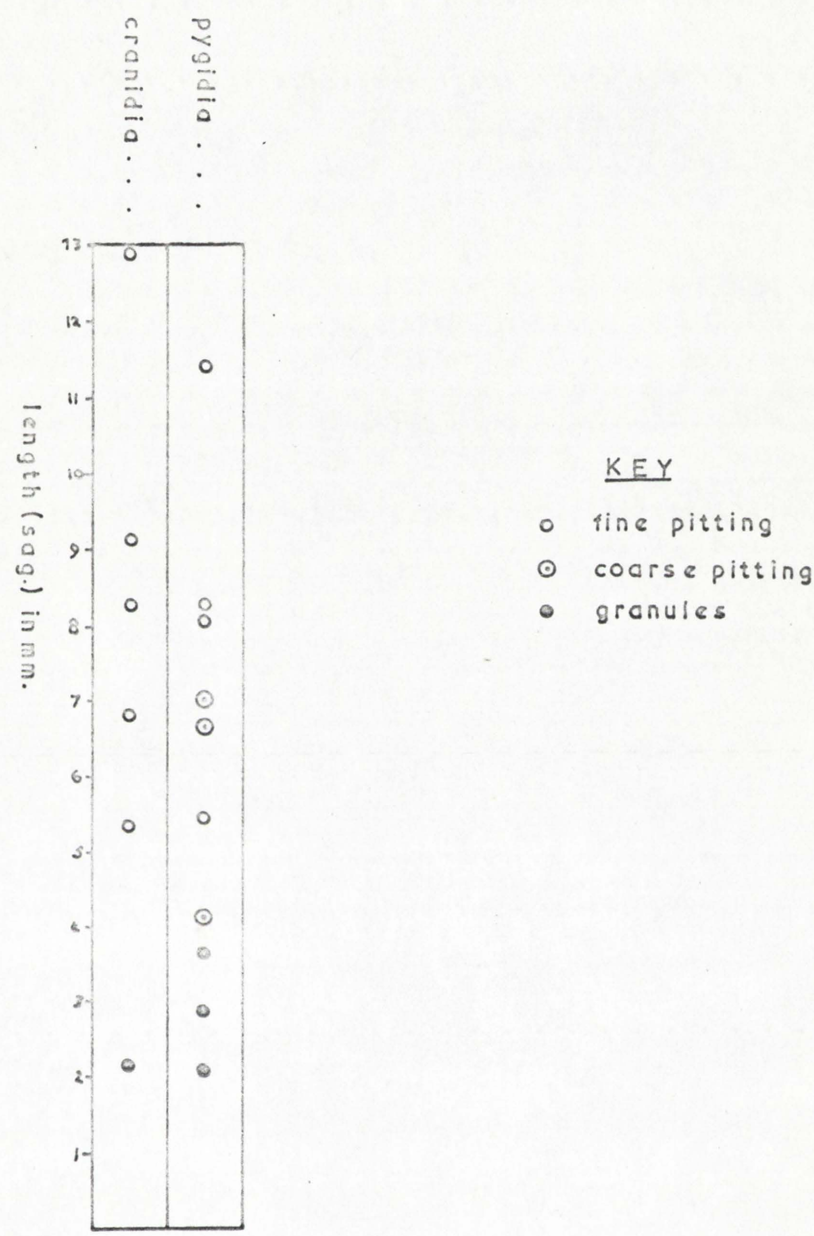


Fig. 5.6. Size range of different types of surface sculpture in Schizoproetus tiro.

Schizoproetus tiro sp. nov.*

Plate 40, Figs. 1-14, Pl. 41, Figs. 1-14.

HOLOTYPE

A cranidium (SGU Coll.), Pl. 40, Figs. 1, 2, 5, 7.

MATERIAL

About 40 cranidia, 13 free cheeks, 2 thoracic segments, about 40 pygidia and 17 hypostomes.

TYPE STRATUM AND TYPE LOCALITY

Hörsne, Gotland, Halla Beds (late Wenlock).

OCCURRENCE

At the type locality, and possibly in the Wenlock Limestone of Dudley, England.

DERIVATION OF THE NAME

From Latin tiro, a beginner, because this species is the earliest known Schizoproetus.

DIAGNOSIS

Cranidium with sagittal length and palpebral width almost equal; glabella rather broader than long, trapezoidal, pointed anteriorly; 3 pairs of glabellar furrows, represented as smooth areas, not impressed; short (sag.) preglabellar field present; occipital lobes laterally fused with glabella; pygidium of parabolic outline, with narrow border; axis wide, with 10-11 rings, interannular furrows shallow; posterior end of axis does not touch the pygidial border; 8 pairs of clearly defined pleural ribs; sculpture of fine pits, with terrace lines marginally; hypostome with moderately convex median body, no posterior spines.

DESCRIPTION

The cephalon is well vaulted. The cranidium has the sagittal length and palpebral width almost equal. The glabella is about five sixthsas long (sag.) as it is wide (trans.). In longitudinal profile it forms an

* Since the above was written, my attention has been drawn to a paper by Hedström (1923- Contributions to the fossil fauna of Gotland. 1. Sver. Geol. Unders. Ser. C. No. 316, 1-25, Pls. 1-5), in which this species is described as Proetus delicatus Hedström. Thus for Schizoproetus tiro sp. nov. herein, read Schizoprotus delicatus (Hedström, 1923).

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Schizoproetus tiro sp. nov.*

Plate 40, Figs. 1-14, Pl. 41, Figs. 1-14.

HOLOTYPE

A cranidium (SGU Coll.), Pl. 40, Figs. 1, 2, 5, 7.

MATERIAL

About 40 cranidia, 13 free cheeks, 2 thoracic segments, about 40 pygidia and 17 hypostomes.

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DESCRIPTION

The cephalon is well vaulted. The cranidium has the sagittal length and palpebral width almost equal. The glabella is about five sixths as long (sag.) as it is wide (trans.). In longitudinal profile it forms an evenly convex curve, while in lateral profile it is flat in the posterior with the frontal lobe sloping steeply downwards to the preglabellar furrow. The glabella is defined by narrow, but distinct lateral and preglabellar furrows. From its widest point, at the anterior end of the lateral occipital lobes it tapers forwards weakly as far as the anterior part of the palpebral lobes, then more strongly from here to the antero-lateral corner, and finally tapers forwards rapidly to a blunt point.

Three pairs of lateral glabellar furrows are developed, represented by smooth areas on the otherwise pitted glabellar surface. 1p is broad and rhomboidal in outline, with its anterolateral corner situated opposite the anterior end of the occipital lobe. The furrow does not run into the axial furrow, and extends a little over half way towards the sagittal line, with the inner posterior cornerreaching closest to it. This part of the furrow is almost in line (trans.) with epsilon. Associated with 1p is a small auxiliary impression, about two-thirds of the way in front of the axial furrow to the sagittal line, and situated more or less on a line produced inwards from the anterior margin of 1p. 2p is narrow, elongated and directed backwards at about the same angle as the posterior margin of 1p. It is entirely isolated from the axial furrow, with its adaxial end situated opposite the anterior part of gamma. It extends further inwards than 1p, but not as far inwards as the auxiliary impression. 3p is short, elongated and directed backwards at about the same angle as 2p, and situated a short distance in front.

The occipital furrow is rather broad and shallow, with its median part running more or less transversely; adaxially, the occipital furrow forks, with the wider anterior branch being the true occipital furrow, running in front of the lateral occipital tubercle. This shallows and becomes obsolete before reaching the axial furrow. The posterior branch is narrower, curing round the back of the occipital tubercle and meeting the axial furrow adaxially. The resultant principle portion of the occipital ring is wide sagittally, but narrowing rapidly behind the occipital lobes so that the only very thin band extends laterally towards the axial furrow. In lateral profile the occipital ring is nearly flat, and gently declined in the anterior towards the occipital furrow. In longitudinal profile the occipital ring slopes down steeply adaxially. On most specimens there is no trace of a median tubercle, but there is a very faint suggestion of one on some specimens, situated posteriorly. The lateral occipital lobes are prominent, ovate, elongated in a transverse direction, and extend further adaxially than does any part of the glabella. Their anterolateral corners are fused with the posterolateral ones of the glabella, thereby giving them the appearance of being part of the glabella rather than of the occipital ring.

The preglabellar field is short (sag.), and is about the same width (sag.) as the narrow convex anterior border from which it is separated by a distinct, narrow anterior border furrow. The anterior branches of the facial sutures are strongly divergent, with the stretch gamma to beta more or less straight. An exsagittal line drawn backwards from beta normally falls on the palpebral lobe, but occasionally falls outside it. Gamma is a long wide angle, situated a little distance from the axial furrow. The posterior branch of the facial suture has epsilon and zeta as independent angles, with epsilon situated nearly opposite the adaxial end of the occipital furrow. The stretch epsilon-zeta is nearly straight and runs close to, and parallel with the axial furrow. On the posterior border the posterior branches diverge strongly to cut the posterior margin between half and one third of the way from the axial furrow to the lateral margin.

The palpebral lobe is small, being a little over one quarter the sagittal length of the glabella, and posteriorly situated. It is subsemicircular and more or less symmetrical in outline. In longitudinal profile it is inclined at a low angle from the axial furrow, flattening distally, and is considerably below the sagittal elevation of the glabella. The eye is banana shaped, and the visual surface is supported on a narrow eye socle, whose upper and lower margins run more or less parallel. The lower margin is defined by a distinct furrow, which crosses onto the fixed cheek on some specimens (e.g. Pl. 40, Figs. 1-2). The part of the free cheek surrounding the eye is flattened, representing an eye platform. From the base of the eye platform the field of the free cheek falls away steeply until it reaches an abrupt change of slope, represented by a very shallow, wide, furrow, and runs down at a less steep angle to the rather shallow lateral border furrow. The abrupt change of slope of the free cheek is continued onto the frontal area of the cranidium, and runs into the preglabellar furrow a short distance from the anterior and of the glabella. This change in slope may represent the inner margin of a very wide, shallow median groove, produced by the fusion of the lateral border furrow and that part of the fixed cheek between the lateral border furrow and the sharp change in slope which runs parallel to it. The lateral border is a little wider than the anterior border, and like it is weakly convex. The posterior border is wider than the lateral adaxially, but abaxially narrows, so that it is of similar width near the axial furrow. It is weakly convex and inclined towards the posterior. The posterior border furrow is considerably deeper, shallowing suddenly at the base of the genal spine where it meets the sharp change in slope of the field of the free cheek. The genal spine is broad based, and rather short, with a very wide, shallow median groove, produced by the fusion of the lateral border furrow and that part of the fixed cheek between the lateral border furrow and the sharp change in slope which runs parallel to it.

The hypostome has a rather convex median body, sloping down strongly to the anterior border furrow, and weakly to the posterior. The anterior border furrow is narrow and shallow, with the narrow anterior border strongly upturned. The anterior wing is moderately large, strongly inclined upwards. The lateral and posterior border furrows are deeper and wider than the anterior, as are the lateral and posterior borders, which are weakly convex. The posterior wing region is widened (trans.) but no posterior wing is developed. The median body is divided by shallow, but distinct backwardly directed median furrows into a long (sag.) anterior lobe and short (sag.) posterior lobe. There are no posterior spines.

The number of thoracic segments is unknown. On the few isolated thoracic segments studied the axis is rather wider than the pleura. The annulus is divided into the post-annulus and preannulus by a shallow intra-annular furrow, which adaxially curves forwards and runs into the articulating furrow, so that the preannulus does not extend as far as the axial furrow. The postannulus and preannulus are of about equal width (sag.), and the two together are about the same width as the articulating half ring. The pleura carries a narrow pleural furrow, extending about half way along the pleura towards the distal end, before being truncated by the facet. It divides the inner part of the pleura into anterior and posterior pleural bands of more or less equal width. The facet is long (trans.) and incorporates most of the distal third of the pleura. The pleura bends down steeply from the fulcrum, and is bluntly truncated distally.

The pygidium is parabolic in outline, with a narrow flattened border. Anteriorly the axis is about half the total pygidial width (trans.), in large specimens, and about three sevenths of the total width in smaller ones. It tapers gradually backwards to a blunt end, which does not reach the border, and the axis is over three quarters of the total pygidial length (sag.). It consists of 10-11 rings, which are separated by very shallow interannular furrows. The first one runs more or less transversely sagittally, but abaxially it is arched weakly forwards. The other furrows are arched weakly forwards, with the direction changing to weakly backwards posteriorly. At the lateral ends of each ring there is a small, darker depressed area, situated just anterior to and touching the interannular furrow immediately behind that ring. About half way towards the sagittal line there is another darker area, elongated in a transverse direction, situated in a median position (exsag.), not touching

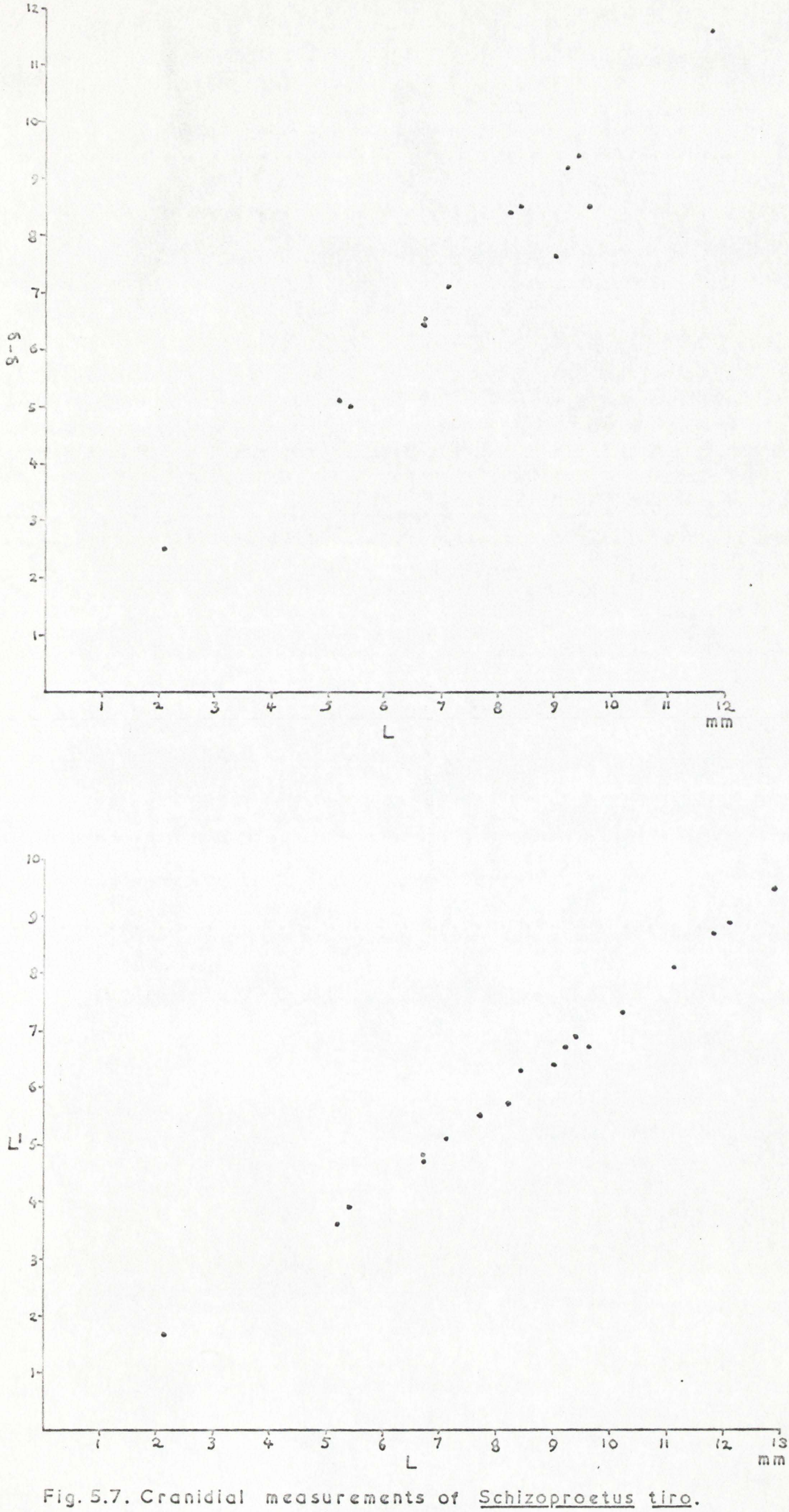
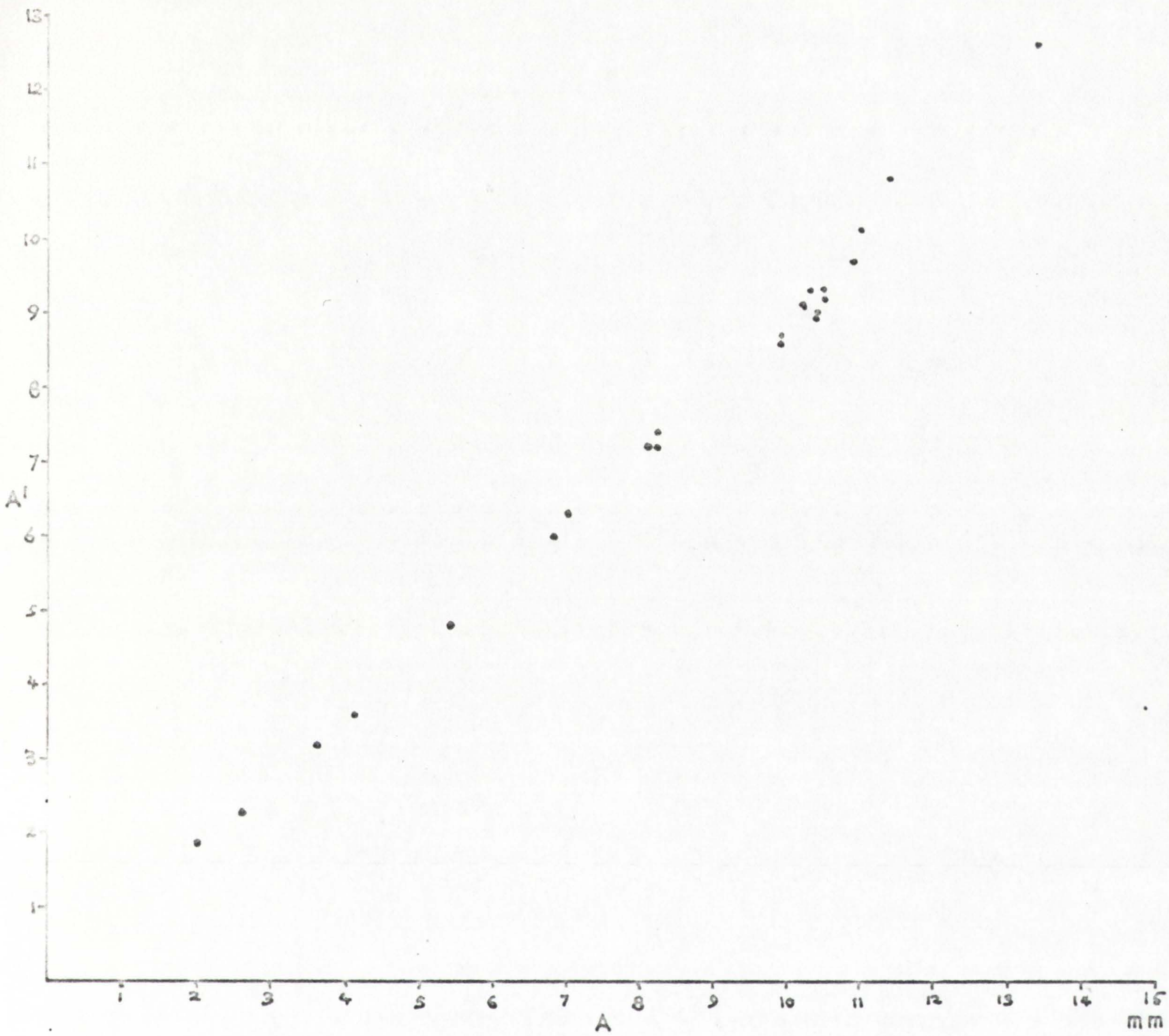


Fig. 5.7. Cranidial measurements of Schizoproetus tiro.

the interannular furrows. Such markings may be interpreted as muscle areas. In lateral profile the axial rings hardly make any impression on the contour of the axis, which curves backwards in a gently convex curve, sloping down almost vertically to the nearly vertical postaxial area from its posterior end. In smaller specimens the slope is not so steep. The pleural areas slope down steeply in a strongly convex curve from the axial furrow, and have 8 pairs of clearly defined ribs, which bend fairly strongly backwards, and widen only slightly abaxially. The pleural furrows are deep, with the first extending as far as the pygidial margin. The succeeding ones do not, and distally they are hooked, so that the extreme distal section runs nearly straight backwards. Adaxially none of the pleural furrows reach the axial furrow. The pleural furrows have a rather steep anterior slope, and rather shallower posterior slope. The inter-pleural furrows are rather faint, but longer than the pleural, extending further both abaxially and adaxially, where they run into the axial furrow. They do not meet the pygidial margin. They are not inclined so strongly backwards as the pleural furrows, but like them turn quite sharply backwards at their distal extremities. Adaxially the posterior pleural band is considerably wider than the anterior, but abaxially they are of more or less the same width (exsag.). In lateral profile both are convex, with the posterior slope of the anterior pleural band curving strongly down to the pleural furrow.

On the large specimens the sculpture is of small pits, interspersed with more dense, even smaller pits (see Pl. 40, Fig. 11). The doublure and the cephalic margin of all specimens has prominent, parallel terrace lines. A few terrace lines are seen on the abaxial part of the facet of the thoracic pleura, and the marginal terrace lines of the pygidium frequently turn inwards onto the pygidial border (e.g. Pl. 41, Fig. 8). Terrace lines are present on the lateral and posterior margins of the hypostome, and on the anterior lobe of the median body a series of irregular terrace lines are arranged in a "V" with its apex pointing forwards. On the posterior lobe of the hypostome the fine terrace lines at either side run more or less exsagittally.

On smaller specimens, the sculpture apart from the terrace lines varies. These can be divided into two main categories - small cranidia (e.g. Pl. 40, Fig. 13) and pygidia (e.g. Pl. 41, Figs. 7, 10, 11) with a granular sculpture and moderately sized pygidia (e.g. Pl. 41, Figs. 4, 5, 8, 12) with a coarse pitted sculpture. The size range of these different sculpture types is shown in Fig. 5.6.



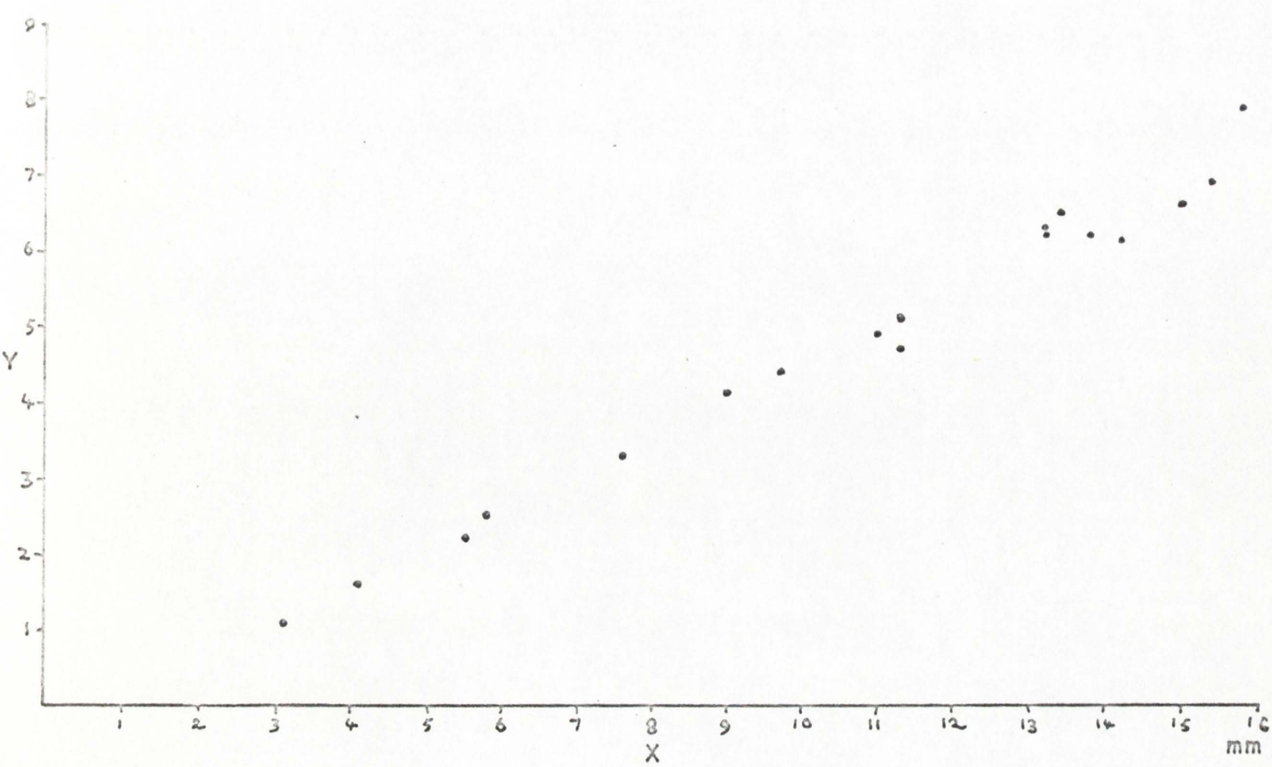


Fig. 5.8. Pygidial measurements of <u>Schizoproetus</u> <u>tiro</u>.

DISCUSSION

It has been possible to take measurements from about half the sample of specimens. These, when plotted graphically against one another show a continuous variation, and this is good evidence for supposing that smaller specimens with a different sculpture from the larger ones all belong to the same species. The changes in sculpture are therefore changes in ontogenetic growth.

A poorly preserved pygidium (Pl. 41, Fig. 3) and a partial external mould of a second onehave been found from the Wenlock Limestone of Dudley. These specimens are likely to be conspecific with S. tiro, but until better material is found, they are included in that species with doubt.

?Subfamily SCHIZOPROETINAE Yolkin, 1968

Genus CRASSIPROETUS Stumm 1953

Crassiproetus? curtisi non. nov. (pro Proetus asaphoides Curtis 1958,znon Hawle and Corda 1847).

Plate 39, Fig. 4.

1958 Proetus asaphoides sp. nov. Curtis p. 140, Pl. 29, Fig. 2.

HOLOTYPE

A large internal mould (GSM GSb 4687) figd. Curtis Pl. 29, Fig. 2 and refigured herein as Pl. 39, Fig. 4. The only specimen known.

TYPE STRATUM AND TYPE LOCALITY

Upper Llandovery, base of Totworth Beds, Cullimore's Trap Quarry, Charfield, Gloucestershire.

DERIVIATION OF THE NAME

After Mr M.L.K. Curtis, who originally described the specimen.

DIAGNOSIS

Glabella ovate, apparently without lateral glabellar furrows; occipital furrow rather narrow; lateral occipital lobes poorly differentiated, anterolateral corners fused with posterolateral corners of glabella; thorax of ten segments; pygidium parabolic, markedly longer (sag.) than thorax; axis with poorly differentiated rings, pleural areas flat with distinct, shallow pleural furrow, interpleural furrows not indicated.

DESCRIPTION

See Curtis 1958, p. 140.

DISCUSSION

This large and interesting species appears closest to Crassiproetus, a Middle Devonian genus, especially in the ovate glabella and elongated pygidium. It is suggested above that this species is possibly ancestral to Schizoproetus tiro. Crassiproetus probably belongs to the same subfamily as Schizoproetus and if curtisi really does belong to the former one, early differentiation of these two genera is indicated.

SPECIES	WENLOCK		LUDLOW	
	LITENIAN		BUDNANIAN	
	Želkovice Beds	Motol Beds	Kopanina Beds	Přídolí Beds
Proetus (*Proetus*) *morinensis*	—	—	—x	
Proetus (*Coniproetus*) *nasutus*	—	—	—x	
Proetus ryckholti	—	—	—x	
Cornuproetus (*C.*) *intermedius*	—	—	—x	
C. (*C.*) *consobrinus*	—	—x—	—x	
C. (*C.*) *venustus*	—	—	—x	
C. (*C.*) *vertumnus*	—	—x		
C. (*C.*) *reussi*	—	—x		
C. (*Lepidoproetus*) *limatulus*	—	—	—x	
C. (*Lodenicia*) *dentatulus*	—	—x		
Decoroproetus decorus decorus	—	—x		
D. decorus quirinus	—	—	—x	
D. octonus	—	—x		
Prantlia longula	—	—	—x	
Cyphoproetus depressus	—	—x		
C. strabismus	—	—x		
Eremiproetus senex	—	—	—x	
Tropidocoryphe heothina	—	—	—x	

Fig. 6.1. Stratigraphical distribution of Proetidae in the Silurian of Bohemia.

CHAPTER 6

SILURIAN PROETIDAE FROM BOHEMIA

ABSTRACT

Old Barrande species are redescribed and illustrated by photographs for the first time, together with a few later ones. In all, 19 species are described or discussed, distributed among 7 genera and 5 subgenera. Four species are new - Cornuproetus (Cornuproetus) peraticus, Decoroproetus octonus, Tropidocoryphe heothina and Cyphoproetus strabismus. Two of the species described are from Britain and Sweden, but are treated here as they are closely allied to Bohemian ones. Proetidae from the Silurian of Bohemia are of great interest, because representatives of groups rare or absent from the Anglo-Baltic area are present. The difference in the fauna is probably the result of a different facies type.

INTRODUCTION

Since Barrande's time the Silurian proetids of Bohemia have received scant attention, a small number of species being described by Pribyl (1946, 1946a, 1965, 1966), Prantl and Vanek (1958), Kriz (1962) and Alberti (1967, 1969). In these works no new figures have been given of Barrande's old types, and in some of them (e.g. Pribyl 1946a) Barrande's old figures are reproduced. Many of Barrande's drawings, though outstanding in their time, were often composed from more than one specimen, and are therefore essentially reconstructions, frequently bearing little resemblance to any single specimen.

The aim of the present paper is to refigure and redescribe these old and important species. Unfortunately it was impossible to photograph the original specimens, and the photographs given are of plaster or latex casts prepared from silicone rubber negatives of the originals made during a visit to Prague in July-August 1969. It was also impossible to prepare any of the type material at Prague, which has necessitated figuring unprepared specimens. This chapter is intended to represent the first draft of a larger paper in which specimens from the Schary collection at Harvard College will be incorporated. Time and finance has not allowed examination of this collection during the course of the preparation of this thesis.

RELATIONSHIPS OF THE FAUNA

The rich Silurian proetid fauna of Bohemia contrasts strongly with contemporaneous faunas in Britain and Scandinavia. The latter are dominated by species of _Proetus (Proetus)_ and _Warburgella_, while the former is dominated by members of the Cornuproetinae. In both areas _Decoroproetus_ and _Cyphoproetus_ occur locally in small numbers. _Proetus (Proetus)_ is only represented by one species in Bohemia, which occurs in the Ludlovian, and _Warburgella_ is entirely absent from the Bohemian Silurian. _Cornuproetus (Cornuproetus)_ is known from a single specimen in the British Silurian, and is unknown from Scandinavia. The distribution of these forms is probably related to facies. The bioherm facies of Gotland and the Welsh Borderland is absent from Bohemia in the Silurian, while the organodetrital limestones common in Bohemia are rare in Britain and Scandinavia. The Bohemian succession also has a good deal of associated volcanic deposits, and such deposits are very infrequent in Britain and absent in Scandinavia.

STRATIGRAPHY

The stratigraphical terminology employed is after Horny et al. (1958), Boucek et al. (1966) and Martinsson (1969), the major stage names Litenian and Budnanian being used, subdivided into the Zelkovice, Motol, Kopanina and Pridoli Beds.

SYSTEMATIC PART

Family PROETIDAE Salter 1864

Subfamily PROETINAE Salter 1864

Genus _PROETUS_ Steininger 1831

Type species _Calymmene concinna_ Dalman 1828

Subgenus _PROETUS (PROETUS)_ Steininger 1831

Proetus (Proetus) morinensis Pribyl 1946

Plate 42, Figs. 5-6.

1946 _Proetus (Proetus) morinensis_: Pribyl Pl. 2, Fig. 12.

1960 _Proetus (Proetus) morinensis_ Pribyl: Pribyl p. 204, Pl. 2, Figs. 1-5.

1967 _Proetus morinensis_ Pribyl: Whittington and Campbell, p. 456.

1967 _Proetus morinensis_ Pribyl: Campbell, p. 15.

HOLOTYPE

A nearly complete specimen (NMP. 29463), figd. Pribyl 1946, Pl. 2, Fig. 12.

MATERIAL

Several additional nearly complete specimens.

TYPE STRATUM AND TYPE LOCALITY

Budnanian, Kopanina Beds, "Amerika" quarry, Moriny.

OCCURRENCE

Only at the type locality.

DIAGNOSIS

Very similar to P. (P.) concinnus from which it differs in the following ways; glabella tapering a little more strongly forwards, and not overhanging the anterior border; eye slightly smaller; pygidial pleural and interpleural furrows sharper, and extending much closer to the margin.

DISCUSSION

This species is exceedingly close to the slightly earlier P. (P.) concinnus, and is the latest representative of the core of the concinnus group. It is the only member of the subgenus Proetus (Proetus) in the Silurian of Bohemia.

Subgenus PROETUS (CONIPROETUS) Alberti 1966
Subgenotype Proetus (Coniproetus) condensus Pribyl 1965

Proetus (Coniproetus) nasutus sp. nov.
Plate 42, Figs. 7-13

1960 Proetus signatus Lindström: Pribyl, p. 206, Pl. 1, Figs.

HOLOTYPE

A cranidium (NMP 218/67), figured Pribyl, 1960, Pl. 1, Figs. 12-18 and refigured herein as Pl. 42, Figs. 7-9,11.

MATERIAL

Besides the type, two pygidia.

TYPE STRATUM AND TYPE LOCALITY

Budnanian, Kopanina Beds, Slivenec, near Prague.

OCCURRENCE

Budnanian, Kopanina Beds, Slivenec and Svaty Jan pod Skalou.

DERIVATION OF THE NAME

From Latin nasutus, large nosed, due to the prominent glabella (original manuscript name of Novak for this species).

DIAGNOSIS

Glabella rather strongly inflated, with three pairs of weakly impressed furrows; pygidium with broad, blunt axis with 8 rings, pleural areas with 5 pairs of ribs; pygidial border developed; sculpture granular.

DESCRIPTION

The cranidium is well vaulted, and the estimated palpebral width is three quarters of the sagittal length. The glabella is as long as wide, coniform and defined by rather narrow, distinct incised axial and preglabellar furrows. It tapers gradually forwards to the rounded frontal margin. In longitudinal and lateral profiles it is strongly convex. Three pairs of weakly impressed lateral glabellar furrows are developed. 1p is situated about a third of the way up the glabella, proximally running nearly adaxially for a short distance, then turning backwards almost through a right angle. The posterior end is pointed, and does not reach the occipital furrow, extending about a third of the way towards the sagittal line. 2p is about half way up the glabella, weakly incised where it joins the axial furrow, but otherwise non-incised and obscure. It is directed backwards at 45° to an exsagittal line, and extends about half way towards the sagittal line, 3p is very obscure, isolated from the axial furrow and a short distance in front of 2p. It is evident only as a slight interruption in the glabellar sculpture.

The occipital furrow runs nearly transversely, curved forwards laterally. The anterior slope is nearly vertical, where the posterior end of the glabella is elevated considerably above the occipital ring. The occipital ring is as wide (sag.) as the anterior border, and transversely is apparently the same width as the glabella. In lateral profile it is very weakly convex. On the holotype it has been damaged, and in the median region the impression of the underside of the dorsal exoskeleton is seen, which shows that the underside was finely pitted, and at the posterior of the median tubercle there was a distinct depression. On the right hand side of the occipital ring the cast of the ventral surface of the doublure is seen, which is very weakly dorsally convex and ornamented with fine, parallel terrace lines. It is impossible to see if lateral occipital lobes were originally present.

The preglabellar field is minute, about a fifth of the sagittal width of the anterior border. The anterior border furrow is rather shallow and narrow, but distinct. The anterior border is broad, flattened and weakly inclined towards the anterior. The anterior branches of the facial sutures are weakly divergent, with gamma-beta a straight line. The palpebral lobe and posterior branches are not preserved.

The middle of the glabella and the occipital ring have coarse granules, while the perimeter of the glabella, the anterolateral portions of the fixed cheeks and the anterior border have finer, more densegranules. On the lateral parts of the anterolateral portions of the fixed cheeks, behind the anterior border furrow are a few fine pits.

The pygidium is semicircular in outline, moderately vaulted with the sagittal length about half the transverse width. Anteriorly the axis is about two fifths of the total pygidial width, and tapers gradually backwards to the rounded posterior end. In longitudinal profile it is moderately convex, while in lateral profile it is gently declined towards the posterior as far as the end piece, where it slopes almost vertically down to the postaxial area, which is distinctly concave. There are 8 axial rings, separated by rather shallow interannular furrows which run more or less transversely and weakly kinked towards the posterior on either side of the sagittal line. In lateral profile each ring is very weakly convex, and is gently declined towards the posterior. On the abaxial parts of each ring, with the exception of the first is a small exsagittally elongated depression which interrupts the sculpture and runs into the preceeding interannular furrow. The axial furrows defining the axis are shallow and non-incised, and become shallower behind it. The inner parts of the pleural areas are nearly horizontal, while the outer parts are rather strongly declined to the margin. Five pairs of pleural ribs are developed, which burve gently backwards and widen slightly abaxially. The first two pairs of pleural furrows are deeper than their corresponding interpleural furrows, but the more posterior ones are about the same depth. The pleural and interpleural furrows become progressively shallower and less distinct towards the posterior. The more anterior ones reach close to the pygidial margin, while the others are abruptly truncated by the pygidial border. The whole pygidium has a granular sculpture, the granules on the axis being larger and in greater numbers than those on the pleural areas. There are a few prominent terrace lines on the margin, but none of these are incurved.

DISCUSSION

P. (Coniproetus)nasutus differs from (P. (C.) condensus (see Pl. 42, Fig. 4) chiefly in the more inflated glabella, and in details of sculpture, one of which is the presence of pitting on the fixed cheek. The latter feature and the inflated glabella suggest that P. (C.) nasutus is close to the stock from which P. (Coniproetus) was possibly derived from Proetus (Proetus). Pribyl (1960, p. 206) considered the Bohemian species described here as P. (C.) nasutus to belong to Proetus signatus Lindstrom, but this species differs widely from it in glabellar outline, shape of the anterior border furrow and width of the pygidial axis.

Proetus ryckholti Barrande, 1846

Plate 42, Figs. 1-3

1846 Proetus ryckholti: Barrande, p. 63

1847 Proetus ryckholti Barrande: Hawle and Corda, p. 76.

1847 Proetus Boops: Hawle and Corda, p. 75.

1847 Proetus mancus: Hawle and Corda, p. 78.

1852 Proetus ryckholti Barrande: Barrande, p. 439, Pl. 15, Figs. 15-19.

1951 Proetus ryckholti Barrande: Erben, p. 15.

1960 Proetus ryckholti Barrande: Pribyl, p. 206, Pl. 2, Fig. 6.

1966 Proetus (Coniproetus) ryckholti (Barrande): Alberti, p. 112.

1969 Proetus (Coniproetus) ryckholti (Barrande): Alberti, p. 93.

HOLOTYPE

A nearly complete specimen (NMP Br. 174), figd. Barrande 1852, Pl. 15, Figs. 15-17, and refigured herein as Pl. 42, Fig. 1.

MATERIAL STUDIED

Two nearly complete specimens and a few isolated cranidia and pygidia.

TYPE STRATUM AND TYPE LOCALITY

Budnanian, Kopanina Beds, Dlonha Hora.

OCCURRENCE

Kopanina Beds, Dlouha Hora and Kosor, Beroun district, central Bohemia.

DIAGNOSIS

Glabella coniform with three pairs of weakly impressed lateral glabellar furrows; no lateral occipital lobes; short (sag.) preglabellar field; pygidium without border and broad pleural areas with 5 pairs of ribs; narrow pygidial axis with 6 rings.

DESCRIPTION

The cranidium has the palpebral width a little less than the sagittal length. The glabella is coniform, as long as wide and defined by narrow, incised axial and preglabellar furrows. It tapers forwards constantly and evenly from the bluntly rounded posterolateral corners and is weakly convex in lateral and longitudinal profiles. Three pairs of weakly impressed lateral glabellar furrows are present. 1p is opposite the centre of the palpebral lobe and runs backwards at about 45° to an exsagittal line, dying out before reaching the occipital furrow. It is bent through a weak angle about half way along its length, and the posterior end is about a third of the way towards the sagittal line. Between the anterior part of 1p and the sagittal line is a rounded, auxiliary impression. 2p is situated opposite gamma, runs backwards a little less strongly than 1p and extends about half way towards the sagittal line. It is club shaped. 3p is a little under half way from 2p to the frontal margin, and runs weakly forwards and extends a little further inwards than 2p.

The occipital furrow is broad, with the median portion running transversely, and the lateral ends curved forwards. The anterior slope is nearly vertical. The occipital ring is about half the width (sag.) of the preglabellar area, and transversely is about as wide as the glabella. It maintains the same width laterally, and there are no lateral occipital lobes. The preglabellar field is minute, about half the width (sag.) of the anterior border. The anterior border furrow is shallow, non-incised but distinct. The anterior border is weakly convex. The anterior branch of the facial suture describes an outwardly convex sigmoidal curve, and an exsagittal line drawn backwards from beta falls on the outer part of the palpebral lobe. Gamma is a little distance out from the axial furrow. The posterior branch has epsilon and zeta as independent angles, the former close to the posterolateral corner of the glabella and the latter about half way along (exsag.) the lateral end of the occipital ring. The stretch zeta-epsilon runs close to and parallel with the axial furrow. From zeta the suture turns strongly adaxially to cut the posterior margin a short distance from the base of the genal spine.

The palpebral lobe is subparabolic, about half the length of the glabella and backwardly placed. The eye is crescentic, a little over half the glabellar length and supported by an indistinct eye socle. The field of the free cheek is rather narrow and quite steeply declined from the eye. The lateral border furrow is a little shallower than the anterior border furrow, and the lateral border is of similar width to the anterior. The posterior border furrow is deep and incised, meeting the axial furrow at the lateral end of the occipital ring. Abaxially, after meeting the lateral border furrow it bends strongly backwards to become the median groove of the genal spine, which gradually shallows backwards and dies out before reaching its posterior end. The genal spine is narrow-based and slender, extending backwards as far as the fourth thoracic segment. The cephalic doublure is about the same width as the border, and is ventrally convex and ornamented with fine, parallel terrace lines. One specimen (Pl. 42, Figs. 2-3) shows the left and right hand connective sutures of the rostral plate, which converge backwards to define a trapezoidal rostral plate whose posterior margin seems to be about two thirds as long as the rostral suture. The same specimen shows the displaced hypostome. This has an elongated median body, which maintains the same width along its length. The anterior lobe is elongated, while the posterior lobe is narrow and crescentic. Associated with the backwardly running median furrows are distinct, convex maculae. The lateral and posterior border furrows are deep and rather narrow, and the narrow lateral and posterior borders are upturned. The latter lacks spines. Towards the anterior end of the hypostome the lateral border furrow shallows, and the anterior border furrow is also rather shallow. The anterior and posterior wings are not seen.

The thorax consists of 10 segments. The axis tapers gradually backwards, and on all specimens seen it is very badly preserved, and it is not possible to give a description of it at this stage. The pleurae are narrower (trans.) than the axis anteriorly, but are about the same width (trans.) posteriorly. Each pleura has a deep, narrow pleural furrow which runs obliquely backwards abaxially, and is abruptly truncated by the posterior edge of the articulating facet about half way between the fulcrum and the distal end of the pleura. The anterior and posterior bands of the pleura are of approximately equal width (exsag.). Distally the pleura is bluntly truncated, and the posterolateral corner is bluntly angular.

The pygidium is subparabolic in outline, and is a little over twice as wide (trans.) as long (sag.). Anteriorly the axis is about two sevenths of the total pygidial width, and it tapers gently backwards to the bluntly rounded posterior end. It consists of 6 rings, which are separated by shallow interannular furrows which become progressively less distinct towards the posterior, and run more or less transversely. The first interannular furrow is considerably deeper than the rest. The axis is moderately convex longitudinally, and is defined by rather shallow, non-incised axial furrows. The pleural areas are gently convex, with 5 pairs of ribs which curve gently backwards. With the exception of the deep, incised first pair of pleural furrows, all the other pleural and interpleural furrows are rather shallow, non-incised and of similar depth, and these become progressively less distinct towards the posterior. None of them reach the pygidial margin. The anterior and posterior pleural bands are of approximately the same width (exsag.). There is no clearly defined border. Some of the marginal terrace lines of the pygidium (see Pl. 42, Figs. 2-3) are incurved into the abaxial parts of the pleural areas, and run subparallel with the pleural and interpleural furrows. The pygidial doublure is similar to the cephalic.

The entire exoskeleton is apparently smooth.

DISCUSSION

Alberti (1966, p. 112) has included this species in the subgenus Proetus (Coniproetus), but it lacks the pygidial border and granular sculpture which seem to be characteristics of that subgenus. The presence of incurved marginal terrace lines on the pygidium suggest relationship with Proetus (Proetus), but the presence of the distinct coniform glabella, lack of pitting on the cheeks and the presence of a preglabellar field preclude inclusion in that subgenus. P. ryckholti may be close to the branch which gave rise to P. (Coniproetus), especially as it shares features of that subgenus with features of Proetus (Proetus). For the present it is simply assigned to Proetus.

Subfamily CORNUPROETINAE R. AND E. Richter, 1956

Genus CORNUPROETUS R. and E. Richter, 1919

Type species Gerastos cornutus Goldfuss, 1843

Subgenus CORNUPROETUS (CORNUPROETUS) R. and E. Richter, 1956

DISCUSSION

Within the genus Cornuproetus there is presently recognised a long series of subgenera, many of which have recently been surveyed in detail by G. Alberti (1969). Examination of the type species of Cornuproetus, C. (C.) cornutus (Goldfuss), has shown that the preannulus is present on the thoracic axial rings. This feature is particularly characteristic of the subfamilies Proetinae and Dechenellinae, but is absent from the Proetidellinae, Tropidocoryphinae and Ereniproetinae. It is therefore of great interest that it should occur in C. (C.) cornutus, but how many other species presently assigned to Cornuproetus (Cornuproetus) possess this feature is unknown. It seems to be absent from the Silurian species of Cornuproetus (Cornuproetus) described below. Two possibilities exist regarding the origin of the preannulus in C. (C.) cornutus - that it is present in its direct ancestors, or that it has been gained independently, and the ancestral stock is without it. There is presently no evidence to support the former hypothesis, while there is plenty to support the latter.

In the Silurian Cornuproetus (Cornuproetus) is found frequently in Bohemia, and less commonly in Morocco and the British Isles. Two further subgenera of Cornuproetus are known from the Bohemian Silurian - C. (Lodenicia) and C. (Lepidoproetus). In the late Ordovician Porkuni Beds of Estonia, "Proetus" ramisulcatus Nieszkowski, 1857 occurs. Specimens probably belonging to this species are figured herin (Pl. 43, Figs. 1, 4, 8, 9), although I have been unable to examine the type of ramisculcatus to compare them. In overall morphology they are rather similar to species of Cornuproetus (Cornuproetus) (see Pls. 43, 44), and there is a good chance that they are ancestral to them. The pygidium is close to certain Decoroproetus species, especially D. furubergensis Owens (see Pl. 1-2), which suggests that the Cornuproetinae may have their origin in Decoroproetus.

The late Ordovician genus Ascetopeltis Owens shows some similarities to "Proetus" ramisulcatus, but is more similar to true Proetus species in gross morphology. The similarity of Ascetopeltis, an early member of Proetinae and "Proetus" ramisulcatus, a probable early member of the Cornuproetinae suggests that the two subfamilies have a common origin and became differentiated in the later Ordovician.

Cornuproetus (Cornuproetus) venustus (Barrande, 1846)
Plate 44, Figs. 4-7, 9, 10

1846 Proetus venustus Barrande; p. 64.

1847 Proetus Lejurus; Hawle and Corda, p. 75

1852 Proetus venustus Barrande, pars: Barrande, p. 467, Pl. 17, Figs. 1-3 (non Figs. 4-6)

1946 Proetus (Cornuproetus) venustus Barr.: Pribyl, p. 6 Pl. 1, Figs. 5, 5a.

HOLOTYPE

A complete specimen (NMP Br. 227), figd. Barrande Pl. 17, Figs. 1-3 and refigured herein as Pl. 44, Figs. 5-7, 9, 10.

TYPE STRATUM AND TYPE LOCALITY

Budnanian, Kopanina Beds, Dlouha Hora.

MATERIAL STUDIED

The type and two additional almost complete specimens.

OCCURRENCE

Only known from the type locality.

DIAGNOSIS

Glabella subquadrate, weakly laterally constricted; anterior branch of facial suture describes an abaxially sigmoidal curve; genal spine long, extending backwards as far as the eighth thoracic segment; thorax of 10 segments; pygidium with sagittal length about two fifths of the transverse width; axis with 4 rings, pleural areas with 4 pairs of ribs; sculpture of striations interspersed with granules.

DESCRIPTION

The cranidium is about five sixths as wide (trans.) across the palpebral lobes as it is long (sag.). The glabella is a little wider than it is long, and is defined by narrow, rather shallow conjoined axial and preglabellar furrows. The glabella tapers weakly forwards, with a bluntly rounded frontal lobe. From the posterolateral corners to a position opposite the palpebral lobes the glabella is nearly parallel sided, widening very slightly towards the anterior. Opposite gamma the glabella is distinctly constricted, and in front of this position is nearly parallel sided as far as the anterolateral corners. In longitudinal and lateral profiles the glabella is rather strongly convex. There are three pairs of lateral glabellar furrows, indicated as smooth areas on the glabellar surface. 1p is opposite the anterior end of the palpebral lobe, directed backwards at about 45° and is lozenge shaped. 2p is a little posterior to gamma, claviculate in outline and directed backwards at a similar angle to 1p. Both 1p and 2p extend about half way towards the sagittal line, and there is an inconspicuous rounded auxiliary impression associated with 1p. 3p is an isolated ovate depression, not far from the anterolateral corner of the glabella.

The occipital furrow is narrow and rather shallow, though deeper than the axial furrow. Neither the anterior nor the posterior slopes are very steep, and the former is a little steeper than the latter. In dorsal view the occipital furrow is curved weakly forwards laterally and sagittally. The occipital ring is rather wide (sag.), about one third the length (sag.) of the glabella. At either end the axial furrows run outwards and backwards so that at the posterior margin the occipital ring is distinctly wider (trans.) than the glabella. In lateral profile the occipital ring is very weakly convex.

The preglabellar field is very short (sag.), about one tenth the sagittal length of the glabella. In lateral profile it is concave, and slopes down steeply from the preglabellar furrow. The anterior border is a little wider (sag.) than the preglabellar field, and in lateral profile extends more or less horizontally and is weakly convex.

The anterior branches of the facial sutures are quite strongly divergent, and describe a wide, adaxially convex curve, so that the stretch from gamma to beta is distinctly outwardly convex. An exsagittal line drawn backwards from beta falls onto the middle of the palpebral lobe. The posterior branch of the facial suture has epsilon and zeta is independent angles, with epsilon close to the lateral end of the occipital furrow and zeta about half way along the lateral end of the occipital ring. The stretch epsilon-zeta runs close to, and nearly parallel with the axial furrow. From zeta, on the posterior border furrow, the posterior branches diverge strongly to cut the posterior cephalic margin not far inwards from the base of the genal spine, and describes a weakly forwardly convex curve.

The palpebral lobe is parabolic in outline, and is about half the sagittal length of the glabella. It is backwardly placed, and in longitudinal profile rises at about 20° from the axial furrow, and the adaxial part is considerably below the sagittal height of the glabella. The visual surface of the eye is more or less crescentic in dorsal view, and rests on a low eye socle, whose lower margin is defined by an abrupt change in slope rather than by a distinct furrow. The lower margin diverges from the upper very slightly at either end.

The field of the free cheek is quite steeply declined from the eye region, and is weakly convex. The lateral border furrows and lateral border are similar to the anterior, but both are a little narrower. The posterior border furrow is deeper and narrower than the lateral, and from it the weakly convex posterior border is inclined towards the posterior. The posterior border widens laterally, being widest at the base of the genal spine. Abaxially the posterior border furrow meets the axial furrow about half way up the lateral end of the occipital ring, while adaxially it meets the lateral border furrow at the base of the genal spine, and the two are continued backwards along the genal spine as the median groove. Anteriorly the inner band of the genal spine is rather wider than the outer, but for most of the length of the genal spine they are of more or less equal width (trans.), with the outer band nearly horizontal, and the inner fairly steeply inclined. The genal spine is long and narrow, extending as far backwards as the eighth thoracic segment, and is some distance out from the distal ends of the thoracic pleurae.

The thorax is marginally longer (sag.) than the cephalon, and consists of 10 segments. In longitudinal profile it is moderately convex, and tapers gently backwards so that the first ring is about twice as wide as the last. Each ring is of comparable length (sag.) to the anterior border, and in lateral profile is very weakly convex, in the anterior sloping down quite steeply to the interannular furrow. Anteriorly the pleurae are only half the width (trans.) of the axis, but posteriorly they are wider. Along the whole length of the thorax the fulcrum is situated about half way along the pleura. Each pleura runs more or less straight outwards in a transverse direction. Each is traversed by a deep pleural furrow, and proximally this divides the pleura into a wide posterior band and a narrow anterior band, but beyond the fulcrum each is of approximately equal width. In lateral profile each band is weakly convex, the posterior margin of the anterior sloping steeply down to the pleural furrow. The distal end of the pleura is bluntly truncated, with the anterolateral corner rounded and the posterolateral drawn out to a point.

The pygidium is about two fifths as long (sag.) as it is wide (trans.) and is subsemicircular in outline. Anteriorly the axis is about a third the total pygidial width, and is about three quarters the length (sag.). It tapers to a blunt point, and behind it is a short, wide, postaxial ridge. The axis consists of 4 axial rings and a short end piece. Each ring is nearly flat in lateral profile, inclined at a low angle towards the posterior. The end piece slopes down steeply to the postaxial area, which is weakly convex in lateral profile. The interannular furrows are rather shallow, and arched very weakly backwards sagittally. The broad pleural areas are weakly convex and contain 4 pairs of ribs which bend gently backwards. The first pleural furrow is deep and well defined, while the rest of the pleural and interpleural furrows are rather shallow, and all of about the same depth. The anterior pleural band is a little wider than the posterior. All pleural and interpleural furrows reach almost to the pygidial margin, with the eception of the third interpleural and fourth pleural and interpleural, which are very inconspicuous. The whole exoskeleton bears a sculpture of very fine striations, interspersed with small granules.

DISCUSSION

Specimens included in this species by Barrande have been shown to belong to Eremiproetus senex Alberti (see below). C. (C.) venustus is closest to C. (C.) vertumnus (see below), from which it differs in having more strongly divergent anterior branches of the facial sutures, a non-constricted glabella and a proportionately large pygidium with one less pair of pleural ribs.

Cornuproetus (Cornuproetus) vertumnus Prantl and Vanek 1958
Plate 44, Figs. 8 and 12

1958 Proetus (Cornuproetus) vertumnus: Prantl and Vanek, p. 261, Pl. 2, Figs. 2-3.

1969 Cornuproetus (Cornuproetus) vertumnus Prantl and Vanek: Alberti p. 121.

HOLOTYPE

A cranidium (NMP L3661), figd. Prantl and Vanek, Pl. 2 Fig. 2, and refigured herein as Pl. 44, Fig. 12.

TYPE STRATUM AND TYPE LOCALITY

Litenian Motol Beds (Upper Wenlock), M. flexilis zone, "Na cernidlech", Lodenice, Near Beroun.

MATERIAL STUDIED

The type and a pygidium (orig. of Prantl and Vanek, Pl. 2, Figs. 3).

OCCURRENCE

Liten Formation, Motol Beds at the type locality and at Svaty Jan pod Skalou.

DIAGNOSIS

Very similar to C. (C.) venustus, from which it differs in the following ways: glabella not constricted laterally, frontal margin more rounded; more weakly divergent, less sigmoidal anterior branches of the facial sutures; proportionately larger pygidium, with distinct pitting and one less rib on the pleural areas.

DISCUSSION

This species is extremely similar to C.(C.) venustus and the earlier C. (C.) peraticus sp. nov., and the three species probably belong to a single lineage. Also similar is C. (C.) walliseri Alberti from the early Ludlovian of Morocco, which differs from C. (C.) vertumnus in the wider (sag.) preglabellar area and the longer palpebral lobe.

Cornuproetus (Cornuproetus) peraticus sp. nov.

Plate 43, Figs. 3, 5-7

HOLOTYPE

A cranidium (GSM Coll.), the only specimen known.

TYPE STRATUM AND TYPE LOCALITY

Woolhope Limestone (early Wenlock), Old Radnor, Radnorshire, Wales.

DERIVATION OF THE NAME

From the Greek peratikos, alien, foreign. This species is the only Cornuproetus known from the British Isles, while it is plentiful in Bohemia and elsewhere.

DIAGNOSIS

This species differs from C. (C.) venustus in the following ways: the anterior branches of the facial sutures are very weakly divergent, the glabella is less inflated and the sculpture is entirely granular, lacking striations.

DISCUSSION

This species is the only representative of Cornuproetus in the British Isles, and the distribution of this genus, at least in the Silurian, seems to have been strictly environmentally controlled. In Bohemia it is frequent in the organodetrital limestones of the Lower Budnanian, and it is of interest to note that the Woolhope Limestone at Old Radnor where C. (C.) peraticus occurs is also organodetrital.

So far, a single cranidium of this species is known to the author, but it is sufficiently distinctive to warrant erection of a new species.

Cornuproetus (Cornuproetus) consobrinus Pribyl 1965

Plate 44, Figs. 1-3

1965 Cornuproetus (Cornuproetus) consobrinus sp. n. Pribyl, p. 94, Pl. 2, Fig. 5.

1967 "C. (Cornuproetus)" consobrinus Pribyl, 1965: G. Alberti, p. 472.

1969 "Cornuproetus consobrinus" Pribyl, 1965: G. Alberti, p. 259.

HOLOTYPE

A cranidium with one attached free cheek (NMP. SBAP No. 312), figd. Pribyl Pl. 2 Fig. 5, and refigured herein as Pl. 44, Figs. 1-3.

TYPE STRATUM AND TYPE LOCALITY

Basal layers of the Kopanina Limestone, Lower Budnanian, Listice near Beroun.

OCCURRENCE

According to Pribyl, 1965, p. 94 - Kopanina Limestone, Listice; Motol Beds (Upper Wenlock, M. testis zone), Butovice near Prague.

DIAGNOSIS

Glabella marginally longer than broad, weakly constricted laterally; preglabellar field convex in lateral profile, and one eighth the sagittal length of the glabella; eye large, about five eighths the glabella length; anterior branches of facial sutures moderately divergent; sculpture minutely granular.

DESCRIPTION

The cephalon is semicircular in outline. The cranidium has the palpebral width about five sevenths of the sagittal length. Glabella is marginally longer than broad. It is weakly constricted laterally and tapers forwards weakly with a rounded frontal lobe. The glabella is defined by shallow, narrow conjoined axial and preglabellar furrows, which seem to shallow and widen at the palpebral lobes. In lateral profile the glabella is rather weakly convex, but is more strongly convex in longitudinal profile. From the holotype there is little evidence of lateral glabellar furrows except for suggestion of their presence by slightly depressed areas on the glabella. On the posterior margin of the glabella, nearly half way from the posterolateral corner to the sagittal line there is a short depression.

The occipital furrow is rather narrow and considerably deeper than the axial furrow. It runs more or less transversely for most of its length, turning weakly forwards at the extreme lateral ends. In lateral profile the anterior slope is nearly vertical. The occipital ring is somewhat wider (trans.) than the glabella, the lateral margin forming a weakly outwardly convex curve. The posterior margin curves very gently backwards sagittally, and the occipital ring maintains more or less the same length (sag. and exsag.) along its width (trans.). There are no lateral occipital lobes, and there is a minute median tubercle. In lateral profile the occipital ring slopes gently upwards from the occipital furrow to the median tubercle, and behind this it is more or less horizontal.

The preglabellar field is about one eighth the length of the glabella (sag.) and in lateral profile is weakly convex. It is about two thirds the length (sag.) of the anterior border. The anterior border furrow is rather broad and shallow, while the anterior border is weakly convex and slightly inclined.

The anterior branches of the facial sutures are moderately divergent, with beta forming a wide curve. From the holotype it is difficult to see the path of the anterior portion of the posterior branch, but the posterior part on the posterior border cuts the posterior margin a little over half way from the axial furrow to the lateral margin.

The palpebral lobe is not preserved on the holotype, nor is most of the eye, but the latter is backwardly placed and about five eighths the length of the glabella and is supported on a narrow eye socle.

The field of the free cheek is rather broad and weakly convex. The lateral border and lateral border furrow are of a similar nature to the anterior. The posterior border furrow is narrower and more clearly defined than the lateral and anterior border furrows, and the posterior border is wider, is weakly convex and slopes up gently towards the posterior. The genal spine has a rather narrow base, and bears a strong median groove, similar in breadth and depth to the anterior and lateral border furrows. The length of the genal spine is unknown, but appears to be rather short.

On the outer part of the lateral and anterior borders there are two narrow parallel terrace lines running parallel with the margin. The whole cephalon is apparently very finely granular.

DISCUSSION

Pribyl (1965, p. 94) compared this species with C. (C.) venustus (Barr.), from which it differs in having a less inflated, proportionately narrower and longer glabella, a longer eye and probably a much shorter genal spine. From C. (C.) intermedius (Barr.), C. (C.) consobrinus differs in having a longer, narrower, glabella, a longer preglabellar field and larger eyes.

Alberti (1967, p. 472 and 1969, p. 121, 259) considered C. (C.) consobrinus to be related to Eremiproetus senex, and should be assigned to Eremiproetus rather than to Cornuproetus. As its morphology is here considered to be close to Cornuproetus species, it is included in that genus. Alberti (1969, p. 118) has indicated the difficulty in distinguishing the cephala of some Cornuproetus and Eremiproetus species when

when there is no pygidium available, and when the pygidium of consobrinus is known, it will confirm whether or not it is correctly assigned to Cornuproetus.

Cornuproetus (Cornuproetus) intermedius (Barrande, 1846)
Plate 43, Figs. 2, 10-13

1846 Proetus intermedius: Barrande, p. 63.
1847 Proetus ovalifrons: Hawle and Corda, p. 76.
1852 Proetus intermedius Barrande: Barrande, p. 464, Pl. 16, Figs. 31-33.
1946 Cornuproetus intermedius (Barrande): Pribyl, p. 7.
1969 Cornuproetus (Cornuproetus) intermedius (Barrande): Alberti, p. 121.

HOLOTYPE

A complete specimen (NMP Br.216), figd. Barrande Pl. 16, Figs. 31-33 and refigured herein as Pl. 43, Figs. 12-13.

TYPE STRATUM AND TYPE LOCALITY

Budnanian, Kopanina Beds, Dlouha Hora.

MATERIAL STUDIED

The type specimen, two cranidia, one free cheek and one pygidium.

OCCURRENCE

Litenian, Motol Beds, Listice, and Budnanian, Kopanina Beds, Dlouha Hora.

DIAGNOSIS

Glabella as long (sag.) as wide (trans.), weakly constricted laterally; field of free cheek broad, genal spine extends as far as sixth thoracic segment, thorax of ten segments, pygidium with short, rapidly tapering axis with 4 rings, pleural areas broad with three pairs of ribs; sculpture of very fine striations, continuous except on the glabella and pygidial axis.

DESCRIPTION

The cephalon is subparabolic in outline and moderately vaulted. The cranidium has the palpebral width five sixths of the sagittal length. The glabella is as long as wide, defined by narrow, incised, conjoined axial and preglabellar furrows, and is weakly constricted near the anterior end of the palpebral lobe. It widens forwards very gently as far as the centre of the palpebral lobe. The posterolateral corner is bluntly angular, and the frontal margin is very bluntly pointed. In lateral and longitudinal profiles the glabella is rather gently convex. On the holotype, the lateral glabellar furrows are very obscure, but three pairs seem to be represented. An additional cranidium (Pl. 43, Fig. 2) possibly belonging to this species, shows them much more clearly as smooth areas interrupting the glabellar sculpture, as well as an auxiliary impression associated with 1p. This specimen is distinct in having a sculpture of rather coarse discontinuous striations. The occipital furrow is deep, with a steep anterior slope, and is arched forwards weakly sagittally and more strongly laterally. It broadens between the sagittal region and the lateral end, where there is a depression running into the occipital ring. The occipital ring is badly preserved on the holotype, but it is transversely wider than the glabella, with the anterolateral corners confluent with the posterolateral corners of the glabella.

The preglabellar field is minute, about half the width (sag.) of the anterior border. The anterior branches of the facial sutures are rather weakly divergent with beta a wide, abaxially convex angle. An exsagittal line drawn backwards from beta falls on the abaxial edge of the palpebral lobe. Gamma is a short distance out from the axial furrow. The posterior branch has epsilon and zeta as independent angles, the former close to the posterolateral corner of the glabella, and the latter about half way along (exsag.) the lateral end of the occipital ring. The stretch of the posterior branch between runs close to the axial furrow. From zeta the posterior branch turns strongly outwards onto the posterior border, and cuts the posterior margin about half way between the axial furrow and the lateral margin. The palpebral lobe is narrow and crescentic, a little over one third the sagittal length of the glabella. It is inclined quite steeply from the axial furrows and flattens distally. The eye is crescentiform and supported by a narrow, curb-like eye socle whose lower margin is parallel with the upper margin and is not defined by a distinct furrow.

The field of the free cheek is broad and gently convex. The anterior and lateral border furrows are narrow, distinct but non-incised. The anterior and lateral borders are gently convex and rather narrow. The posterior border is narrow and incised. At the adaxial end it meets the axial furrow about half way along the lateral end of the occipital ring, and abaxially it shallows at the base of the genal spine where it runs into the median groove of the genal spine, which is of similar depth to the lateral border furrow. The median groove shallows and dies out rapidly towards the posterior. The genal spine is rather narrow based, and extends backwards as far as the sixth thoracic segment. The anterior and posterior pleural bands are of similar width (trans.). The dorsal surface of the cephalon has a sculpture of fine, dense continuous striations except on the glabella, where they are apparently discontinuous. On the cephalic margin and on the margins of the genal spine are two or three parallel terrace lines, some of which bifurate (see Pl. 43, Fig. 11).

The cephalic doublure is as wide as the border, strongly ventrally convex and ornamented with fine, parallel terrace lines.

The thorax consists of 10 segments, with a broad gently tapering axis. The axial rings are badly preserved on the holotype, the only specimen from which the thorax is known, and have been partially exfoliated. The axial rings are arched gently forwards sagittally and the articulating furrow is deep and incised. The articulating half ring is dorsally convex, and about three quarters of the width (sag.) of the annulus. There is no indication of the preannulus. The inner part of the pleura is more or less horizontal and runs transversely, while the outer part beyond the fulcrum is gently declined and directed weakly backwards. The pleura is traversed by an oblique, incised pleural furrow which shallows when it meets the posterior edge of the facet, and continues outwards along it, curving backwards to bisect the posterolateral angle. Along this stretch the anterior edge of the pleural furrow is bounded by a single terrace line, which has its "scarp" slope towards the posterior. The posterior pleural band is a little wider than the anterior. The posterolateral angle of the pleura is distinctly angular. The sculpture of the thorax seems to be of fine, dense raised striations.

The pygidium is subparabolic in outline, without a border and a little over twice as broad (trans.) as long (sag.). The anterolateral corners are acutely angular. Anteriorly the axis is about three tenths of the total pygidial width, and is about five sixths of its length (sag.). It is quite strongly longitudinally convex, and tapers backwards rather rapidly to the bluntly rounded posterior end. There are four rings, separated by deep, narrow incised interannular furrows which are arched backwards weakly sagittally and more strongly laterally. The articulating furrow is deep, incised and transverse. On the lateral parts of each ring, running into the preceeding interannular furrow is an exsagittally elongated depression. Behind the axis is an ill-defined postaxial ridge. The broad, gently convex pleural areas have three pairs of ribs which curve gently backwards and widen slightly abaxially. The first pair of pleural furrows is narrow and deeply incised, and extends to the margin. The other pleural furrows are weak and non-incised and are no deeper than the interpleural furrows which run backwards a little less strongly. These pleural and interpleural furrows do not quite reach the pygidial margin.

The dorsal surface of the pygidium is finely striate apart from the axis, which has short, discontinuous coarse striations, almost dissociated into granules concentrated towards the posterior margin of each ring. There are fine terrace lines on the extreme margin, running parallel with it. The pygidial doublure is gently convex ventrally, and is about as broad as the cephalic doublure. It bears fine, parallel terrace lines, bunched together a little behind the axis.

DISCUSSION

This species and C. (C.) reussi (see below) seem to form a branch distinct from C. (C.) venustus, C. (C.) peraticus, C. (C.) vertumnus, C. (C.) consotrinus and C. (C.) walliseri, and it differs from them in glabellar shape - more elongated as opposed to more subquadrate. Other features suggest that they are otherwise very similar.

Cornuproetus (Cornuproetus) reussi (Hawle and Corda, 1847)
Plate 44, Figs. 11, 13

1847 Proetus reussii: Hawle and Corda, p. 76.

1958 Proetus (Cornuproetus) reussi Hawle and Corda: Prantl and Vanek, p. 260, Pl. 1, Figs. 5-6.

1969 Cornuproetus (Cornuproetus) reussi (Hawle and Corda): Alberti, p. 121.

LECTOTYPE

(See Prantl and Vanek, p. 260). A cranidium (NMP Br.236) figd. Prantl and Vanek Pl. 1, Fig. 5, and refigured herein as Pl. 44, Fig. 13.

TYPE STRATUM AND TYPE LOCALITY

Litenian, Motol Beds (Upper Layers) Listice, near Beroun.

MATERIAL STUDIED

The two cranidia figured by Prantl and Vanek.

OCCURRENCE

Only at the type locality.

DIAGNOSIS

Glabella pyriform, tapering rather strongly forwards, weakly constricted laterally; occipital ring as wide (sag.) as the preglabellar area, and a little wider (trans.) than the glabella; anterior branches of facial sutures weakly divergent; sculpture of fine striations.

DISCUSSION

This species is rather similar to C. (C.) intermedius (Barrande), from which it differs in having a more pyriform glabella and in having a sculpture of very fine, apparently continuous striations. C. (C.) reussi may well be conspecific with C. (C.) intermedius.

Subgenus CORNUPROETUS (LEPIDOPROETUS) Erben, 1951
Subgenotype Cornuproetus (Lepidoproetus) lepidus (Barrande 1846)
Type species Proetus lepidus Barrande 1846

DIAGNOSIS

See Alberti (1969, p. 195)

OCCURRENCE

Upper Silurian to later Lower Devonian, Bohemia, Germany, Morocco, ?Carnic Alps ?USSR.

DISCUSSION

Alberti (1969, p. 195) has recently given a new diagnosis for Cornuproetus (Lepidoproetus), and for its type species C.(Lepidoproetus) lepidus Barrande), describing and figuring additional species from Morocco and central Europe. He drew attention to the detailed structure of the preglabellar area, demonstrating the presence of an "inner anterior border furrow" and an "outer anterior border furrow", between which lies a flattened area, the "intersulcal field". He supposed the "inner anterior border furrow" to be the equivalent to the anterior border furrow proper of other Proetidae, as laterally this runs into the lateral border furrow. This produces an extremely short (sag.) preglabellar field, as Alberti (p. 195) noted. He also demonstrated a similar development of the anterior border in Cornuproetus (Diademaproetus)(p. 196, and 213). Examination of specimens of Cornuproetus (Xiphogonium) has shown that this subgenus too has such a feature. (Comparison between Diademaproetus and Xiphogonium shows little justification to place them as separate subgenera. Alberti (1964, p. 127; 1969, p. 211) was apparently unaware of the detailed morphology of Xiphogonium, as he makes no comparative comments on this subgenus in dealing with Diademaproetus).

Although Lepidoproetus and Xiphogonium show similar development of the anterior border, they do not appear to be very closely related - the pygidium of the latter is close to Cornuproetus (Cornuproetus), and is thus rather dissimilar to Cornuproetus (Lepidoproetus). Hence the broadened anterior border is a feature recurring in two independent lines in the Cornuproetinae.

Cornuproetus (Lepidoproetus) limatulus Pribyl, 1966
Plate 44, Figs. 15-16

1966 Cornuproetus (Lepidoproetus) limatulus sp. n.: Pribyl, p. 52, Text Figs. 5-6, Pl. 1, Fig. 3.

1969 C. (Lepidoproetus) limatulus Pribyl, 1966, Alberti, p. 197.

HOLOTYPE

A cranidium (NMP SMP 6802). Pl. 44, Figs. 15-16.

TYPE STRATUM AND TYPE LOCALITY

Budnanian, Kopanina Beds, quarry near Kraluv Dvur.

OCCURRENCE

Only at the type locality.

DIAGNOSIS

Glabella subquadrate, distinctly constricted laterally; preglabellar area about half the length of the glabella (sag.); occipital ring broad, about one third the length of the glabella (sag.); sculpture of fine striations, interspersed irregularly with granules on the glabella and occipital ring. No median occipital tubercle.

DESCRIPTION

The cranidium is nearly two thirds as wide across the palpebral lobes as it is long (sag.). The glabella is subquadrate in outline, and about as wide as long. It is widest near the centre of the palpebral lobe, and tapers forwards weakly to the bluntly rounded frontal lobe, and is distinctly constricted laterally opposite gamma. In longitudinal profile the glabella is weakly convex, while in lateral profile most of the glabellar surface is almost horizontal, before bending down in a gentle curve on the anterior end. The glabella is defined by narrow, rather shallow conjoined axial and preglabellar furrows, which deepen somewhat opposite gamma. Three pairs of inconspicuous lateral glabellar furrows are developed. The proximal end of lp is situated opposite the anterior part of the palpebral lobe. From here the posterior edge of the furrow runs backwards at an angle of about 45° to an exsagittal line, while the anterior edge runs inwards at about 80°, before turning sharply backwards following an exsagittal course. Hence 1p is nearly triangular, and extends about half way towards the sagittal line. The distal end does not reach the occipital furrow. 2p is short and narrow, situated opposite gamma at the point of greatest constriction. It runs almost straight inwards, extending about one third of the way to the exsagittal line. 3p is very inconspicuous, shorter than 2p, situated at the widest part of the glabella anterior to the constriction. 1p and 2p both interrupt the glabellar surface sculpture as smooth areas, but 3p hardly interrupts it at all.

The occipital ring is rather broad (sag.), being nearly one third the sagittal length of the glabella, from which it is separated by a narrow, fairly shallow occipital furrow, which runs more or less transversely. Its anterior slope is nearly vertical, and posterior rather shallow. The occipital ring is very weakly convex in lateral profile, and there is no median tubercle. It is not elevated to the height of the glabella. Information on the lateral parts of the occipital ring and furrow, as well as the posterior branches of the facial sutures must await a time when it is possible to prepare the specimen fully. Pribyl's (1966, p. 53, Text Fig. 6) drawing of the complete occipital ring may have been based on another specimen, not available for study by the author.

The preglabellar area is nearly half as long as the glabella (sag.), and the whole is weakly concave. The anterior border furrow ("inner anterior border furrow" of Alberti) is very shallow, narrow sagittally, but widening adaxially. Behind it there is a very short (sag.) preglabellar field, about one twelfth of the sagittal length of the glabella. The "intersulcal field" of Alberti is about the same width (sag.) as the preglabellar field, and dies out abaxially, well before the anterior branch of the facial sutures. The "outer anterior border furrow" is very indistinct, but runs more or less parallel to the anterior margin, merging with the "inner anterior border furrow" adaxially. The outer part of the anterior border is inclined, and very weakly convex.

The anterior branches of the facial sutures are weakly divergent, with the stretch from gamma to beta running more or less straight. An exsagittal line drawn backwards from beta falls about half way across the palpebral lobe. The palpebral lobe is moderately broad, its outline giving a negative skew towards the posterior. In longitudinal profile it is inclined from the axial furrow at about 30°.

The cranidium has a sculpture of fine, raised striae, arranged in a Bertillon pattern on the glabella and occipital ring. On the palpebral lobe the striae run forwards and outwards, and more or less transversely on the preglabellar area. On the posterior part of the glabella and on the occipital ring, the striae areirregularly interspersed with small, sporadic granules.

DISCUSSION

Only the holotype cranidium of this species is known to the author, but more material may exist, as Pribyl states (p. 52) that it occurs very seldomly at the type locality, which seems to imply more than one ? specimen.

C. (Lepidoproetus) limatulus is of particular interest as it is the earliest species of Lepidoproetus, and is the only one known from the Silurian. This species is quite similar to the subgenotype, L. lepidus from the Lower Devonian, Lochkovian, the differences being indicated by Pribyl (1966, p. 52) as: the smaller size of limatulus, its shorter preglabellar area, a more constricted glabella, less divergent anterior branches of the facial sutures, smaller palpebral lobes and the occurrence of small granules on the glabella and occipital ring of limatulus.

Subgenus CORNUPROETUS (LODENICIA) Prantl and Vanek, 1958
Subgenotype Proetus (Phaetonellus) dentatulus Novak 1890
Synonym Cornuproetus (Voigtaspis) Alberti, 1967

DIAGNOSIS

Preglabellar field short (sag.); glabella broadly bell-shaped; cephalic border rather narrow, moderately convex; pygidium of subparabolic outline, with 4 axial rings and 3 pairs of pleural ribs and 1 additional anterior pleural band; anterior and posterior pleural bands of similar width and convexity; pygidial margin denticulate, with 3/4 pairs of short spines.

OCCURRENCE

Upper Wenlock, Bohemia, Lower Devonian (Pragian), NW Morocco.

DISCUSSION

Pribyl (1965, p.73) considered Lodenicia to be junior synonym of

Phaetonellus, indicating that the type species of the former only differed from Phaetonellus species at a specific level. Examination of specimens of C. (Lodenicia) dentatulus, and comparison with Phaetonellus species shows several important differences. The cephalon of all Phaetonellus species has a wide, poorly defined anterior border furrow (see Pribyl, 1965 Pl. 2, Figs. 3, 5, Pl. 3, Figs. 1, 2), with an upturned anterior border, while C. (Lodenicia) has a narrow, clearly defined anterior border furrow with a convex anterior border (see Pribyl 1965, Pl. 4, Fig. 1). The pygidium of Phaetonellus has a deep pleural furrow dividing the pleural rib into a wide anterior pleural band and a narrow posterior pleural band, with the pleural furrow continuing onto the long marginal spine (see Pribyl 1965, Pl. 2, Fig 4 etc.). C. (Lodenicia) has the anterior and posterior pleural bands of almost equal width, and the pleural furrow does not continue onto the marginal spine (see Pl. 44, Fig. 14). In Phaetonellus the pygidial axial interannular furrows are curved distinctly backwards sagittally, and each ring bears a small node in a sagittal position on the posterior edge. There is a narrow postaxial ridge. In C. (Lodenicia) the interannular furrows are not curved distinctly backwards sagittally, nor are the node and the postaxial ridge present. Lodenicia is considered to be a subgenus of Cornuproetus on the basis of its pygidial rib structure and on the overall cephalic morphology, and hence is in no way related to Phaetonellus.

Alberti (1967b, p. 488) proposed the subgenus Cornuproetus (Voigtaspis), based on the Lower Devonian (Pragian) of NW Morocco. He (1967b, p. 489 and 1969, p. 236) appreciated close similarities between C. (Voigtaspis) and Lodenicia, which he placed as a subgenus of Phaetonellus. He distinguished C. (Voigtaspis) from Phaetonellus on the difference in pygidial rib structure referred to above which distinguish C. (Lodenicia) from Phaetonellus. Comparison between the single species of C. (Voigtaspis), C. (V.) voigti Alberti (see Alberti 1964, Pl. 11, Figs. 1-4) and C. (Lodenicia) dentatulus indicates the presence of two species, but not of two subgenera, and hence Voigtaspis becomes a junior synonym of Lodenicia.

C (Lodenicia) includes two known species, C. (Lodenicia) dentatulus (Novak) and C. (Lodenicia) voigti Alberti, of Upper Wenlock and Lower Devonian age respectively. C. (Lodenicia) dentatulus is not dissimilar, with the exception of the denticulate pygidial margin, from Silurian Cornuproetus species from Bohemia, so that C. (Lodenicia) may have branched off from Cornuproetus sometime in the earlier Silurian. The condition of pygidial spines seems to have appeared independently in several different proetid lineages at different times - e.g. C. (Lodenicia), Phaetonellus and Prionopeltis.

Cornuproetus (Lodenicia) dentatulus (Novak 1890)
Plate 44, Fig. 14

1890 Proetus (Phaetonellus) dentatulus Novak, p. 16, Text Fig. 4.
1946 Phaetonellus dentatulus (Novak); Pribyl, p. 28
1953 Phaetonellus dentatulus (Novak): Pribyl, p. 54
1958 Lodenicia dentatula (Novak): Prantl and Vanek, p. 19, Pl. 12, Fig. 4.
1962 Phaetonellus dentatulus (Novak) Kriz p. 139, Text Fig. 3, Pl. 15 Fig. 1, Pl. 16 Fig. 2.
1965 Phaetonellus dentatulus (Novak) Pribyl, p. 73, Pl. 1 Fig. 6-7, Pl. 2, Fig. 1-2, Pl. 4 Fig. 1.
1969 Phaetonellus (Lodenicia) dentatulus (Novak) Alberti, p. 236.

HOLOTYPE

A pygidium (NMP CE 275) Pl. 44, Fig. 14.

MATERIAL

According to Pribyl (1965, p. 74) - 2 cephala (one with 6 attached thoracic segments), 5 cranidia and 6 pygidia.

TYPE STRATUM AND TYPE LOCALITY

Motol Beds (Upper Wenlock), M. testis zone, Cernidla near Lodenice.

DIAGNOSIS

Cranidium a little longer (sag.) than wide (trans.); glabella with sagittal length 85 per cent of the greatest width (trans.); preglabellar field about a sixth of the length (sag.) of the glabella; anterior branches of facial sutures weakly divergent; eye crescentic, backwardly placed; thorax with at least 6 segments, ends of pleurae bluntly truncated; pygidium slightly over twice as broad (sag.) as long.

DESCRIPTION

See Prantl and Vanek (1958, p. 19) and Kriz (1962, p. 139).

DISCUSSION

The only other species of C. (Lodenicia), C. (L.) voigti Alberti is only known from the pygidium, which is exceedingly similar to that of C. (L.) dentatulus from which it differs in being proportionately shorter (sag.), has deeper interannular furrows which bend more strongly backwards laterally and in having the pleural and interpleural furrows reaching not so close to the pygidial margin.

Subfamily EREMIPROETINAE G. Alberti 1967
Genus EREMIPROETUS R. and E. Richter, 1919
Type species Proetus dufresnoyi Hawle and Corda 1847

DISCUSSION

The earliest Eremiproetus species is E. agellus, which occurs in the Upper Ordovician of Scandinavia (see Chapter 2). The Caradoc species Proetus (?Eremiproetus) reedi Pribyl 1947 from Girvan has been shown elsewhere (see Chapter 3) to belong to Decoroproetus. E. agellus and E. senex are the only pre-Devonian Eremiproetus species known.

Eremiproetus senex Alberti 1967
Plate 45, Figs. 1-6

1852 Proetus venustus Barrande pars: Barrande, p. 467, Pl. 17 Figs. 4-6 (non Figs. 1-3)

1967 Eremiproetus senex n. sp.: G. Alberti, p. 472, Pl. 1, Fig. 2.

1969 Eremiproetus senex G. Alberti: G. Alberti, p. 258, Pl. 22, Fig. 8.

HOLOTYPE

An almost complete exoskeleton (IMGPT Ar.1318) of which Alberti figures (Pl. 22 Fig. 8) the cephalon and pygidium.

MATERIAL

Besides Alberti's type material, several complete or nearly complete specimens.

TYPE STRATUM AND TYPE LOCALITY

Budnanian, Kopanina Beds, Dlouha Hora.

OCCURRENCE

Only known from the type locality

DIAGNOSIS AND DESCRIPTION

See Alberti 1969, p. 258.

DISCUSSION

Dr. G. Alberti (personal communication, June 1969) pointed out to the author that one of the specimens figured by Barrande (Pl. 17, Figs. 4-6) as Proetus venustus Barr. belonged not to that species, but to Eremiproetus senex Alberti. Barrande considered specimens of P. venustus with 9 thoracic segments (= Eremiproetus senex) to be immature, and he figures (Pl. 17) the specimen with 10 thoracic segments (Figs. 1-3) as "individu adulte ... montrant 10 segmens thoraciques" and that with 9 (Figs. 4-6) as "individu non adulte ... ayant seulement 9 segmens thoraciques". As the specimen with 10 thoracic segments (= Cornuproetus (Cornuproetus) venustus) is smaller than that with 9 there can be no question of the latter being an immature specimen of the former, and morphologically the two specimens differ in other aspects, particularly in the pygidial structure (cf. Pl. 44 Figs. 4-6 and Pl. 45, Figs. 1-3).

Subfamily PROETIDELLINAE Hupe 1953

Genus DECOROPROETUS Pribyl 1946

Type species Proetus decorus Barrande 1846

Decoroproetus decorus (Barrande 1846)

1846 Proetus decorus Barrande: Barrande, p. 64

DIAGNOSIS

Glabella tapers evenly forwards, well rounded anteriorly and sometimes weakly constricted laterally; 3 pairs of glabellar furrows, of which 1p is deepest and weakly impressed; preglabellar field sigmoidal, between one third and one fifth the glabellar length; anterior and lateral border furrows shallow and broad; thorax of 10 segments, with narrow, evenly tapering axis, narrower than the pleurae throughout its length; pygidium of subparabolic outline, three fifths as long (sag.) as wide (trans.); axis narrow with 8 rings separated by shallow interannular furrows; pleurae with 6 pairs of rather strongly backwardly curved ribs.

OCCURRENCE

Upper Wenlock to early Ludlow, Bohemia, Poland (Holy Cross Mountains), Morocco.

SUBSPECIES

D. decorus decorus (Barrande), D. decorus quirinus Prantl and Vanek, 1958, D. decorus maurulus Alberti 1969.

DISCUSSION

The three subspecies of D. decorus occur in the "Mediterranean zooprovince" - i.e. in Bohemia, Poland and Morocco, while in the Anglo-Baltic area a different species, D. scrobiculatus, related to D. decorus is present in approximately equivalent beds. In all areas in the Silurian, Decoroproetus seems to be rather strictly facies controlled (see Chapter 4).

Decoroproetus decorus decorus (Barrande 1846)
Plate 45, Figs. 9-13, Plate 46, Fig. 3

1846 Proetus decorus Barrande; Barrande, p. 64

1852 Proetus decorus Barrande; Barrande, p. 468, Pl. 17 Figs. 13-15, 21 (non Figs. 16-20).

1946 Proetus (Decoroproetus) decorus Barrande; Pribyl, p. 92.

1946a Proetus (Decoroproetus) decorus Barrande; Pribyl, p. 10, Pl. 1 Figs. 2, 2a.

1953 Proetus (Decoroproetus) decorus Barrande; Pribyl, p.

1958 Proetus (Decoroproetus) decorus decorus Barrande; Prantl and Vanek, p. 259, Pl. 1 Fig. 1, Pl. 2 Fig. 1.

1969 Decoroproetus decorus decorus (Barrande): Alberti, p. 349.

LECTOTYPE

(Prantl and Vanek, 1958, p. 259). A complete but poorly preserved specimen (NMP 233), figured by Barrande (1852, Pl. 17, Figs. 13-15) and by Pribyl (1946a, Pl. 1 Figs. 2, 2a). Refigured herein as Pl. 45, Fig. 12.

MATERIAL STUDIED

Three complete specimens and several cranidia, pygidia and free cheeks.

TYPE STRATUM AND TYPE LOCALITY

Motol Beds (Upper Wenlock), M. flexilis zone, Lodenice.

OCCURRENCE

Motol Beds (Upper Wenlock), Bohemia; G. nassa zone, Holy Cross Mountains, Poland.

DIAGNOSIS

Cephalic border narrow, brimlike, upturned; glabella with moderately deep 1p furrows which do not reach the axial furrow; preglabellar field about one third the glabellar length.

DESCRIPTION

The exoskeleton is depressed. The cephalon is semioval in outline, with a narrow, upturned brim-like border defined by a broad, shallow cephalic border furrow. The glabella is a little longer than wide, tapers gently forwards and is not distinctly constricted laterally. In lateral and longitudinal profile it is weakly convex. Three pairs of lateral glabellar furrows are developed. 1p is rather deep, with its anterior end situated more or less opposite the centre of the palpebral lobe. Both proximal and distal parts of 1p shallow rapidly, so that at neither end does it run into the axial or occipital furrows. It is directed backwards at an angle of about 45° to an exsagittal line. 2p is situated opposite the anterior end of the palpebral lobe, deepening and widening a little distally, running almost straight inwards (trans.), extending about three quarters the way to the sagittal line. 3p is a short distance in front of 2p, not far behind the anterolateral corner of the glabella, is narrower and shorter than 2p, and like it runs more or less transversely. On some specimens (e.g. Pl. 45, Fig. 12) a small auxiliary impression is seen associated with 1p. The glabella is defined by deep, conjoined axial and preglabellar furrows. The occipital furrow is a little deeper than the axial furrow, with a rather steep anterior slope, and shallower posterior slope. It runs more or less transversely, bending forwards weakly at either end. The occipital ring is rather narrow (sag.), and maintains the same width (exsag.) along its length. It is about one sixth the length of the glabella (sag.). Transversely it is marginally wider than the glabella. There are no lateral occipital lobes, and apparently no median tubercle. Sagittally the occipital ring is elevated almost to the height of the glabella.

The preglabellar field is long (sag.), about one third the length of the glabella. In lateral profile it is sigmoidal. The narrow, upturned anterior border is about one third the length (sag.) of the preglabellar field. The anterior branches of the facial sutures are strongly divergent, with the stretch from gamma to beta almost straight. An exsagittal line drawn backwards from beta falls on the outer part of the eye. The palpebral lobe is narrow, crescentic in outline, and inclined from the axial furrow at about 45°. The eye is crescentiform, about five ninths of the glabella length on small specimens (e.g. Pl. 45, Figs. 10-11), but a little over half its length on larger specimens (e.g. Pl. 45, Fig. 9). The visual surface rests on a narrow eye socle, whose lower margin diverges weakly from the upper margin at either end, the lower margin being defined by a shallow furrow. The whole eye lobe is backwardly placed, and the posterior end lies close to the posterior border furrow. The posterior branch of the facial suture runs close to the axial furrow at epsilon, and diverges strongly onto the posterior cephalic border from a point near to the junction of the occipital furrow with the axial furrow. It cuts the posterior margin about three fifths of the distance from the axial furrow to the lateral margin.

The field of the free cheek is broad and weakly convex, rising up from the lower margin of the eye socle before curving gently down in all directions to the lateral and posterior border furrows. The posterior border furrow is deeper and more clearly defined than the lateral and anterior border furrows, with a rather steep anterior slope. The posterior border is weakly inclined towards the posterior. It is a little narrower (exsag.) than the occipital ring at its inner end, but widens slowly so that at its outer end it is approximately the same width. The genal spine is long and narrow, narrow based and extending backwards as far as the sixth thoracic segment. Down the centre is a broad groove, produced by the merging of the lateral and posterior border furrows, which divide the genal spine into inner and outer bands of approximately the same width (trans.).

The thorax is about the same length (sag.) as the cephalon, and consists of 10 segments. The axis is narrow, at all parts of its length narrower than the pleural area. It tapers gradually and constantly backwards so that the last ring is about four sevenths the width (trans.) of the first. In longitudinal profile the axis is rather weakly convex. Each ring is a little narrower (sag.) than the occipital ring. The interannular furrows are curved weakly forwards sagittally and laterally. In lateral profile each ring is inclined backwards from the interannular furrow, and in lateral profile is weakly convex. The posterior slope of each ring is almost vertical. The pleura runs nearly transversely out from the axial furrow. The deep pleural furrow divides it into a narrow anterior band and a wide posterior band. The pleural furrow has a nearly vertical anterior slope and a rather shallow posterior slope, interrupted by the interpleural furrow. The pleural furrow extends nearly to the extreme distal end of the pleura, whose anterolateral corner is curved while the posterolateral corner is drawn out to a point.

The pygidium is about two thirds the length (sag.) of the thorax. It is a little over half as long as wide, and is approximately semicircular in outline. Anteriorly the axis occupies between one quarter and one fifth the total pygidial width. The axis tapers evenly backwards, in continuation with the thoracic axis, and extends for about three quarters of the pygidial length (sag.). On some specimens there is evidence of a weak, narrow postaxial ridge. The axis consists of 8 rings, which are separated by shallow interannular furrows, which are bent weakly backwards sagittally and laterally. The first ring is slightly narrower (sag.) and elevated a little higher than the remainder, which in lateral profile slope up gently towards the posterior. The pleural areas are broad and weakly convex, and carry six pairs of ribs, which curve strongly backwards and widen slightly distally. The pleural furrows are deep, with a steep anterior slope which deepens slightly distally and a shallow posterior slope. The interpleural furrows are shallow, following more or less the same course as the pleurae, diverging from them slightly distally. Only the first two or three pairs are generally discernible. Both the pleural and interpleural furrows reach close to the pygidial margin. There is no pygidial border. The pygidial doublure is moderately wide, extending as far inwards as the posterior end of the pygidial axis. It bears about 6 parallel terrace lines, the innermost of which are somewhat drawn together behind the axis, where the doublure is a little narrower.

The surface sculpture consists of a fine Bertillon pattern, which apparently covers the whole exoskeleton, although no specimens available have it preserved completely. It is clearly seen on one paralectotype pygidium (see Pl. 45 Fig. 13).

DISCUSSION

Barrande (1852, p. 469) discussed specimens which he considered to be ontogenetic stages of D. decorus decorus, which he figured (Pl. 17 Figs. 16-21) as "jeunes individus". Examination of the specimens figured as Fig. 16 and Fig. 17 has revealed them to be Scharyia micropyga, the former being a degree 5 meraspis. The specimen represented in Fig. 19, which has 8 thoracic segments is a separate species, as it is almost the same size as the specimen in Fig. 21, which has 10 and is a D. decorus decorus. The former differs from the latter in several other features besides only having 8 thoracic segments, and there can be no question of it being a degree 8 meraspis of D. decorus decorus, and it is described below as D. octonus sp. nov. I have not been able to see the specimens figured as Fig. 18 and Fig. 20 ("degree 7" and "degree 9" meraspides respectively), and these really may be meraspides of D. decorus decorus.

D. decorus decorus is apparently restricted to central Bohemia. D. decorus from Poland (Holy Cross Mountains) from beds of later Wenlock

(G. nassa) age, has, from specimens examined apparently a wider cephalic border. This difference may merely be due to preservation, however, for otherwise there seems to be little difference.

D. decorus maurulus (Alberti 1969, Pl. 29, Figs. 14-16) from the early Ludlow of Morocco differs from D. decorus decorus in its slightly more tapering glabella, a wider anterior border, shorter preglabellar field, and shallower lp furrows.

Decoroproetus decorus quirinus (Prantl and Vanek 1958)
Plate 46, Figs. 1-2

1958 Proetus (Decoroproetus) decorus quirinus: Prantl and Vanek, p. 258, Pl. 1, Figs. 2-4.

1969 Decoroproetus decorus quirinus (Prantl and Vanek): Alberti, p. 349.

1969 Decoroproetus decorus quirinus Prantl and Vanek: Haas, p. 644, pl.81, Fig. 2.

HOLOTYPE

A cranidium (NMP Br. 287) figd. Prantl and Vanek Pl. 1 Fig. 2, and refigured herein as Pl. 46, Fig. 1.

MATERIAL STUDIED

Besides the type, two pygidia.

TYPE STRATUM AND TYPE LOCALITY

Budnanian, Kopanina Beds (upper layers), Prague-Jinonice.

OCCURRENCE

Only at the type locality.

DIAGNOSIS

This subspecies differs from decorus decorus in having a wider cephalic border, beta a more acute angle and a narrower, more strongly tapering glabella.

DISCUSSION

When more information is available on variability within this subspecies, it may be possible to separate it specifically from decorus.

Decoroproetus octonus sp. nov.
Plate 46 Fig. 13

1852 Proetus decorus Barrande pars; Barrande, Pl. 17, Fig. 19 (non Figs. 13-18, 20, 21).

HOLOTYPE

A complete specimen, the only one known. Figd. Barrande Pl. 17, Fig. 19, and refigured herein as Pl. 46, Fig. 13 (NMP Br.238).

TYPE STRATUM AND TYPE LOCALITY

Motol Beds (Upper Wenlock), M. flexilis zone, Lodenice.

DERIVATION OF THE NAME

From the Latin octonus, consisting of 8, alluding to the number of thoracic segments.

DIAGNOSIS

Cranidium with palpebral width about three quarters of the sagittal length; preglabellar field nearl half the length of the glabella (sag.); eye about four fifths of the glabellar length; occipital ring distinctly wider (trans.) than glabella; thorax of 8 segments, widest part of broad axis at second thoracic segment; pygidium with short, rapidly tapering axis, about a quarter the pygidial width (trans.) and about three fifths its length (sag.); pleural areas with 5 pairs of ribs.

DESCRIPTION

The cephalon is semioval in outline, with a rather narrow, upturned border, separated from the rest of the cephalon only by a very wide, shallow and ill defined border furrow. The cranidium is about three quarters as wide (trans.) across the palpebral lobes as it is long (sag.). The glabella is slightly wider (trans.) than it is long (sag.) and tapers forwards weakly, has a well rounded frontal lobe and is not constricted laterally. It is defined by rather shallow, narrow conjoined axial and preglabellar furrows, which become a little shallower in the region of the palpebral lobes. In lateral and longitudinal profiles the glabella is very weakly convex. On the single specimen available there is no indication of lateral glabellar furrows, but the absence may be apparent rather than real, as the glabella is somewhat crushed.

The preglabellar field approaches half the sagittal length of the glabella, and is sigmoidal in profile. The occipital furrow is a little deeper and wider than the axial and preglabellar furrows. The anterior slope rises up at about 80°, while the posterior rises up at about 30°. The occipital furrow is markedly arched forwards sagittally, and rather less laterally. The occipital ring is about half as wide (sag.) as the preglabellar field, and maintains a constant width (exsag.) laterally.

The posterior margin runs more or less parallel with the occipital furrow, while the lateral margins diverge backwards, so that the occipital ring is rather wider (trans.) than the glabella at the posterior margin. There do not appear to be any lateral occipital lobes, nor does there appear to be a median occipital tubercle.

The anterior branches of the facial sutures are quite strongly divergent, so that an exsagittal line drawn backwards from beta falls on the outer part of the eye lobe. At the posterior end of the eye the posterior branch runs close to the axial furrow before diverging strongly on the posterior border.

The palpebral lobe is rather narrow, elongated and close to the glabella. The visual surface of the eye is about four fifths of the sagittal length of the glabella and is backwardly placed so that its posterior end falls close to the posterolateral corner of the glabella. A very narrow eye socle seems to be present.

The field of the free cheek is moderately broad and convex. The posterior border furrow is narrower and deeper than the lateral and anterior, and has a steep anterior slope and a rather shallow posterior slope. The posterior margin is inclined towards the posterior, and widens a little towards the base of the genal spine. The genal spine is rather broad based, and extends backwards at least as far as the fourth thoracic segment.

The cephalic doublure is a little wider than the cephalic border, is ventrally convex and bears strong, parallel terrace lines.

The thorax is only marginally shorter (sag.) than the cephalon. It consists of 8 segments. The axis is broad, and achieves its greatest width (trans.) at the second axial ring, from where it tapers gradually, then more rapidly backwards. In longitudinal profile the axis is very weakly convex. In lateral profile each ring is weakly convex, and slopes up gently from anterior to posterior. The interannular furrows follow a similar course to the occipital furrow - i.e. they are arched fowards sagittally, and again more weakly at the lateral ends. The pleurae are rather narrower than the axis, and only the last pleura reaches approximately the same width as the axis. The pleurae are turned gently backwards, and each bears a strong pleural furrow, with a steep anterior slope and shallow posterior slope, dividing the pleura into a wide posterior band and a narrow anterior band, both of which are inclined upwards towards the posterior. The pleural furrow appears to die out before reaching the distal end of the pleura.

The pygidium is more or less semicircular in outline, about half as long (sag.) as wide (trans.). The axis is about a quarter of the pygidial width (trans.) at its anterior end, and about three fifths of its length. It tapers rapidly to a blunt point. As the axis is damaged it is difficult to ascertain the number of axial rings, but based on the number of pleural ribs, there are probably about 5 or 6. The pleural areas have five pairs of ribs whose interannular furrows are not apparent on the specimen available, except perhaps for the most anterior one. The pleural furrows are prominent, and curve backwards evenly. The posterior slope is steep, while the anterior is shallow. The furrow nearly reaches the pygidial margin. The pygidial doublure is rather wide, bearing parallel, undulating terrace lines. The doublure of the thoracic pleurae is also apparent on the specimen, of a similar width to the pygidial doublure.

As the specimen is an internal mould, there is no evidence as to the nature of the original surface sculpture.

DISCUSSION

This rare species was figured by Barrande (1852, Pl. 17, Fig. 19) as a degree 8 meraspis of Decoroproetus decorus. However, the specimen is less than a millimeter shorter than a specimen of D. decorus with 10 thoracic segments (Barrande, Pl. 17, Fig. 21), and the proportions of the two specimens differ greatly, particularly in the length of the preglabellar field, eye, length/width proportion of the glabella, width of the occipital ring, thoracic axis and pygidial axis. These differences, considering the minute size difference of the specimens are too great to be due to ontogenetic changes, and so the specimen is described as a distinct, new species of Decoroproetus.

In having 8 thoracic segments, Decoroproetus octonus is the only species of Decoroproetus known to the author that does not have 10 segments. It is possible that it represents a degree 8 meraspis of some large, unknown species, but the size of the specimen seems too great for this to be the case. If additional similar species should come to light in the future, it may be worth separating them at least at a subgeneric level from Decoroproetus.

Genus PRANTLIA Pribyl 1946

Type species Proetus longulus Hawle and Corda 1847

DIAGNOSIS

Exoskeleton moderately vaulted; glabella trapezoidal, with distinct, partially isolated basal lobes; weak 2p furrows may be present; preglabellar field broad (sag.), concave or sigmoidal in lateral profile; anterior branch of facial suture a strongly abaxially convex curve; cephalic border furrow shallow and non-incised; thorax of 9 segments, axis narrow; pygidium with elongated, narrow axis with 9 rings in the type species; pleural areas with 6 pairs of ribs in the type species, with the pleural and interpleural furrows more or less parallel, the former a little deeper than the latter; an ill defined pygidial border is developed; exoskeleton smooth or with short ridges in a scale-like arrangement.

Species Prantlia longula (Hawle and Corda, 1847), P. longifrons (Lindström, 1885).

GEOLOGICAL RANGE

Silurian, Ludlow series.

DISCUSSION

Prantlia is a rare genus, and only two species are known to date, both from the Ludlovian. It is considered elsewhere (see Chapter 4) to belong to the "Warburgella branch" of the Proetidellinae, and its cephalic morphology is not far removed from Rutellum and Ogmocybe (see Pls. 31, 32). Pribyl and Vanek (1962) described specimens from the Lower Devonian (Lochkovian) of Bohemia as Prantlia minuta. This species lacks the broad preglabellar field characteristic of Prantlia, and is not considered here to belong to that genus. Instead, it may belong to Ogmocybe, with which it shares cranidial and pygidial characters.

Prantlia longula (Hawle and Corda, 1847)
Plate 46 Figs. 8-12

1847 Proetus longulus: Hawle and Corda, p. 76

1946 Prantlia longula (Hawle and Corda): Pribyl, p. 90, Text fig. 6.

1946a Prantlia longula (Hawle and Corda): Pribyl, p. 16, Pl. 1, Fig. 12.

1959 Prantlia longula (Hawle and Corda): R. and E. Richter and Struve in Moore, p. O.395-6, Fig. 301, 6.

1966 Prantlia longula (Hawle and Corda): Erben, p. 180, Text Fig. 1a.

1969 Prantlia longula (Hawle and Corda): Alberti, p. 456.

HOLOTYPE

A nearly complete, though badly preserved exoskeleton (NMP Coll.), figd. Pribyl 1946 Text Fig. 6, 1946a Pl. 1 Fig. 12, and refigured herein as Pl. 46, Figs. 8-10, 12.

MATERIAL STUDIED

The holotype and an additional pygidium.

TYPE STRATUM AND TYPE LOCALITY

Budnanian, Kopanina Beds, Dlouha Hora.

OCCURRENCE

Not known outside the type locality.

DIAGNOSIS

Glabella tapering rather strongly forwards with well rounded frontal margin; deep 1p furrows partially isolated basal lobes, and there are weak, transverse 2p furrows; thoracic axis narrower (trans.) than pleurae along its entire length; pygidial axis about two sevenths of the total pygidial width, with 9 axial rings; pleurae with 6 pairs of pleural ribs and traces of the anterior pleural band of a seventh; exoskeleton smooth.

DESCRIPTION

The cephalon is moderately vaulted and parabolic in outline. The cranidium has the sagittal length considerably greater than the palpebral width. The glabella is trapezoidal, as long (sag.) as wide (trans.) and defined by narrow, incised conjoined axial and preglabellar furrows, the former shallowing in the region of the palpebral lobes. From the bluntly rounded posterolateral corner the glabella expands gently forwards as far as the middle of the palpebral lobe, and then tapers forwards rather rapidly to the well rounded frontal margin, being weakly constricted opposite gamma. In longitudinal profile (see Pl. 46, Fig. 12) the glabella is moderately convex, and in lateral profile (see Pl. 46, Fig. 8) it is weakly convex and gently declined forwards as far as the frontal lobe which is more convex and more steeply declined. 1p furrow is deep, and from the shallow posterior end which runs into the occipital furrow, it turns abaxially in a gently inwardly convex curve and deepens towards the anterior, and terminates abruptly before reaching the axial furrow. The posterior end is opposite the widest part of the glabella. The resultant, partially isolated, 1p lobe is ovate, exsagittally and transversely about a third of the glabellar length and width respectively, and has independent convexity from the rest of the glabella. 2p is situated at the lateral constriction of the glabella, and is weakly impressed and nearly transverse, extending for about two thirds of the way towards the sagittal line.

The occipital furrow is badly preserved on the only cephalon seen, but appears to be broad, deep, curved gently forwards laterally and with a steep anterior slope. The occipital ring is very badly preserved, sagittally about a third of the width (sag.) of the preglabellar area, and transversely as wide as the glabella. It maintains the same width laterally, and appears to have distinct lateral occipital lobes.

The total preglabellar area is about two thirds the sagittal length of the glabella. In lateral profile the preglabellar field is gently sigmoidal. The anterior branch of the facial suture describes a strong abaxially convex sigmoidal curve, and an exsagittal line drawn backwards from beta falls well abaxially from the eye. Gamma lies close to the axial furrow. The posterior branch is not well preserved, but epsilon and gamma apparently represent independent angles. The palpebral lobe and eye are both ill preserved, but the latter is a little under half the sagittal length of the glabella and seems to be supported on a narrow, curb-like eye socle. The field of the free cheek is rather broad and gently convex. The anterior and lateral border furrows are broad, shallow and ill defined. The anterior and lateral borders are rather narrow, and gently convex. The posterior border furrow is apparently narrow, and incised, and runs into the axial furrow about half way along (exsag.) the lateral end of the occipital ring. The posterior border is not preserved, and neither is most of the genal spine. At the base of the damaged left hand genal spine the cephalic doublure is seen, which is quite strongly ventrally convex, and ornamented with fine terrace lines which run parallel to the margin.

The thorax consists of 9 segments. The axis is narrow, moderately convex longitudinally and hardly tapering backwards. It is always narrower than the pleurae. Each ring is arched weakly forwards sagittally and more strongly laterally. In lateral profile each is nearly flat and very gently inclined towards the posterior. The axial furrows are rather deep and narrow. The pleurae are very badly preserved, but are transversed by prominent pleural furrows which extend almost to the distal ends. They are gently declined at the fulcrum.

The pygidium is subparabolic in outline, with the sagittal length about three quarters of the width (trans.). The axis is narrow, anteriorly about two sevenths of the total pygidial width, and tapers gently backwards to the bluntly pointed posterior end. It extends for about three quarters of the total pygidial length and behind it is a long narrow postaxial ridge which dies out before reaching the posterior margin. There are 9 axial rings, separated by rather shallow, transverse interannular furrows. The axis is defined by narrow, weakly incised axial furrows, which shallow and become obsolete at the posterior end. The pleural areas are gently convex with 6 pairs of ribs and the anterior pleural band a seventh, and curve gently backwards, truncated at the broad, pygidial border. The first pair of pleural furrows is narrow and incised, while the remainder are narrow but non-incised. The interpleural furrows are narrower than the pleural, and diverge very weakly from them abaxially. The posterior pleural band is wider (exsag.) than the posterior, and both are gently convex in lateral profile (see Erben, 1966, Text Fig. 1 a). The pygidial doublure is rather broad and weakly ventrally convex. Like the cephalic it is ornamented with fine terrace lines, running parallel with the margin.

The exoskeleton is apparently smooth.

DISCUSSION

Drawings of this species published hitherto (e.g. Pribyl 1946a Pl. 1 Fig. 12, Treatise Fig. 301, 6) are all inaccurate and misleading, particularly in the glabellar shape, path of anterior branches of the facial sutures, depth of cephalic border furrow and the pleural areas of the pygidium. Photographs of this species are published for the first time herein. Unfortunately the available material is not well preserved, and more accurate description of certain parts of the exoskeleton must await better specimens.

Prantlia longifrons (Lindström, 1885)
Plate 46, Figs. 4-7

1885 Phaëtonides longifrons: Lindström, p. 76 Pl. 16 Fig. 14

HOLOTYPE

(By monotypy), an incomplete cephalon (RM Ar.2183), figd. Lindström Pl. 16, Fig. 14, and refigured herein as Pl. 46, Figs. 4-7.

TYPE STRATUM AND TYPE LOCALITY

Hemse Beds (Ludlovian), Lindeklint, Gotland.

DIAGNOSIS

Glabella tapering weakly forwards, bluntly rounded anteriorly;

deep 1p furrows partially isolate triangulate basal lobes; no 2p furrows seen; sculpture of short, irregular ridges in a scale-like arrangement.

DESCRIPTION

The cephalon is parabolic in outline and moderately vaulted. The cranidium is considerably longer sagittally than it is wide across the palpebral lobes. The glabella is trapezoidal, a little longer than wide and defined by shallow non incised axial furrows, conjoined with the narrow weakly incised preglabellar furrow. From the bluntly angular posterolateral corners it is almost parallel sided, and then narrows gently forwards to the bluntly rounded frontal margin, being weakly constricted opposite gamma. It is a little more strongly convex in lateral profile than it is in longitudinal profile. The median portion of 1p is deep and incised, and is directed strongly backwards at about 30° to an exsagittal line. At either end it is very shallow and non incised where it runs into the axial and occipital furrows. The resultant partially isolated, triangulate basal lobe is about a third of the sagittal length of the glabella (exsag.) and about a quarter of its basal width (trans.). It has independent convexity from the remainder of the glabella. The occipital furrow and occipital ring are badly preserved. The former is apparently deep and arched weakly forwards sagittally and laterally. The latter is (est.) about two fifths of the sagittal length of the preglabellar area, and transversely is not narrowed and is distinctly wider than the glabella. There do not seem to be any lateral occipital lobes.

The preglabellar area is broad, about five sevenths the sagittal length of the glabella. In lateral profile the preglabellar field is distinctly concave. The anterior branches of the facial sutures cannot be clearly seen, but Lindström (Pl. 16, Fig. 14) figures them as being rather strongly divergent, but not so much as P. longula. The posterior branch has epsilon and zeta as a single angle, close to the posterolateral corner of the glabella. From here the posterior branch turns abaxially onto the posterior border, and cuts the posterior margin not far abaxially from the axial furrow. It defines a minute triangular posterior portion of the fixed cheek.

The palpebral lobe is crescentic, about three sevenths of the sagittal length of the glabella and backwardly placed. In longitudinal profile it is rather steeply inclined from the axial furrow and flattens distally. The distal edge is elevated almost to the height of the sagittal region of the glabella. The eye is crescentic, with a strongly convex visual surface. It is a little over half the sagittal length of the glabella, and is supported on a narrow, curb-like eye socle, whose lower margin runs parallel with the upper margin, and is not defined by a furrow. The field of the free cheek is quite strongly declined from the eye region, and is very weakly convex. The anterior and lateral border furrows are shallow and ill-defined, and the anterior and (probably) the lateral borders are rather narrow and gently convex. The posterior border furrow is narrow and incised with rather steep anterior and posterior slopes. It meets the axial furrow about half way up the lateral end of the occipital ring. The inner end of the posterior border is a little narrower than the anterior border. The outer end is not preserved. The genal spine is not preserved.

The whole cephalon, save the preglabellar field has a sculpture of fine, short irregular ridges arranged in a scale-like pattern. The preglabellar field is smooth, with a few, sporadic, short, raised ridges.

DISCUSSION

This species is known from a single, imperfect cephalon, which shows differences to the more or less contemporaneous *P. longula* in the glabellar shape, transverse width of the occipital ring and in the surface sculpture.

Subfamily TROPIDOCORYPHINAE Pribyl, 1946 emend. Erben, 1966

Genus *TROPIDOCORYPHE* Novak 1890

Type species *Tropidocoryphe filicostata* Novak 1890

Tropidocoryphe heothina sp. nov.

Plate 45, Figs. 7-8

HOLOTYPE

A pygidium (BM.42384), Pl. 45, Fig. 7.

MATERIAL

Besides the type, two more pygidia.

TYPE STRATUM AND TYPE LOCALITY

Litenian, Motol Beds (late Wenlock), Svaty Jan.

OCCURRENCE

Only known from the type locality.

DERIVATION OF THE NAME

From Greek *heothinos*, early. This is one of the earliest known species of *Tropidocoryphe*.

DIAGNOSIS

Pygidium subparabolic, about five ninths as long as broad, depressed; axis with 7-8 rings, separated by shallow interannular furrows which are arched very gently backwards sagittally; broad pleural areas with 4-5 pairs of ribs which curve strongly backwards; pleural furrows with steep anterior slope, interpleural furrows inconspicuous and close to the succeeding pleural furrow.

DESCRIPTION

The pygidium is subparabolic in outline, about five ninths as long as broad, and weakly vaulted. From the axial furrow, the anterior margin is transverse for a distance about equal to the anterior width (trans.) of the axis, and at the anterolateral corner the margin turns abruptly backwards through about 100° to run nearly exsagittally in an abaxially convex curve as far as a transverse line running through the posterior end of the axis. Anteriorly the axis is between a third and a quarter of the total pygidial width. It is defined by narrow, distinct axial furrows which shallow and become obsolete at the anterior end. Longitudinally the axis is rather gently convex. There are 7 to 8 axial rings and a short end piece. Each is divided from the next by a rather shallow interannular furrow, which is arched very gently backwards sagittally. The articulating furrow is deep and incised, and runs more or less transversely. The articulating half ring is about three quarters of the width (sag.) of the first axial ring. The axis is a little over three fifths of the total pygidial length, and behind it is a long, narrow postaxial ridge, which extends almost to the margin.

The pleural areas are gently convex, with 4-5 pairs of strongly backwardly curved ribs, which widen a little abaxially. The pleural furrows are distinct, with steep anterior slopes which shallow adaxially and at the extreme distal ends. The interpleural furrows are indistinct. only the first two or three pairs being commonly seen. They diverge from the preceeding pleural furrows at mid length, and then converge again abaxially, so that the posterior pleural band is broadest at mid length, where it is almost as wide as the anterior pleural band. Elsewhere the anterior pleural band is distinctly wider. In lateral profile the posterior pleural band is steeply inclined towards the posterior, reaching its greatest elevation at the anterior edge of the pleural furrow, which is crest-like. The anterior pleural band is rather less steeply inclined towards the posterior, reaching its greatest height at the interpleural furrow, which is manifested merely as a change in slope in lateral profile.

On more posterior pleural ribs the anterior and posterior pleural bands form a single backwardly inclined slope, becoming progressively steeper towards the pleural furrow.

The pygidial doublure is very broad, extending inwards as far as the posterior end of the axis where it is slightly constricted. The inner edge of the doublure is seen as a lighter line on the dorsal surface (see Pl. 45, Fig. 7). The doublure is very gently convex ventrally, and is ornamented with a dozen irregularly spaced, parallel terrace lines. Between these are short, discontinuous terrace lines which run sub-parallel with them.

The dorsal surface of the pygidium has a sculpture of very fine, dense, raised striations which run more or less transversely on the pleural areas and are arched forwards on the axis.

DISCUSSION

Three pygidia in the collections of the British Museum (Natural History) have been identified as Tropidocoryphe because of the structure of the pleural ribs and the rather short axis with a long, narrow post-axial ridge. As such, they are the earliest known representatives of the genus. Examination of casts of 'Proetus' rattei Etheridge and Mitchell, 1892 from the Ludlovian of New South Wales has shown that these also belong to Tropidocoryphe. T. heothina is late Wenlock in age, and is thus a little earlier than T. rattei. It is suggested elsewhere (see Chapter 4) that Rutellum may be ancestral to Tropidocoryphe, and it occurs in the late Llandovery and early Wenlock. The early presence of Tropidocoryphe suggests that it represents the root stock of the Tropidocoryphinae. Another member of the Tropidocoryphinae, Astycoryphe is present in the early Devonian. Although it has the tropidium, the pygidium is somewhat different from that of Tropidocoryphe, and there is a possibility that it has an independent origin in Decoroproetus. Thus the Tropidocoryphinae as presently conceived may be polyphyletic, with the tropidium as a functional adaptation developed in more than one line.

Subfamily UNCERTAIN

Genus CYPHOPROETUS Kegel, 1927

Type species Cyphaspis depressa Barrande, 1846

DIAGNOSIS

Glabella with deep 1p furrows, isolating or partially isolating prominent basal lobes; 2p and 3p weak and shallow when present;

preglabellar field very short (sag.) or absent; occipital ring with or without lateral lobes, not narrowed laterally; median occipital tubercle normally forwardly placed; anterior border often broadened sagittally; thorax of 10 segments; preannulus present on at least some species; pygidium without border, axis with 5-8 rings, pleural areas with 3-6 pairs of ribs, whose pleural and interpleural furrows run nearly parallel and of similar depth; sculpture granular or striated, or a combination of both.

Species C. depressus (Barrande), C. punctillosus (Lindström), C. externus (Reed), C. bellus (Cooper and Kindle), C. rotundatus (Begg), C. facetus Tripp, C. binodosus (Whittard), C. nasiger sp. nov, C. strabismus sp. nov., C. densistriatus (Kummerow).

GEOLOGICAL RANGE AND GEOGRAPHICAL OCCURRENCE

Middle Ordovician (Caradoc)-Upper Silurian (Ludlow); British Isles, Scandinavia, Germany, Czechoslovakia, Quebec.

DISCUSSION

Differences between Cyphoproetus and the morphologically similar Warburgella are discussed above (see Chapter 4). A particularly interesting feature, which occurs in the type and at least some other species of Cyphoproetus is the preannulus. The preannulus is especially characteristic of the Proetinae and derived groups, but is absent from other subfamilies - e.g. the Proetidellinae. It is seen to occur in the type species of Cornuproetus (see above), where it has apparently developed from ancestors without it.

The earliest Cyphoproetus (see Chapter 3) occurs in the Caradocian, but the specimens are not sufficiently well preserved to see if the preannulus is present. It is already present, however, in the late Ordovician species C. rotundatus (see Chapter 3). The pygidial structure of Cyphoproetus is close to that of members of the Proetinae, especially Proetus. This similarity, combined with the preannulus suggests the strong possibility of the Proetinae having their origins in Cyphoproetus. The origins of Cyphoproetus itself are uncertain. It is not closely related to Decoroproetus, which seems to form the root stock of many later proetid groups, and possibly has its origins in some early Otarion. If this is so, and Cyphoproetus is the ancestor of Proetus, then the Proetidae as presently conceived comprise two major groups - a good basis for recognising two separate families, the Proetidae and the Decoroproetidae, as Erben (1966) has proposed.

Cyphoproetus depressus (Barrande, 1846)

Plate 46, Figs. 16-19 (also Pl. 32, Figs. 8, 10-12)

1846 Cyphaspis depressa: Barrande, p. 60.

1847 Lichas simplex: Hawle and Corda, p. 143.

1852 Cyphaspis depressa Barrande: Barrande, p. 492, Pl. 16, Figs. 38-40.

1927 Proetus (Cyphoproetus) depressus (Barrande): Kegel, p. 636, Pl. 32, Fig. 11.

1946 Cyphoproetus depressus (Barrande): Pribyl, p. 15, Pl. 1, Figs. 9, 9a.

1959 Proetus (Cyphoproetus) depressus (Barrande): R and E. Richter and Struve in Moore, p. O.385, Fig. 293 3.

HOLOTYPE

A rather damaged exoskeleton (NMP Br.221), figd. Barrande, Pl. 16, Figs. 38-40, and refigured herein as Pl. 46, Figs. 17-19.

MATERIAL STUDIED

Besides the type, the cranidium figured by Kegel, and 10 nearly complete exoskeletons from Britain.

TYPE STRATUM AND TYPE LOCALITY

Litenian, Motol Beds (late Wenlock), Listice, near Beroun.

OCCURRENCE

Wenlock, Bohemia, Germany (Giessen), British Isles.

DIAGNOSIS

Glabella tapering very weakly forwards, frontal margin nearly transverse; 1p deep, shallow at either end, partially isolating exsagittally elongated basal lobe; preglabellar field minute, about a quarter of the width (sag.) of the anterior border which is sagittally widened; lateral margin incurved near base of genal spine; lateral occipital lobe small, occipital ring distinctly wider (trans.) than glabella; thorax of 10 segments, preannulus present; pygidium rather small, axis with 5 rings, pleural areas with 4 pairs of ribs; sculpture of rather coarse granules, over much of the exoskeleton.

DESCRIPTION

The cephalon is subparabolic in outline. The cranidium has the sagittal length considerably greater than the palpebral width. The glabella is as long as wide, and is rather weakly inflated. It is defined by narrow, incised conjoined axial and preglabellar furrows.

From the bluntly rounded posterolateral angles it widens weakly forwards as far as the centre of the palpebral lobe, and then narrows weakly forwards to the blunt, nearly transverse frontal margin. 1p is inclined backwards at about 40° to an exsagittal line, and is very weakly adaxially convex. The anterior end is situated opposite the anterior part of the palpebral lobe. It is deep, broad and incised in the median stretch, and shallows abruptly at either end, where it is represented by a shallow depression interrupting the granular sculpture. The resultant partially isolated basal lobe is elongated exsagittally and has independent convexity from the remainder of the glabella. Exsagittally the basal lobe is two fifths of the sagittal length of the glabella, and transversely is a fifth of the basal width of the glabella. 2p is just anterior to gamma, and is a narrow, weakly impressed depression which runs inwards and weakly forwards, extending about a third of the way towards the sagittal line. No 3p furrow is seen.

The median portion of the occipital furrow is more or less transverse, and rather narrow. Behind the basal glabellar lobe the occipital furrow is deflected weakly backwards, and at the extreme lateral end it curves forwards. The occipital furrow widens at the abaxial end of the occipital lobe, where the furrow defining the latter widens and deepens as it runs into the occipital furrow. The occipital ring is as wide (sag.) as the anterior border, and is not narrowed laterally. Transversely it is wider than the glabella. In lateral profile the occipital ring is gently inclined towards the posterior, rising up to the median node and flattening behind it. The median node is placed distinctly forwards. The lateral occipital lobes are small and ovate, defined by shallow furrows which deepen adaxially.

The preglabellar field is minute, about a quarter of the width (sag.) of the anterior border. The anterior branch of the facial suture describes an abaxially convex sigmoidal curve, with beta a wide angle. An exsagittal line drawn backwards from beta falls on the palpebral lobe. The stretch beta-gamma is gently abaxially convex, and gamma is close to the axial furrow. The posterior branches have epsilon and zeta as a single angle, close to the lateral end of the occipital furrow. From epsilon plus zeta the posterior branch turns strongly outwards onto the posterior border and cuts the posterior margin close to the base of the genal spine.

The palpebral lobe is rather broad and subparabolic in outline, and the distal edge is elevated almost to the height of the sagittal region of the glabella. The eye is large, prominent, backwardly placed and is about half the sagittal length of the glabella. There is a narrow, indistinct curb-like eye socle, whose lower margin is parallel with the upper, and not defined by a furrow. The field of the free cheek is weakly convex and declined from the eye to the lateral border furrow. The lateral parts of the anterior border furrow and the lateral border furrow are narrow and distinct, while the median part of the anterior border furrow is shallower and less distinct. The cephalic border is rather broad and the anterior border is broadened distinctly sagittally. The lateral margin of the cephalon is distinctly incurved at the base of the genal spine. The posterior border furrow is wider and deeper than the lateral, which it meets at an angle of about 45^{o} at the base of the genal spine. The posterior border is of similar width to the lateral border, and is inclined towards the posterior. The genal spine is narrow based, without a median groove and extends backwards as far as the fourth thoracic segment.

The thorax consists of 10 segments. The axis is quite strongly longitudinally convex and tapers gently backwards so that the last ring is five sevenths of the width (trans.) of the first. The preannulus is present on the axial ring, and is about a third the width (sag.) of the postannulus on anterior rings, and less than this on more posterior ones. The intra-annular furrow is non-incised, and curves forwards abaxially to meet the articulating furrow shortly before the latter runs into the axial furrow. The postannulus has a granular surface, while the preannulus is smooth. In lateral profile the postannulus is gently convex, and inclined towards the posterior. The articulating furrow is deep and incised, and the articulating half ring is at least half the width (sag.) of the annulus. The inner part of the pleura is horizontal and transverse, whilst the outer part is curved gently backwards and gently declined. The pleural furrow is narrow and incised, and extends close to the distal end of the pleura. The posterior pleural band is distinctly wider (exsag.) than the anterior. It is almost straight and inclined gently towards the posterior in lateral profile. The anterior pleural band is gently convex in lateral profile. The posterolateral corner of the pleura is rounded.

The pygidium is subtriangular in outline, without a border and is a little over twice as broad (trans.) as it is long (sag.). Anteriorly the axis is about a third of the total pygidial width, and it tapers gently backwards to the bluntly rounded posterior end, which is not far from the margin. There are 5 rings, which are defined by rather shallow, transverse interannular furrows. Each is almost flat in lateral profile. The axis is defined by distinct, but non-incised axial furrows which shallow at the posterior end of the axis. There is no postaxial ridge. The pleural areas are gently convex, with 4 pairs of gently backwardly curved ribs. The pleural and interpleural furrows are of comparable depth, and reach close to the margin. The anterior and posterior pleural bands are of similar width (exsag.) and convexity.

The exoskeleton has a distinctive sculpture of rather coarse granules, which reach maximum size and density on the glabella, occipital ring and axes of the thorax and pygidium. On the field of the cheeks and on the pleural areas of the thorax and pygidium they are more sporadic. On the anterior border the granules are rather smaller. The lateral border and genal spine are almost devoid of granules. Fine raised terrace lines occur in the margins of the cephalon and pygidium, and also on the genal spine.

DISCUSSION

Cyphoproetus punctillosus (Lindström) from the Wenlock of Gotland is close to C. depressus, but from Lindström's figures (p. 77) this species appears to differ in the longer genal spine, angular posterolateral angles of the thoracic pleurae and a proportionately longer pygidium.

Cyphoproetus strabismus sp. nov.

Plate 46 Figs. 14-15 (also Pl. 31, Fig. 15, Pl. 32 Figs. 1-7)

HOLOTYPE

A complete internal mould (BM.42362), with a little of the original exoskeleton remaining, Pl. 46, Fig. 14.

MATERIAL

(From Bohemia) 2 complete specimens, 2 cephala and 1 pygidium.

TYPE STRATUM AND TYPE LOCALITY

Litenian, Motol Beds, Lodenice.

OCCURRENCE

At the type locality and in the late Wenlock, ludgreni zone, Long Mountain, Welsh Borderland.

DERIVATION OF THE NAME

From Latin strabismus, squinting, alluding to the position of the eyes, close to the glabella.

DIAGNOSIS

Similar to C. depressus from which it differs in the following ways: glabella narrower, more elongate, with narrower 1p furrows; preglabellar field longer (sag.), as wide (sag.) as the anterior border; lateral occipital lobes a little larger; field of free cheek broader, lateral border narrower; pygidium proportionately larger, with a greater number of axial rings (7) and a greater number of pleural ribs (5-6); sculpture of fine rather than coarse granules.

DISCUSSION

Specimens ascribed to this species from the British Isles are figured on Plates 31-32. It occurs in contemporaneous beds with C. depressus in Bohemia, but apparently in a slightly different facies. The same seems to apply for the distribution of these species in the British Isles.

C. strabismus, C. depressus, C. punctillosus and C. nasiger seem to form a core group of Cyphoproetus, all possessing the sagittally widened anterior border and incurved lateral margin at the base of the genal spine. Earlier Cyphoproetus species do not show these features.

Link Paragraph 3

In Chapter 7 representatives of the genus *Scharyia* are described. This unusual genus, although often associated with the Proetidae, is no longer considered to belong. However, in revising early Proetidae, further information on this genus has come to light, which it was considered of interest to include in a short chapter.

CHAPTER 7

NEW INFORMATION ON THE TRILOBITE GENUS SCHARYIA

New discoveries of *Scharyia* have led to a critical reappraisal of the genus, and details of its morphology, particularly that of the cedariiform suture, are discussed. Two new species, *Scharyia britannica* and *S. siljanensis* are described, the latter being the first occurrence of the genus in the Ordovician. *Scharyia* may be related to the possible otarionid or dimeropygid genus *Panarchegonus*.

INTRODUCTION

Although *Scharyia* Pribyl has generally been associated with the Proetidae, and its type species, *Proetus micropygus* Hawle and Corda included in the genus *Proetus* for a hundred years, its morphology is so distinct that it is now included in a separate family. Since its creation by Pribyl (1946, p. 92), *Scharyia* has been included in the proetid subfamilies Tropidocoryphinae (by Pribyl, 1946b, p. 23) and Eodrevermanniinae (by Hupe, 1953, p. 217) and in the "family" Cyrtosymbolidae (by Osmolska, 1957, p. 61). Osmolska (1957, p. 61) created the subfamily Scharyiinae to accommodate *Scharyia*, and Pribyl (1967, p. 286) raised it to family status. Herein I follow Pribyl, placing *Scharyia* in the Scharyiidae.

Hitherto, five *Scharyia* species have been described, ranging from the late Wenlock to the Middle Devonian, all based on central European material. The two new species described here extend *Scharyia*'s geographical range to Sweden and the British Isles, and one of them takes the genus back into the late Ordovician. Further *Scharyia* species occur in the Swedish Ordovician, and *Scharyia* is also noted from the Silurian of New South Wales, Australia. Herrn R. Feist (Bonn) (personal communication, 1969) has found *Scharyia* in the Givetian of the Montagne Noire, S. France. This is the youngest known occurrence of the genus, and Feist intends to describe it in a future paper.

MORPHOLOGY

1. Cephalon

Hawle and Corda (1847, p. 78) based *Proetus micropygus* Hawle and Corda on a pygidium. A cranidium later figured by Barrande (1852, Pl. 15 Figs. 37-38) as *P. micropygus* has since been identified as a separate species, *S. angusta* (Pribyl, 1966, p. 52). Barrande (1852, Pl. 17 Figs.

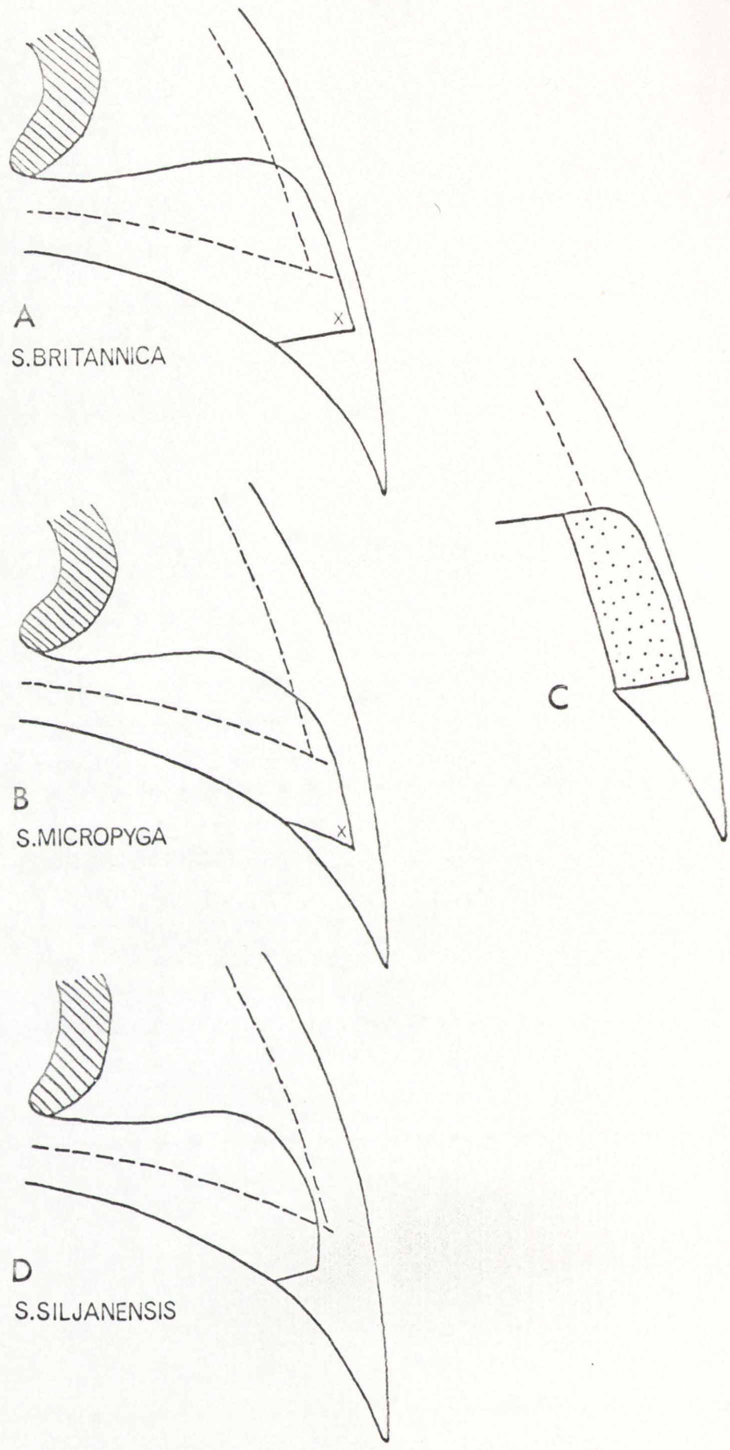


Fig. 7.1. COMPARISON OF FACIAL SUTURES IN THREE SCHARYIA SPECIES.

A - C. Type (a) sutures, running parallel to the lateral border furrow. Note the narrower angle at 'X' in S. micropyga compared with S. britannica. C. shows part of the doublure attached to the free cheek which is overlain by the fixed cheek (cf. Pl.48, figs.5-6).

D. Type (b) suture, found in S. siljanensis (cf. Pl.49, figs.6-7). The path of the lateral border furrow is assumed.

16-17) figured complete specimens of S. micropyga, as meraspides of Decoroproetus decorus, one of which (Pl. 47, Fig. 1) is a degree 5 meraspis of S. micropyga. Barrande was apparently unaware of the unusual facial suture of Scharyia, and he later figured (1872, Pl. 14, Figs. 20-21) a further complete specimen as Proetus micropygus from which the facial sutures were missed out. Pribyl's (1946, p. 5, Fig. 9; 1946a, Pl. 2, Fig. 9; 1967, p. 289, Text Fig. 1, Fig. 1) reconstructions of the cephalon of S. micropyga and S. angusta have shown the abaxial part of the posterior branch of the facial suture running along, or just inside, the posterior end of the lateral border furrow. The real course in S. micropyga and S. angusta is described below, based on examination of the type and additional material. Two types of course of the posterior branch of the facial suture are present. Type (a) is found on all species except S. siljanensis, which possesses type (b).

Type (a)

The suture abaxially crosses the lateral border furrow, and runs backwards, parallel to the lateral margin of the cephalon onto the anterior part of the genal spine and then turns abruptly adaxially across the base of the genal spine (see Fig. 7.1, A-C).

Type (b)

The suture does not cross the lateral border furrow, but runs along or inside it, and turns abruptly adaxially across the inner part of the base of the genal spine (see Fig. 7.1, D).

Apart from details of the posterior branch of the facial suture, the cephalic morphology of Scharyia is remarkably stable over a long period of time. Small changes are apparent in the degree of divergence of the anterior branches, in the outline of the glabella and in the presence or absence of lateral glabellar furrows.

2. Pygidium

The only variable factor of great significance in the pygidium is the border. It is absent on Ordovician specimens, on the Australian specimens and only weakly developed on adult S. britannica. It is distinct on S. micropyga, S. angusta, S. vesca and S. brevispinosa. On the last named it is crenulated. The evolutionary tendency in Scharyia has, therefore been towards the development of a pygidial border. A feature found on the pygidium of all known Scharyia species is a single granule on the adaxial end of each posterior pleural band (e.g. Pl. 47, Fig. 9, Pl. 48 Fig. 3, Pl. 49 Figs. 3, 10). Pribyl (1967, p. 287) states that this

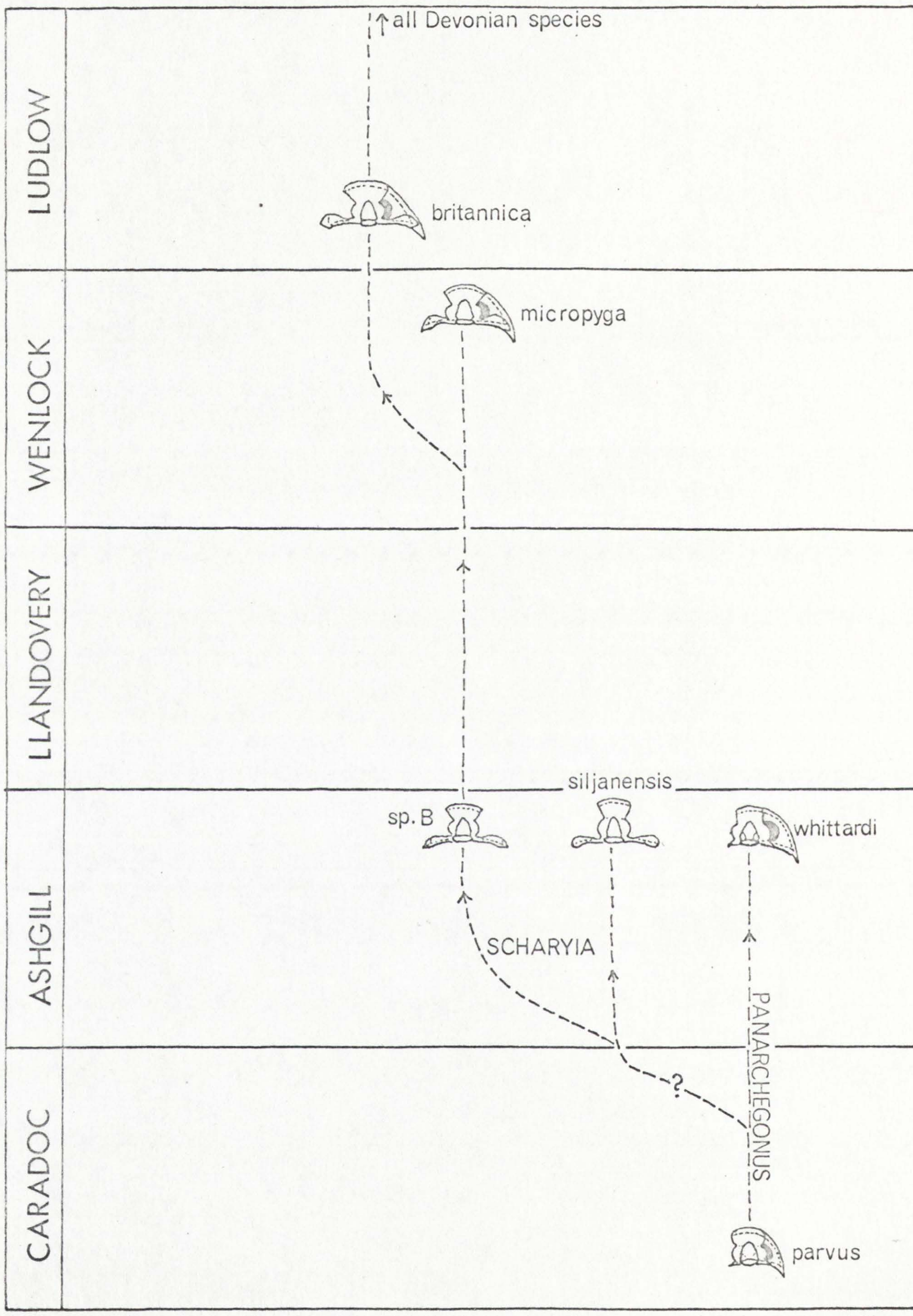


Fig.7.2. Possible interrelationships between earlier *Scharyia* species and *Panarchegonus*.

feature is on the anterior pleural band, although his figures (Text Fig. 1) show it on the posterior. A similar granule is found on the adaxial end of each posterior pleural band of the thorax (see Pl. 47, Fig. 6).

ORIGIN AND RELATIONSHIPS OF SCHARYIA

Pribyl (1967, p. 287) discussed the relationships of Scharyia in his monograph of Bohemian species. He dismissed Scharyia as being an example of necteny, as no meraspides of other trilobites are known with the cedariid type of suture where the adult has a normal opisthoparian suture. He suggested that Scharyia may be a distant descendent of the Upper Cambrian cedariids, on account of the similar facial suture and the small number of thoracic segments. This relationship is unlikely, as there is an enormous time span, embracing most of the Ordovician, between the last cedariids and the earlies Scharyia. Moreover, Scharyia, is always smaller than the cedariids, and always has six thoracic segments as opposed to their seven. Hence, the similar morphology of Scharyia and the cedariids is likely to be the result of homeomorphy. Erben (1961, p. 88) suggested that the cedariiform suture of Scharyia was simply an aberrant development of the normal opisthoparian suture. This is the most likely origin of Scharyia's strange suture, and its ancestors must have had a similar morphology, but a normal opisthoparian suture. Species of Panarchegonus Öpik, which occur in the Middle and Upper Ordovician have such a morphology, e.g. P. whittardi (Begg), from the Upper Ordovician of Girvan, Ayrshire (see Pl. 47, Fig. 7). Features shared by this species and Scharyia species include the triangulate glabella, the large palpebral lobe, well out from the axial furrow and the overall small size. Differences, besides the suture, include the prominent basal glabellar lobes and the larger number of thoracic segments (9). Panarchegonus is likely to be related to the otarionids or dimeropygids, and if Scharyia really is related to this genus, then its associations lie not with the proetids, but with these other families.

SYSTEMATIC PART

Family SCHARYIDAE Osmolska 1957

Genus SCHARYIA Pribyl 1946

DIAGNOSIS

Exoskeleton small, up to 12 mm. long; glabella triangulate, with

	SPECIES	angusta	brevispinosa	britannica	couviniana	micropyga	siljanensis	vesca	sp. A.	sp. B.	sp. (Feist)	sp. (Haas)	"n.sp. A" Alberti '69	"n.sp. B" Alberti '69
	Carnic Alps											×		
	Montagne Noire					?					×			
	Holy Cross Mountains				×	×								
	Central Bohemia	×	×			×		×						
	Morocco												×	×
	New South Wales								×					
	British Isles			×										
	Central Sweden						×			×				
DEVONIAN	Givetian										×			
	Eifelian				×								×	
	Zlichovian		×										×	×
	Pragian							×						
	Lochkovian	×												
SILUR-IAN	Ludlow			×		×			×			×		
	Wenlcock					×								
	Llandovery													
UPPER ORDOVICIAN							×			×				

Fig. 7.3. Stratigraphical and geographical distribution of known Scharyia species.

or without shallow lateral furrows; occipital ring of almost constant width (sag. and exsag.), without lateral lobes; preglabellar field long (sag.), convex in profile; eye large, placed well out from axial furrow; anterior branches of facial sutures divergent, posterior branches cedariiform; thorax of six segments; pygidium with or without a distinct border, axis conical with 5-9 rings, pleural areas with 4-6 pairs of ribs; a small granule is present on the adaxial end of each thoracic and pygidial posterior pleural band.

Species - S. micropyga (Hawle and Corda, 1847) (2 subspecies, micropyga Hawle and Corda, 1847 and wenlockiana Pribyl, 1967), S. angusta Pribyl 1966, S. vesca Pribyl 1966, S. brevispinosa Pribyl 1967, S. conviniana Osmolska, 1957, S. britannica sp. nov., S. siljanensis sp. nov. S. sp. A, sp. B, sp. C (herein) amd a few undescribed species.

OCCURRENCE

Upper Ordovician to Middle Devonian, British Isles, Europe, Morocco, Australia.

Scharyia britannica sp. nov.

Plate 48, Figs. 1-11, Fig. 7.4.

HOLOTYPE

External mould of a cranidium (BM IT.8838), of which a silicone rubber cast is figured as Pl. 48, Fig. 1.

MATERIAL

Ten cranidia, 3 free cheeks, 15 pygidia, with a number of growth stages including 2 late protaspides.

TYPE STRATUM AND TYPE LOCALITY

Ludlow, Lower Eltonian, Oldcastle Farm, near Colwall Green, Herefordshire.

OCCURRENCE

Lower Eltonian, Colwall Green and Wenlock Edge (Middlehope).

DERIVATION OF THE NAME

From the occurrence of this species in the British Isles.

DIAGNOSIS

Like S. angusta, from which it differs in the narrower glabella, without furrows in the adult stage, the wider pygidial axis, and the poorly developed pygidial border in the adult stage.

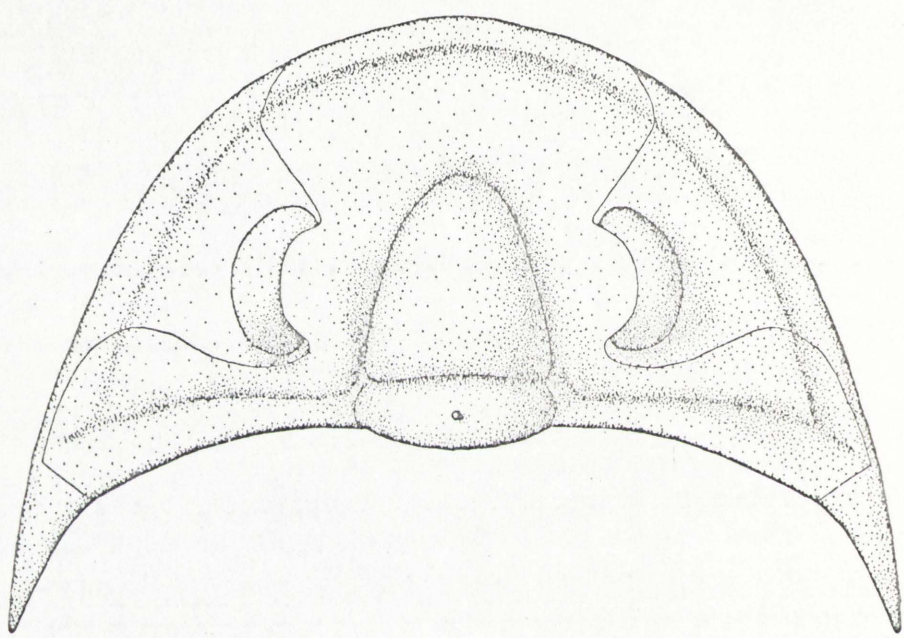


Fig.7.4 Reconstruction of the cephalon of Scharyia britannica sp.nov.

DESCRIPTION

Cephalon semicircular in outline, with a narrow border. The palpebral width and the sagittal length of the cranidium are more or less equal. The glabella is coniform, widest at the posterolateral angle and of approximately equal length and breadth. No glabellar furrows are evident on adult specimens, but two pairs are seen on some protaspids and meraspids, directed obliquely backwards quite strongly. The glabella is weakly convex in lateral and longitudinal profiles, and in lateral profile curves down gently from the posterior to the anterior. It is defined by rather deep, wide, conjoined axial and preglabellar furrows, from which the adaxial parts of the free cheeks are elevated almost to the height of the glabella.

Occipital furrow fairly wide, but rather shallower than the axial furrow, and it is arched weakly forwards sagittally. Occipital ring without lateral lobes, rather wide (sag.), and considerably wider than the anterior border. Transversely it is slightly wider than the glabella, narrowing very slightly laterally. In lateral profile it is quite strongly convex, and is elevated a little higher than the glabella. In longitudinal profile it is bent down quite steeply abaxially, declined at the same rate as the glabellar surface.

Anterior branches of the facial sutures strongly divergent, with beta forming a rather sharp, abaxially convex curve. An exsagittal line from beta falls well outside the palpebral lobe. The posterior branches follow the path described above as 'type (a)' (see Figs. 7.1 A, 7.4). Palpebral lobe large, semielliptical in outline and about two thirds the length of the glabella. It is placed well out from the glabella on a wide free cheek, and is about half the glabellar length. A shallow furrow runs along the inner part of the palpebral lobe, from gamma to epsilon, which is weakly adaxially convex. Eye large, reniform, with a convex visual surface, composed of rather large facets (see Pl. 48, Fig. 10).

Preglabellar field about two thirds the length of the glabella (sag.), and is convex in lateral profile. The anterior border is narrow, inclined steeply from the wide, shallow, anterior border furrow. The anterior part is weakly convex.

The free cheeks are rather small, with a convex field. The lateral border furrow is weakly impressed, and the narrow lateral border is upturned. The genal spine is moderately long, and dorsoventrally flattened.

The posterior border furrow is distinct and fairly wide, with a moderately steep anterior slope rising up to the field of the cheek. The posterior border is quite strongly upturned, and widens at the abaxial end. The cephalic doublure is about the same width as the border, and bears fine, subparallel terrace lines.

The number of thoracic segments is unknown. Each segment has the axis wider than the pleural areas. The axis is weakly arched, and lacks the preannulus. The annulus is slightly wider (sag.) than the articulating half ring, divided from it by a moderately deep articulating furrow. The pleura is directed slightly backwards, and is bent down weakly at the fulcrum. It bears a strong oblique pleural furrow, which divides it into a wider posterior band and a narrower anterior band, the former narrowing and the latter widening distally. The posterolateral angle of the pleura is bluntly angular.

Pygidium of subparabolic outline, with a poorly defined border (in the adult stage). Anteriorly the axis occupies one third of the pygidial width, and tapers quite rapidly backwards to a blunt point, not reaching the posterior margin. It consists of six or seven rings, which in lateral profile are weakly convex. The first axial ring is elevated well above the remainder. On the inner end of the posterior band each pleural rib is a small granule. The pygidial doublure is convex ventrally, and is traversed by fine, subparallel terrace lines.

The exoskeleton seems to be smooth.

DISCUSSION

The material of this species is of particular interest as it includes ontogenetic stages. The late protaspides (see Pl. 48, Figs. 7, 10) show two pairs of lateral glabellar furrows, and a narrow pygidial border. Unfortunately they are too badly preserved to ascertain the path of the facial suture. Small cranidia (e.g. Pl. 48, Fig. 8) have two pairs of lateral glabellar furrows, and the glabellar proportions are comparable with S. angusta (cf. Pl. 47, Fig. 8). Transitory pygidia (e.g. Pl. 48, Fig. 9) have a distinct border, which contrasts strongly with large pygidia (cf. Pl. 48 Fig. 4). The ontogenetic stages, as well as the overall adult morphology (especially the suture) indicate a close relationship between S. britannica and the later (Lower Devonian) species S. angusta. S. micropyga is possibly more primitive, as its suture (see Fig. 7.1 B) is similar to an Ordovician species (S. sp. B, see below).

Scharyia sp. A

Plate 47, Figs. 2-4

1892 Proetus rattei sp. nov. pars Etheridge and Mitchell, Pl. 25, Fig. 2D, ?2E non Figs. 1, 2 A-C.

MATERIAL

Cast of original of Etheridge and Mitchell Pl; 25 Fig. 2D and an additional cranidium and pygidium on the same slab.

HORIZON AND LOCALITY

Upper Ludlow, Bowning Series, Lower Trilobite Beds, Bowning Creek, New South Wales, Australia.

DISCUSSION

Etheridge and Mitchell (1892, p. 317) considered a small specimen they figured (Pl. 25, Fig. 2D) to be a possible larval condition of "Proetus" rattei Etheridge and Mitchell. Examination of a cast of their original specimen has shown it to be a Scharyia. A further specimen they figured (Pl. 25, Fig. 2E) is also quite likely to be a Scharyia, although I have not seen the original or a cast.

Etheridge and Mitchell's specimen is nearly complete, and disarticulated between the fourth and fifth thoracic segments. This specimen, and a cranidium and a pygidium on the same slab are close to S. britannica and S. angusta. The Australian material differs from the former in possessing lateral glabellar furrows (see Pl. 47, Fig. 2) and from the latter in having a wider pygidial axis and lacking a pygidial border. A new species is probably represented, but full description must await better preserved material.

Scharyia siljanensis sp. nov.

Plate 49 Figs. 1-7

1925 "Cyphaspis" sp. ind. b. Warburg, p. 208, Pl. 5, Fig. 61.

HOLOTYPE

A cranidium (RM Ar.47554), Pl. 49

MATERIAL

One cranidium, 7 pygidia.

TYPE STRATUM AND TYPE LOCALITY

Ordovician (Harjuan) Boda Limestone, Kallholn, Lake Siljan district, Sweden.

OCCURRENCE

Boda Limestone, Kallholn, Boda, Lake Siljan district, Sweden.

DERIVATION OF THE NAME

After Lake Siljan.

DIAGNOSIS

Glabella with two faint pairs of furrows; palpebral lobe about three quarters of the sagittal length of the glabella; posterior branch of facial suture follows course "type (b)" (see above); pygidial axis with 6-7 rings; pleural areas with 4-5 pairs of ribs, sometimes poorly defined, with the interpleural furrows extending to the margin, and the pleural furrows dying out a short distance from it. Sculpture of minute granules.

DESCRIPTION

The cephalon is strongly vaulted. The cranidium is about one and a third times as long (sag.) as it is wide (trans.) across the palpebral lobes. The glabella is seven eighths as long (sag.) as it is wide, and is a little over half the total length (sag.) of the cranidium. It is conical in outline, and tapers forwards rapidly to a blunt point. It is defined by deep axial and preglabellar furrows. In longitudinal profile it is moderately convex, and in lateral profile curves down evenly towards the preglabellar field, reaching its greatest elevation opposite epsilon. Two very indistinct pairs of lateral furrows are present, apparent as slightly darker areas. 1p is situated opposite the widest (trans.) part of the palpebral lobe, running backwards and inwards at an angle of about 30° to an exsagittal line. 2p is situated nearly half way between 1p and the anterior end of the glabella, and is fainter and shorter, and does not run backwards at such a great angle. The occipital ring is rather narrow (sag.), being about one quarter the sagittal length of the glabella. It maintains the same width adaxially, and is somewhat wider (trans.) than the glabella. It is separated from the glabella by a rather narrow, shallow occipital furrow, which is arched gently backwards sagittally. It is not as deep as the axial furrow, but deepens and widens at the lateral ends. In lateral profile the occipital furrow has shallow anterior and posterior slopes, the latter sloping up gently to the occipital tubercle, which is prominent, elevated as high as the glabella and situated a little posterior to the centre of the occipital ring, in a sagittal position.

The preglabellar field is about a quarter the length of the glabella (sag.), and is convex in lateral profile. Anteriorly it is separated from the anterior border by the narrow, distinct anterior border furrow. The anterior border is about the same length (sag.) as the preglabellar field, and is also weakly convex in lateral profile. The anterior branches of the facial sutures are moderately divergent, and form a strong, even abaxially convex curve. An exsagittal line drawn backwards from beta falls on the outer part of the palpebral lobe. The palpebral lobe is about three quarters the sagittal length of the glabella, parabolic in outline showing a negative skew towards the posterior. Gamma and epsilon are situated at more or less equal distances from the anterior and posterior ends of the glabella respectively. The palpebral lobe is situated well out from the axial furrow, with a broad longitudinally convex area between the axial furrow and distal edge of the palpebral lobe. The posterior branch of the facial suture follows a cedariiform path, and cuts the posterior cephalic margin just inside the base of the genal spine. The angle where the suture turns inwards across the top of the genal spine is distinctly rounded. The posterior border furrow is wide and deep, but shallows adaxially, so that it is not apparent at the facial suture. The posterior border is convex, and widens adaxially, where it is of the same width (exsag.) as the occipital ring.

The free cheek and thorax are unknown.

The pygidium is parabolic in outline, three quarters as long (sag.) as wide (trans.). Anteriorly the axis is between a third and two fifths of the transverse width, and tapers to a blunt point, and is about four fifths the total pygidial length (sag.). There is a faint, narrow postaxial ridge. The axis consists of six rings and a short end piece. Each ring is separated by a wide,shallow interannular furrow, which in lateral profile hardly makes any impression on the contour of the axis. Each ring is very weakly convex. The first ring is narrower, and elevated higher than the remainder, and its posterior margin is not interupted sagittally like those of the succeeding rings. Each ring is arched weakly forwards sagittally and laterally. The postaxial area is weakly convex in lateral profile. Pleural areas are convex, with 4-5 pairs of ribs. On some specimens (e.g. Pl. 49, Fig. 1) they are rather inconspicuous, while on others they are distinct (e.g. Pl. 49, Fig. 4). The first pleural furrow is deep and conspicuous, but the succeeding pleural furrows are shallower, and die out before reaching the pygidial margin. The interpleural furrows have a steep posterior and shallow anterior slope, and do not turn backwards so strongly as the pleural furrows, so that the posterior pleural band narrows almost to a point distally. The anterior pleural band is considerably wider than the posterior. On the adaxial end of each posterior pleural band is a single, small granule.

The sculpture is of fine granules, which are absent in the regions of the lateral glabellar furrows, pygidial axial interannular furrows, and sometimes on the sagittal region of the axial ring. On the extreme anterior margin of the anterior border there is a single, fine terrace line, and on the anterior part of the anterior border are sporadic short terrace lines, running more or less parallel to the margin.

DISCUSSION

Warburg (1925) figured and described "Cyphaspis"sp. ind. a (p. 205, Pl. 5, Figs. 59-60), "C" sp. ind. b (p. 208, Pl. 5, Fig. 61), "C" sp. ind. c (p. 209 Pl. 5, Fig. 58) and "C"? sp. ind. d (p. 210, Pl. 5, Fig. 62) and compared all with the type species of Scharyia, Proetus micropygus. Of these species, "Cyphaspis" sp. ind. b is included in Scharyia siljanensis and "Cyphaspis" sp. ind. c is included in Isbergia planifrons. "Cyphaspis" sp. ind. a (see Pl. 49, Figs. 8-9) is represented by two cranidia, and one has the left hand posterior branch of the facial suture preserved, which shows that it is a Scharyia. Here, unlike S. siljanensis the posterior branch follows the "type (a)" course (see above), and is very similar to S. micropyga (see Pl. 47, Fig. 5). An eye ridge also seems to be present on one of the specimens (see Pl. 49, Fig. 8). A species distinct from S. siljanensis is evidently represented, here referred to as Scharyia sp. B. "Cyphaspis"? sp. ind. d (see Pl. 49, Fig. 10), represented by a single pygidium, also seems to be referable to Scharyia. The pygidium is elongated, and differs from S. siljanensis in outline, and in its larger number of pleural ribs in which the narrow pleural and interpleural furrows are both incised. The feature which confirms that this pygidium belongs to Scharyia is the presence of a distinct granule on the adaxial end of each posterior pleural band. Whether this pygidium belongs to Scharyia sp. B is unknown, and as it comes from a different locality, it is referred here to Scharyia sp. C.

The above specimens demonstrate that besides S. siljanensis, one, possibly two additional species, occur in the later Ordovician. Scharyia sp. B demonstrates the early presence of the "type (a)" posterior branch of the facial suture, occurring alongside the more primitive "type (b)". The deep, narrow, pleural and interpleural furrows on the pygidium of Scharyia sp. C are reminiscent of the condition in Panarchegonus (see Pl. 47, Fig. 7), adding weight to suggestion that this genus and Scharyia are related.

CHAPTER 8

PHYLOGENETIC CONCLUSIONS

In the foregoing chapters, remarks have been made concerning the relationships between certain genera and species on a limited scale. In this chapter an attempt is made to bring all these ideas together in the context of a survey of the early phylogenetic history of the Proetidae as a whole. Conclusions are drawn from the interpretation of evidence available at present, and the hypotheses expressed are based on the most likely course of events in the eyes of the author. These hypotheses will doubtless be modified in the future with the arrival of new material, and their correctness will be judged by the course of time.

This chapter is divided into two sections. In the first the origins of the Proetidae and other members of the Proetacea are examined, and in the second inter-relationships between different Ordovician and Silurian proetids are discussed. I do not attempt to discuss details of post Silurian proetid phylogeny here.

SECTION 1. THE ORIGIN OF THE PROETACEA

Many later Cambrian and early Ordovician ptychopariid trilobites have a generalised "proetid" morphology (e.g. Elrathia, Weeksina and Hystricurus), especially in the forwardly tapering glabella, opisthoparian suture and well developed preglabellar field. Whittington (1966, p. 709) has already suggested a relationship between certain Hystricurinae and Proetacea such as Otarion, Dimeropyge and Phaseolops, and genera classified with the former (see Moore et al., 1959, p. O.278) do seem to be the best candidates for ancestors of the latter. A noteworthy feature of Hystricurus is the presence of a trapezoidal rostral plate, a feature typical of proetids and otarionids. This common character lends extra support to a relationship. Possible relationships between some members of the Hystricurinae and proetids, otarionids and dimeropygids are summarised in Fig. 7.1, and in the paragraphs below different genera of the Hystricurinae are compared with different proetacean genera.

Hystricurus is not far removed in gross morphology from Decoroproetus although the tuberculate surface sculpture of the former contrasts strongly with the finely striated surface sculpture of the latter. It is possible that Decoroproetus has its origins in Hystricurus, or in a Hystricurus-like form. Hystricurus occurs in the Lower Ordovician, and the earliest

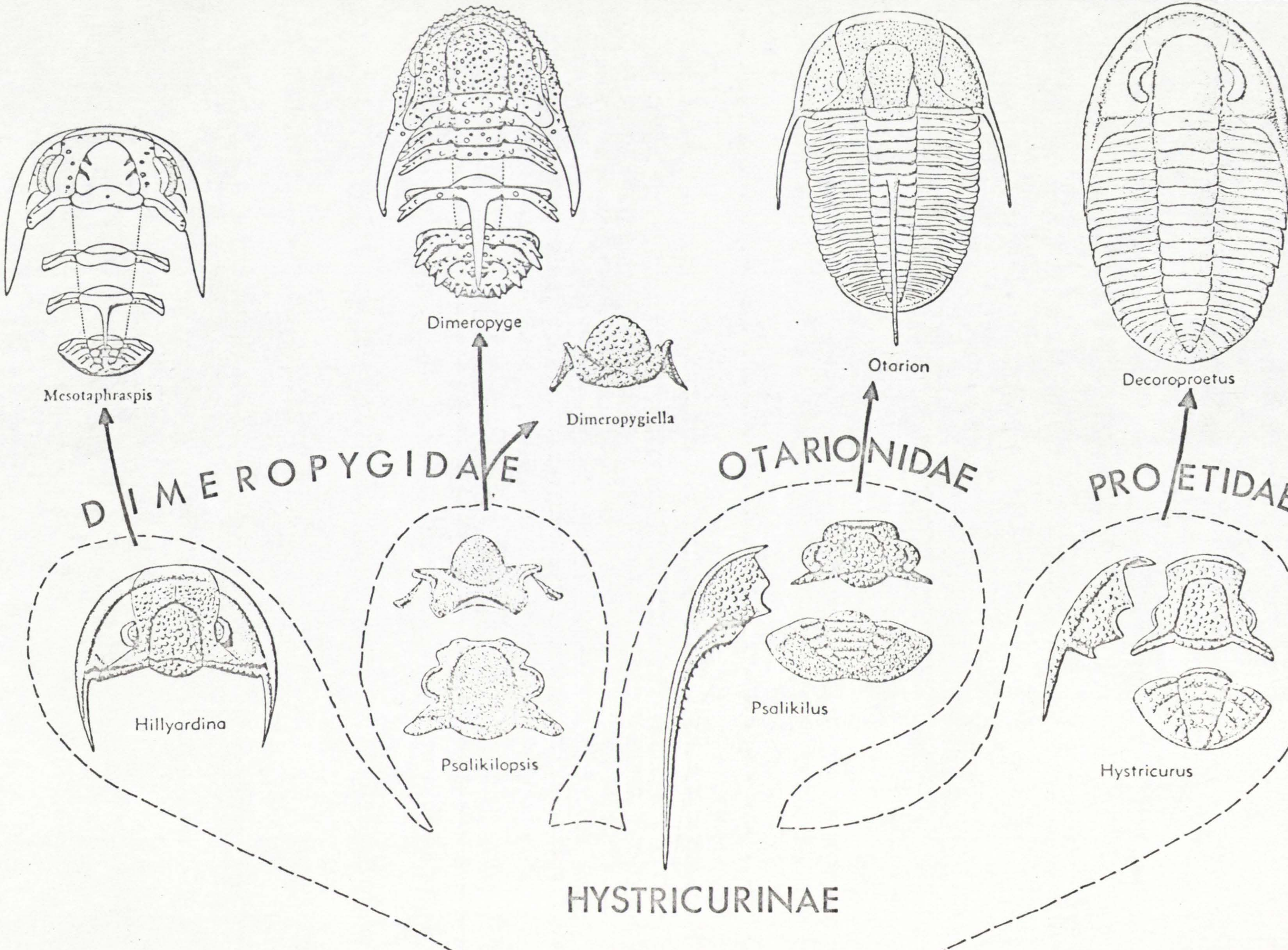


Fig.8.1. Possible relationships between certain Proetacea and Hystricurinae.

(Drawings taken from Treatise (Part O), except that of Decoroproetus, which is from Kielan, 1960).

known _Decoroproetus_ comes from the Llandeilo. _Phaseolops sepositus_ (Whittington, 1963, p. 37, Pl. 4 Figs. 11-13, Pl. 5 Figs. 1-6), of Llanvirn age has a subtriangular rostral plate, and has been considered by Whittington (1963, p. 37; 1966, p. 709) to be a proetid. It is not difficult to imagine that this species has branched off as a small off-shoot from a possible _Hystricurus-Decoroproetus_ line. Dean (1966, p. 338, Pl. 15 Figs. 1, 7) described and figured a cranidium from the Arenig of the Montagne Noire (S. France) as "proetid gen. et sp. indet.". This cranidium does not have a clearly defined occipital furrow, but otherwise is not dissimilar to _Hystricurus_, and could therefore also be linked to the possible _Hystricurus-Decoroproetus_ line.

Psalikius is not unlike _Otarion_ in its overall morphology, especially in the palpebral lobe placed well out from the axial furrow, and the incurved cephalic margin at the base of the genal spine. The earliest known _Otarion_ species, _O. insolitum_, occurs in the Arenig of the Montagne Noire (see Dean, 1966, p. 337, Pl. 19, Figs. 11, 13, 14), but this species has already developed strong basal glabellar lobes, a feature absent in _Psalikius_. _Psalikiopsis_, with its strongly inflated glabella and forwardly placed eye is reminiscent of dimeropygid genera such as _Dimeropyge_, _Dimeropygiella_, _Toernquistia_, _Ischyrotoma_ and _Ischyrophyma_, while _Hillyardina_ is quite similar to _Mesotaphraspis_, both the latter genera sharing the sagittal furrow on the preglabellar field.

From the above comments it can be seen that the Proetidae may have their origin in _Hystricurus_, the Otarionidae in _Psalikius_ and the Dimeropygidae in _Psalikiopsis_ and _Hillyardina_. I am doubtful whether the Celmidae and Plethopeltidae, classified with the Proetacea in the _Treatise_ really belong. If the Hystricurinae really are ancestral to one or more families of the Proetacea, then they could perhaps be classified with that superfamily.

SECTION 2. PHYLOGENY OF THE EARLY PROETIDAE

In the following paragraphs, different genera and subfamilies are considered in turn, and the overall hypotheses are summarised in Fig. 8.2 which shows the ranges of all the early proetid genera incorporated in this thesis and possible inter-relationships between them.

a) The Proetidellinae

The typical genus of this subfamily, _Decoroproetus_ is first known from the Llandeilo, and ranges into the lower Devonian. It is the most widespread Ordovician genus, occurring widely in Britain, Scandinavia,

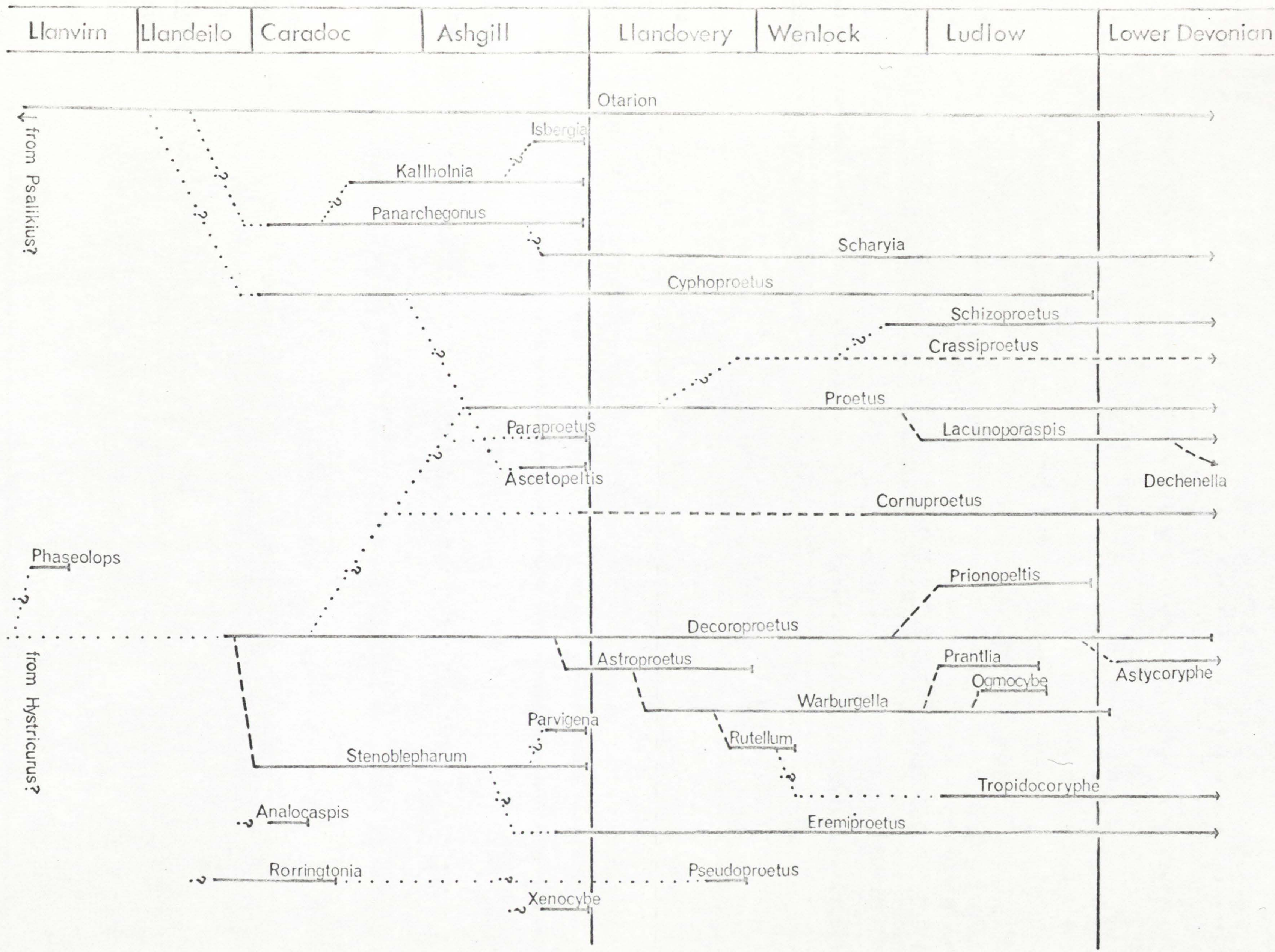


Fig.8.2. Stratigraphic range and possible phylogenetic relationships between Ordovician and Silurian Proetidae and Otarionidae.

North America and Poland. It has not, to my knowledge, been found in the Ordovician of Bohemia. Decoroproetus seems to form the root stock from which many other proetid lines have originated. In the Ordovician two further genera belonging to the Proetidellinae occur, namely Stenoblepharum and Astroproetus. The former occurs as early as the Caradoc, but is restricted to rather specialised environments such as the Boda reef limestone of Sweden. Stenoblepharum might be ancestral to Eremiproetus, which is first known in the late Ordovician. The earliest known species of the latter, E. agellus, has a similar cephalon to Stenoblepharum, although the pygidium is closer to that of Decoroproetus. Parvigena, a strange genus from the Boda reef limestone possibly has its origins in Stenoblepharum, but the morphology of the type species, P. parvigena almost mimics that of illaenids.

Astroproetus appears in the late Ordovician, and this genus has some characteristics of Decoroproetus and others of Warburgella, and thus may be a link between the two genera. It is shown elsewhere (Chapter 2) that Astroproetus, Warburgella, Prantlia, Rutellum and Ogmocybe seem to form a distinct branch within the Proetidellinae, and may therefore be the basis for a new subfamily.

Prionopeltis, with a spinose pygidium, appears to have been derived from Decoroproetus in the later Silurian, occurring in central Europe and the Urals, but is unknown in the Anglo-Scandinavian area. Decoroproetus and Warburgella are the only members of the Proetidellinae to persist into the lower Devonian.

The "Warburgella branch" of the Proetidellinae may be ancestral to at least some members of an important, primarily Devonian subfamily, the Tropidocoryphinae. Early species of Tropidocoryphe are already present in the later Silurian and morphologically they approach such genera as Rutellum, especially in cephalic characters. It is possible that the subfamily Tropidocoryphinae as conceived at present (see Treatise and Erben 1966) is polyphyletic, and that the tropidium was independently gained by several different lines. Astycoryphe, for example, may have been derived from Decoroproetus rather than from members of the "Warburgella branch."

b) The Cornuproetinae

Three subgenera of Cornuproetus, Cornuproetus, Lepidoproetus and Lodenicia, are established by late Wenlock times, but seem to be restricted to certain environments (see Chapter 6). Specimens figured as "Proetus ramisulcatus?" (pl. 43, Figs. 1, 4, 8, 9) have a pygidium which is suggestive of Cornuproetus, and may be ancestral to the Cornuproetinae. These occur in the late Ordovician of Estonia, and could form a link between Decoroproetus and the Cornuproetinae, as the pygidial rib structure is almost intermediate between the two. Several Decoroproetus species, especially D. furubergensis (see Chapter 1) have a pygidial structure which tends towards "Proetus ramisulcatus?" and this species is compared (see Chapter 1) to a Cornuproetus (Lepidoproetus) species. The Cornuproetinae become abundant in the Devonian, from which a large number of subgenera have been recognised. It is likely that some of these are the result of unnecessary "splitting", but their value is not assessed here. Eremiproetus was formerly included in the Cornuproetinae, but Alberti (1967) transferred it to the subfamily Eremiproetinae, along with the Devonian genus Phaetonellus, which like Prionopeltis developed a spinose pygidium. The origins of Eremiproetus, and consequently the Eremiproetinae may lie in Stenoblepharum. Eremiproetus would then have no direct relationship with the Cornuproetinae, the similar cephalic morphology being the result of the parallel evolution.

c) The Proetinae

The inter-relationships between early Proetus subgenera and species are discussed in Chapter 5. Proetus is first known from the Ashgill of Wales, but does not become abundant until the Silurian. In the late Ordovician two short-lived genera of the Proetinae, Ascetopeltis and Paraproetus occur. The former possesses the preannulus, a characteristic of the Proetinae, while the latter lacks it. The pygidium Paraproetus approaches that of the Proetidellinae in rib structure, and thus Paraproetus could be a descendant of a line leading from the Proetidellinae to the Proetinae. This line may also have given rise to the Cornuproetinae. The genus Cyphoproetus, which ranges from the early Caradoc to the late Silurian is particularly interesting in having a similar pygidial structure to the Proetinae, and in possessing the preannulus. These features suggest that the Proetinae might have their origins in Cyphoproetus rather than in the Proetidellinae. Cyphoproetus does not appear to be related to the latter, but instead possibly has its origins in Otarion. Hence the Proetidae as currently conceived might in fact be conveniently split into two families. Erben (1966) did name two families, the Proetidae and the Decoroproetidae, but did not discuss them, proposing to do so in a later paper. The possible polyphyletic origins of the Proetidae outlined above lend much support to Erben's suggestion of having two separate families.

Many important Devonian groups appear to have their origins in the Proetinae. It has already been suggested (see Chapter 5) how the Schizoproetinae and the Dechenellinae might be related to the Proetinae. Later subfamilies such as the Cyrtosymbolinae, Phillipsiinae, Griffithidinae and Cummingellinae are apparently to be related to the Dechenellinae (see Ormiston, 1967 and G. and R. Hahn, 1967).

d) Problematical Genera

Because the present state of knowledge is incomplete, there are several genera which cannot be accommodated in any of the subfamilies discussed above. For example, Panarchegonus may have arisen from the Otarionidae or from the Dimeropygidae (the former being the more likely), and hence should be classified with one or other of those families. Cranidial and/or pygidial characters of Kallholnia and Isbergia suggest that they may well be related to Panarchegonus (see Chapter 2). There is a likelihood that Scharyia also has its origins in Panarchegonus (see Chapter 7). There is a case for considering Panarchegonus to be the root stock of a new subfamily including Kallholnia and Isbergia. Scharyia is at present classified in its own family, the Scharyiidae. The genera Xenocybe, Rorringtonia, Analocaspis and Pseudoproetus apparently belong to the Proetidae, but how they are related to other members of the family remains uncertain, and until more is known about them they are classified as *incertae sedis*.

The foregoing remarks are intended to be of a generalised nature, and further details are to be found in the systematic section of this thesis. As I have indicated in the introduction, phylogenetic conclusions have been derived from the examination and comparison of a combination of characters. Any one character may recur in a number of lineages, particularly the cranidial shape.

It has been noted that different genera often prefer a single type of environment. Stenoblepharum, for example, is unknown in non-calcareous sediments. Some genera may become more restricted in their distribution over the course of time. Decoroproetus occurs widely in the Ordovician, over several different types of environment, but in the Silurian it becomes confined to dark shales and dark, fine grained limestones. Some environments appear to be more dynamic than others in initiating radiation, and the particular example which may be singled out here is the reef environment, exemplified by the Ordovician Boda limestone and the Gotland Silurian reefs. In these environments there is commonly a great increase in numbers of individuals and a great diversification of species, and the origins of several taxa can be traced back to Ordovician or Silurian reefs.

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APPENDIX 1

RESULTS OF A PRELIMINARY EXAMINATION OF EXOSKELETAL DETAILS USING THE SCANNING ELECTRON MICROSCOPE

Small silicified specimens isolated from blocks of Edinburg and Llandeilo limestone were considered good material to test the potential of the scanning electron microscope for the study of small morphological details on the surface of the exoskeleton. Examples of results are given on plates 50-52. The scanning electron microscope was also used for the photographing of small growth stages of *Decoroproetus pristinus* (e.g. Pl. 23 Figs. 4-11) and for illustrating the eye of *Kallholnia dapsilis* (Pl. 13, E). It was found that the silicified specimens would stand up to a magnification of about x 200, greater magnifications only showing the crystals of the replacing material. Non silicified specimens may well be able to stand higher magnifications. The stereographs on plates 50-52 give an indication of the details which can be obtained from silicified specimens.

Besides the obvious advantages of obtaining a high magnification, there is the added one of being able to obtain a good depth of focus, as the photographs show. Such a great depth of focus is impossible at a high magnification using conventional techniques. Perhaps the greatest disadvantage of the stereoscan is the upward limit in size of specimens which it is possible to use, which is about half an inch. Any larger specimens must be broken if they are to be used on the stereoscan, and such a course is impossible with museum specimens.

In the paragraphs below brief comments are offered on the specimens figured on plates 50-2. These are, of course, isolated observations, but are intended to indicate the great potential of the stereoscan in the study of small surface details. The use of stereoscopic pairs of photographs enhances their value enormously, affording three dimentional views of the specimens.

a) The Dorsal Surface of the Cranidium of *Stenoblepharum strasburgense* (Cooper 1953), Pl. 50, Figs. 1-4

General dorsal views are given in stereographs 1 and 2. These show that most of the dorsal surface is striated, with the exception of the smooth, slightly depressed area of the lp furrow. The true nature of the striations is shown more clearly in the lateral view of the occipital ring (stereograph 3), where they have the aspect of a series of "dip and scarp" slopes, with the scarps facing adaxially. The steep "scarp" slopes appear to underhang the edge of the "scarps". The highest limit of magnification which still shows reasonable detail is shown in stereograph 4, which is of the dorsal aspect of the occipital tubercle. It would appear that recrystallisation has destroyed any original very fine detail - perhaps a pore in the centre of the tubercle - which may have been present.

b) The Pygidial Doublure of Stenoblepharum strasburgense (Cooper 1953), Pl. 51, Figs. 1-4

The genal ventral pygidial aspect is shown on stereograph 1. This clearly shows the constriction of the doublure behind the axis and the bunching together of terrace lines in the same region. A prominent vincular furrow is present near the pygidial margin. Stereographs 2 and 3 show progressively greater magnifications of the doublure behind the axis. The terrace lines are clearly shown to be a series of parallel "dips and scarps", similar to those on the dorsal surface of the cranidium, but longer and more regular. The "scarps" do not seem to underhang the scarp edges as they do on the cranidium (see Pl. 50, Fig. 3), and they face outwards, towards the pygidial margin. It is to be expected that corresponding terrace lines on the cephalic doublure would have the "scarps" facing inwards, away from the margin, so that they could fit into the pygidial ones during enrollment,each "scarp" forming a stop and thereby locking the cranidium and pygidium together. Stereograph 4 shows the anterolateral end of the pygidial doublure.

c) The Cephalic Doublure of Decoroproetus pristinus sp. nov., Pl. 52, Figs. 1-4

Stereographs 1-3 are all from one specimen. 1 and 2 show the construction of the doublure, and show how it is rolled over leaving a fairly substantial void in the centre. Stereographs 2 and 3 indicate that the terrace lines are unlike those discussed above in S. strasburgense, and are instead a series of steep sided ridges rather than "dips and scarps". Stereograph 4 shows a longitudinal view of the anterior end of the doublure of another specimen. Here two distinct lamellae can be detected. Whittington and Campbell (1967) note a similar structure in silicified specimens of Proetus pluteus, but considered it to be of secondary origin associated with the silicification rather than a primary exoskeletal structure. The same could apply here, but corresponding views of non-silicified specimens are required to show if two distinct lamellae were originally present.

APPENDIX 2

A SYSTEMATIC CLASSIFICATION OF ORDOVICIAN AND SILURIAN PROETIDAE

The following classification lists all known Lower Palaeozoic Proetidae, and includes the synonyms and known stratigraphical range of each genus. A question mark before a genus indicates that assignment to the subfamily is uncertain. Most of the genera listed have received detailed treatment in Chapters 1-6, and those not considered are marked with an asterisk.

Family PROETIDAE Salter 1964

Subfamily PROETINAE Salter 1964

Genus Proetus Steininger 1831 (Ashgill-Middle Devonian). (Syn. Aeonia Burmeister, 1843; Gerastos Goldfuss, 1843; Forbesia M'Coy, 1846; Trigonaspis Sandberger and Sandberger 1850.) See Chapters 2, 3, 5, 6.

Subgenus Proetus Steininger 1831 (Wenlock-Ludlow, ?Middle Devonian). See Chapters 5, 6.

Subgenus Coniproetus Alberti, 1966 (Ludlow-Lower Devonian). See Chapters 5, 6.

Subgenus Lacunoporaspis Yolkin, 1966 (Wenlock-Lower Devonian). See Chapter 5.

Genus Ascetopeltis gen. nov. (Ashgill). See Chapters 2, 3.

Genus Paraproetus Pribyl, 1964 (Ashgill). See Chapter 3.

? Genus Cyphoproetus Kegel, 1927 (Caradoc-Ludlow). See Chapters 3, 4, 6.

Subfamily SCHIZOPROETINAE Yolkin 1968

Genus Schizoproetus R. Richter 1912 (Wenlock-Middle Devonian). See Chapter 5.

?Genus Crassiproetus Stumm, 1953 (?Upper Llandovery, Middle Devonian). See Chapter 5.

Subfamily CORNUPROETINAE R. and E. Richter 1956

Genus Cornuproetus R. and E. Richter 1919 (Wenlock-Middle Devonian). See Chapter 6.

Subgenus Cornuproetus R. and E. Richter 1919 (Wenlock-Middle Devonian). See Chapter 6.

Subgenus Lepidoproetus Erben 1951 (Ludlow-Lower Devonian). See Chapter 6.

Subgenus _Lodenicia_ Prantl and Vanek 1958 (Wenlock-Lower Devonian). (Syn. _Voigtaspis_ Alberti, 1967). See Chapter 6.

Subfamily EREMIPROETINAE Alberti 1967

Genus _Eremiproetus_ R. and E. Richter 1919 (Ashgill-Middle Devonian). See Chapter 2, 6.

Subfamily PROETIDELLINAE Hupe 1953

Genus _Decoroproetus_ Pribyl 1946 (Llandeilo-Lower Devonian). (Syn. _Proetidella_ Bancroft 1949, _Ogmocnemis_ Kielan 1960, _Warburgaspis_ Pribyl 1946). See Chapters 1, 2, 3, 4, 6.

*Genus _Phaseolops_ Whittington 1963 (Llanvirn).

*Genus _Prionopeltis_ Hawle and Corda, 1847 (Ludlow)

*Genus _Latiproetus_ Lu, 1962 (Silurian)

Genus _Stenoblepharum_ gen. nov. (/Ashgill). See Chapter 2. /Caradoc-

?Genus _Parvigena_ gen. nov. (Ashgill). See Chapter 2.

The following genera are considered to belong to the "_Warburgella_ branch" of the Proetidellinae (see Chapter 4 and Fig. 8.2), and may later be isolated as a separate subfamily:

Genus _Warburgella_ Reed 1931 (Llandovery-basal Devonian). See Chapter 4.

Genus _Astroproetus_ Begg, 1939 (Ashgill-Llandovery). (Syn. Clypoproetus Begg, 1939.) See Chapters 3, 4.

Genus _Prantlia_ Pribyl 1946 (Ludlow). See Chapter 6.

Genus _Rutellum_ gen. nov. (late Llandovery-Wenlock). See Chapter 4.

Genus _Ogmocybe_ gen. nov (Ludlow). See Chapter 4.

Subfamily TROPIDOCORYPHINAE Pribyl, 1946

Genus _Tropidocoryphe_ Novak 1890, (Ludlow-Middle Devonian). See Chapter 6.

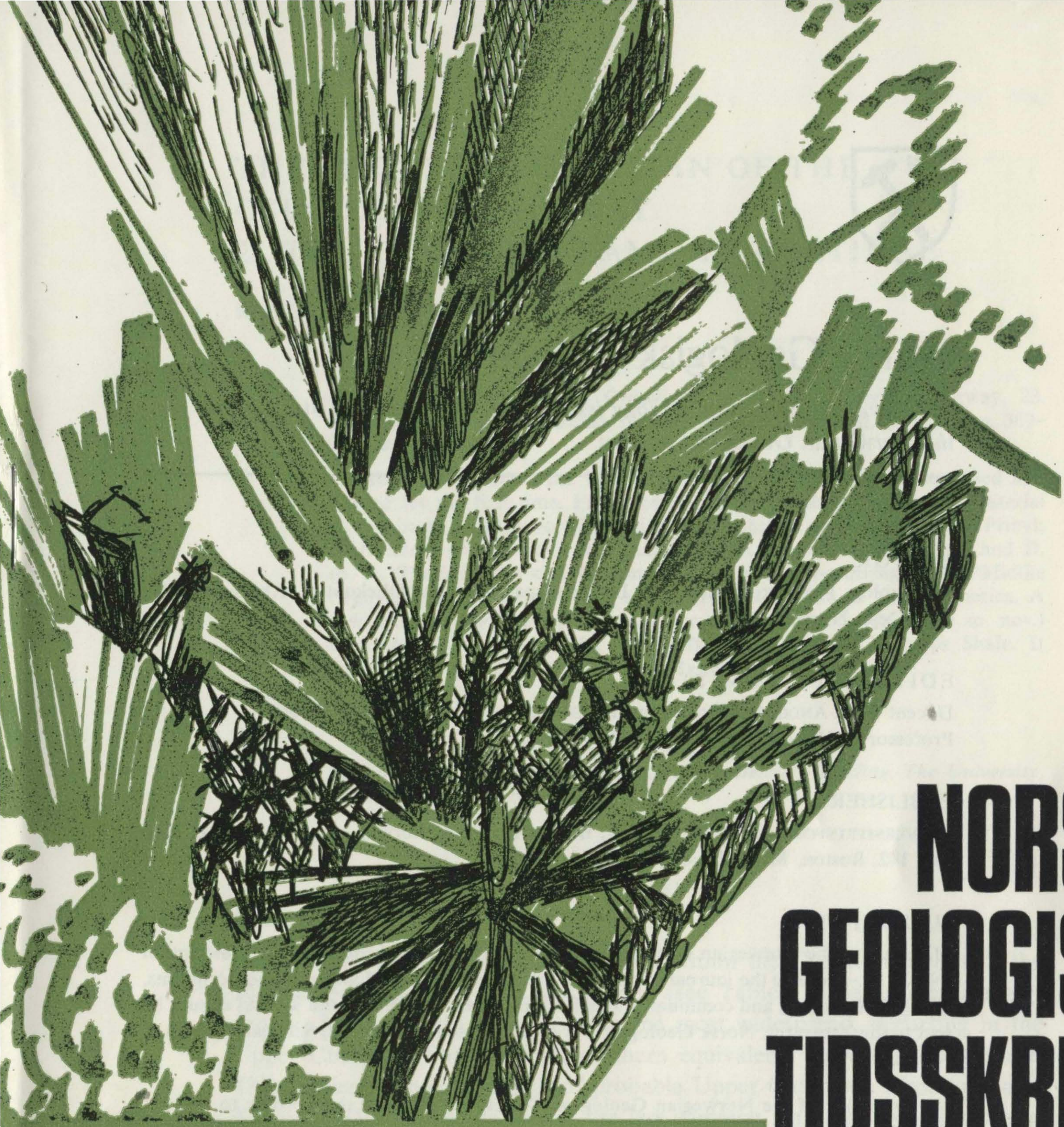
Subfamily UNCERTAIN

Genus _Analocaspis_ gen. nov. (Caradoc). See Chapter 1.

*Genus _Pseudoproetus_ Poulsen 1934 (Llandovery).

Genus _Rorringtonia_ Whittard, 1966 (Llandeilo-Caradoc). See Chapter 3.

Genus _Xenocybe_ gen. nov. (Ashgill). See Chapter 2.



NORSK GEOLOGISK TIDSSKRIFT

Owens, Robert M.:
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Volume 50 · 1970 Number 4

Universitetsforlaget

Norsk Geologisk Tidsskrift

A Norwegian journal of geology issued under the auspices of the Norwegian Geological Society

PUBLISHER

UNIVERSITETSFORLAGET, P.O. Box 307, Blindern, Oslo 3, Norway. American office: P.O. Box 142, Boston, Massachusetts 02113, U. S. A.

SUBSCRIPTIONS

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THE MIDDLE ORDOVICIAN OF THE OSLO REGION, NORWAY
23. THE TRILOBITE FAMILY PROETIDAE

ROBERT M. OWENS

Owens, R. M: The middle Ordovician of the Oslo Region, Norway, 23. The trilobite family Proetidae. *Norsk Geologisk Tidsskrift,* Vol. 50, pp. 309–332. Oslo 1970.

Proetid trilobites from the Middle Ordovician of Norway are described and figured for the first time. From the fragmentary but well preserved material it has been possible to distinguish four species af *Decoroproteus* Přibyl; *D. furubergensis* sp. nov., *D. gyratus* sp. nov., *D. solenotus* sp. nov., and *D.* sp. A. These species can be compared with ones occurring in the Middle Ordovician in the Girvan area of the British Isles and in North America. A new genus, *Analocaspis* gen. nov. (type species *Analocaspis ursina* sp. nov.) is erected for a proetid-like species from the Lower Chasmops Shale. It has not been found outside the Oslo Region.

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Introduction

Proetid trilobites only occur at horizons within the Chasmops Series of the Middle Ordovician in the Oslo Region (see Table 1), the species *Decoroproetus furubergensis* sp. nov. being the most widespread, occurring in the Upper Chasmops Shale and its northern equivalent, the Cyclocrinus Shale. This species is present in beds of probable Upper Chasmops Limestone age. The other *Decoroproetus* species are less common, and have not been found at so many localities. The supposed proetid *Analocaspis ursina* gen. et sp. nov. is known only from the type locality.

The term 'Middle Ordovician' is accepted herein in the sense of Størmer, i. e. from the base of the Didymograptus bifidus zone (4aα_1) to the top of the Upper Chasmops Limestone (4bδ_2).

Terminology

Most of the terms used are those defined by Harrington et al. in Moore (1959, pp. O 117 – O 126). The following additional terminology is useful when describing proetids.

Eye socle, defined by Shaw & Ormiston (1964, p. 1002), is used for that curb-like ridge which supports the visual surface of the eye.

Standard British Graptolite Succession		Shelly Succession of Shropshire and N. England		Upper Part of Middle Ordovician Succession of Oslo District	Proetid Trilobites with Known Stratigraphic Distribution	Districts of the Oslo Region: Oslo-Asker	Ringerike	Hadeland	Neshamar
CARADOC	Dicranograptus clingani	ONNIAN		4bδ Upper Chasmops Limestone	Decoroproetus solenotus	+	+	•	•
		ACTONIAN			Decoroproetus sp. A.	•	+	•	•
					Decoroproetus furubergensis	•	•	+	•
	Climacograptus wilsoni	MARSHBROOKIAN		4bγ Upper Chasmops Shale	Decoroproetus furubergensis	•	+	+	+
		LONGVILLIAN	UPPER						
			LOWER	4bβ Lower Chasmops Limestone		•	•	•	•
	Climacograptus peltifer	SOUDLEYAN		4bα Lower Chasmops Shale	Analocaspis ursina	+	•	•	•
		HARNAGIAN			Decoroproetus gyratus	+	•	•	•

Table I Known distribution of Proetid trilobites in the Middle Ordovician of the Oslo District. Correlation of Shelly succession after Dean 1960.

Greek lettering, introduced by R. & E. Richter (1949, p. 69) to define points on the course of the facial suture is found useful, and the terms beta, gamma, epsilon and zeta are employed herein (see Fig. 1).

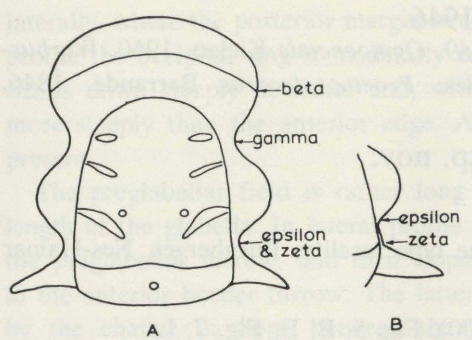

Fig. 1. Generalized proetid cranidium showing the different points on the facial suture indicated by the Greek litteration.
A. Epsilon and zeta as one angle
B. Epsilon and zeta as separate angles.

Orientation and measurement of specimens

To facilitate comparison, measurements are made on cranidia and pygidia wherever possible, and are tabulated under each species. All measurements are in millimetres. The measurements taken are shown in Fig. 2. In the taking of the measurements, and in the photographs, the cranidium is orientated so that the palpebral lobe is horizontal, and the pygidium so that the axial furrow is horizontal.

Systematic descriptions

Family PROETIDAE Salter, 1864, Subfamily PROETIDELLINAE Hupé, 1953.

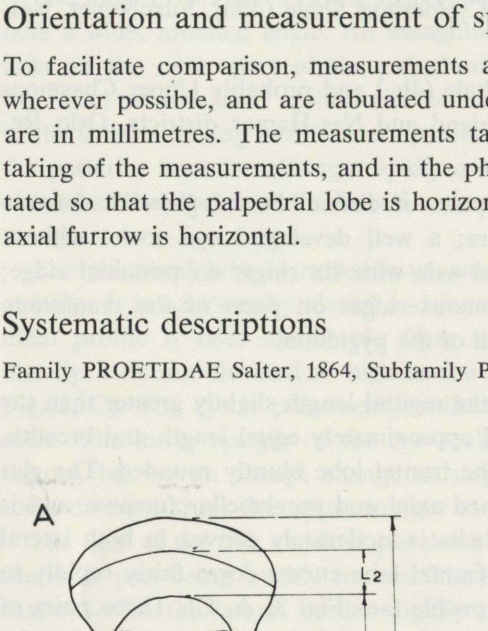

Fig. 2. Orientations and measurements used on the proetid cranidium and pygidium. The cranidium is orientated so that the palpebral lobe is horizontal, and the pygidium so that the axial furrow is horizontal. These orientations are also used in the photographs (Figs. 5–8).

Cranidial measurements: (Fig. 2, A).
L = total length of cranidium (sag.).
L_1 = sagittal length of the glabella.
L_2 = sagittal length of the preglabellar field (except in *Analocaspis ursina*, where L_2 is the sagittal length of the preglabellar field plus the anterior border).
W = width (trans.) of the glabella at its widest point.
δ–δ = palpebral width (trans.) of the cranidium.

Pygidial measurements: (Fig. 2, B).
A = sagittal length of pygidium.
A_1 = sagittal length of pygidial axis.
X = greatest width (trans.) of pygidium.
Y = anterior width (trans.) of pygidial axis.

Genus *Decoroproetus* Přibyl, 1946

(Synonyms *Proetidella* Bancroft, 1949, *Ogmocnemis* Kielan, 1960, *Warburgaspis,* Přibyl, 1946). Type species: *Proetus decorus* Barrande, 1846.

Decoroproetus Furubergensis sp. nov.

Fig. 5, A–K, Fig. 6, E, G–M, Fig. 7, L.

Derivation of the name. – From the type locality, Furuberget, Nes-Hamar district.

Holotype. – A cranidium (PMO 8700), Fig. 5, B, E, Fig. 7, L.
Material. – Besides the type, 12 cranidia 7 free cheeks and 9 pygidia.

Type stratum and type locality. – Cyclocrinus Shale (4bα), Furuberget, Nes-Hamar-district, Oslo Region.

Occurrence. – Upper Chasmops Shale (4bγ) and probably Upper Chasmops Limestone (4bδ); Ringerike, Hadeland and Nes-Hamar districts, Oslo Region, Norway.

Diagnosis. – Glabella with three pairs of distinct lateral glabellar furrows interrupting the glabellar sculpture; a well developed eye socle, without a deep furrow at its base; pygidial axis with six rings; no postaxial ridge; sculpture of fine, raised, discontinuous ridges on parts of the cranidium, free cheeks, and on the axial region of the pygidium.

Description. – The cranidium has the sagittal length slightly greater than the palpebral width. The glabella is of approximately equal length and breadth, narrowing forwards weakly with the frontal lobe bluntly rounded. The glabella is defined by distinct conjoined axial and preglabellar furrows, and is weakly constricted at 2p. The glabella is moderately convex in both lateral and longitudinal profiles, and the frontal lobe curves down fairly rapidly to the preglabellar furrow in lateral profile (see Fig. 3, A, C). Three pairs of glabellar furrows are present, represented by smooth areas in the glabellar sculpture. 1p is situated opposite the anterior end of the palpebral lobe, directed inwards and backwards at about 45° to an exsagittal line. The furrow widens at mid-length, but narrows to a point distally. It does not reach the occipital furrow, and extends about half way towards the sagittal line. Associated with 1p is a small auxiliary impression. 2p is situated opposite gamma, and is directed backwards at about 30° to an exsagittal line, extending a little further inwards than 1p. 3p is situated near the anterolateral corners of the glabella, represented by a small ovate area, isolated from the axial furrow and no larger than the auxiliary impression (see Fig. 7, L).

The occipital furrow is rather deep, shallowing at the lateral ends, with a steep anterior slope and a shallow posterior slope. It is arched forwards weakly sagittally, and at either end. The occipital ring is fairly wide (sag.), about one quarter of the sagittal length of the glabella. It narrows somewhat laterally, where the posterior margin bends forwards quite strongly. In lateral profile the occipital ring is moderatly convex, and in longitudinal profile it bends down steeply at either end, with the posterior edge bending down more steeply than the anterior edge. A small median occipital tubercle is present.

The preglabellar field is rather long (sag.), about one third the sagittal length of the glabella. In lateral profile it is convex immediately in front of the preglabellar furrow, and then slopes down in a weakly concave curve to the anterior border furrow. The latter is poorly defined, indicated merely by the change in slope between the preglabellar field and the anterior border, which is weakly convex and upturned.

The anterior branches of the facial sutures are moderatly divergent, with beta a wide, rounded angle. An exsagittal line drawn backwards from beta falls on the outer part of the palpebral lobe. The posterior branches of the facial sutures have epsilon and zeta as independent angles, this stretch of the suture running more or less parallel with the axial furrow. From zeta the posterior branches diverge rapidly outwards to cut the posterior margin about half way between the lateral end of the occipital ring and the lateral margin.

The palpebral lobe is rather large, about half the sagittal length of the glabella. It is backwardly placed and is semi-elliptical in outline. In longitudinal profile it rises up steeply from the axial furrow, and is flattened distally. It is not elevated as high as the sagittal region of the glabella (see Fig. 3, C). The eye is prominent, reniform, and mounted on a distinct eye socle. The lower margin of the eye socle is not demarcated by a distinct furrow, but by an abrupt change in slope. The lower margin of the eye socle diverges from the upper margin at both anterior and posterior ends.

The field of the free cheek slopes down fairly steeply from the eye region, the inner part being weakly convex. The lateral border furrow is broad and shallow, with the lateral border slightly upturned and weakly convex. The posterior border furrow is narrower and more steep sided than the lateral, with the posterior border quite strongly upturned. The genal spine is fairly long and rather narrow. Fusing near the base of the genal spine, the lateral and posterior border furrows continue on to it as the median furrow, which quickly shallows posteriorly and is hardly perceptible distally.

The cephalon has a sculpture of short, fine, discontinuous ridges, which form a 'broken thumbprint' pattern on the glabella. The ridges are arched forwards on the occipital ring. They are also present on the posterior part of the preglabellar field, and on the inner part of the anterior border of the holotype. On smaller specimens the latter area is smooth. While discontinuous ridges are found on the inner part of the free cheek, the outer part and the lateral border region are smooth. On the palpebral lobe the discontinuous ridges run forwards and outwards. On the anterior and lateral borders, and on the inner of the genal spine there are two or three strong, subparallel, raised striae.

The pygidium is of subparabolic outline, without a border, and about twice as wide as long on larger specimens, but proportionately longer in smaller specimens (cf. Fig. 6, G and Fig. 6, J) Anteriorly the axis occupies about one third of the total pygidial width, tapering gradually backwards to the bluntly rounded posterior end, not reaching the posterior margin. There is no postaxial ridge. The axis consists of six rings and a short end piece. In lateral view the axis slopes gently backwards, sloping down steeply at the posterior end where it forms a continuous concave curve with the postaxial area (see Fig. 4, A and Fig. 5, G). Each axial ring is weakly convex in lateral profile, with the first ring elevated considerably above the remainder. In longitudinal profile the axis is strongly arched (see Fig. 4, C and Fig. 5, K). The pleural areas have four or five pairs of ribs, which curve gently backwards. Each rib consists of an anterior and posterior pleural band of approximately equal width, and widens distally. The pleural furrow is strong, deepening distally with a steep anterior slope and a shallower posterior slope. The interpleural furrow is rather weak, evident along its entire length and deepening distally. The pleural and interpleural furrows turn backwards quite sharply distally, and the first three or four pairs reach the pygidial margin.

The pygidial axis has a sculpture of forwardly arched, discontinuous ridges. Sometimes these occur on the most anterior pleural band (e. g. Fig. 6, J). The pleural areas are otherwise almost devoid of sculpture, apart from occasional short striae. At the margin there are two or three fine, continuous ridges, which run subparallel to it.

Dimensions (in millimetres). –

Cranidia

Specimen no.	L	L_1	L_2	W	δ–δ
Holotype					
PMO 8700	9.9	5.4	2.5	5.6	?8.0
PMO 68283		1.9	?0.5	2.0	2.9
PMO 68504		3.2	0.9	3.1	4.6
PMO 70442	?3.1	1.8	0.5	2.0	?3.0
PMO 70460		2.7		2.7	4.0
PMO 20649	4.1	2.3	0.7	2.4	3.5
PMO 8816	2.8	1.6	0.5	1.6	?2.2
PMO 8817	3.6	2.1	0.4	2.1	3.0
PMO 8818	3.3	1.8	0.6	1.7	?2.7

Pygidia

Specimen no.	A	A_1	X	Y
PMO 8692	3.5	2.7	?6.8	2.0
PMO 8694	3.7	2.9	?7.0	2.0
PMO 20654	4.5	3.6	9.0	3.0
PMO 70447	3.0	2.4	5.5	2.0
PMO 68281	2.5	2.1	4.8	1.6

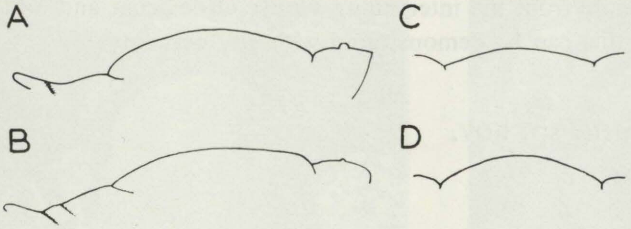

Fig. 3. Lateral and longitudinal profiles of the cranidia of *Decoroproetus furubergensis* sp. nov. (A and C) and *Decoroproetus solenotus* sp. nov. (B and D). The lateral profile is taken along the sagittal line, and the longitudinal profile along δ–δ.

Discussion. – *Decoroproetus furubergensis* is one of the more abundant Middle Ordovician proetids in the Oslo Region. The small differences exhibited between different specimens (cf. Fig. 5, A and E) are taken to be minor intraspecific variations (e.g. glabellar outline, presence or absence of small sculptural elements, degree of convexity of border,etc.). Most of the material comes from the Upper Chasmops Shale or its equivalents, but one cranidium and two free cheeks (Fig. 5, D, H) are from beds of probable Upper Chasmops imestone age.

From the Middle Ordovician outside Norway, *Decoroproetus furubergensis* may be compared with *Decoroproetus jamesoni* (Reed, 1914, Pl. 4, Fig. 8) from the Balclatchie Mudstones of the Girvan area, and with three species of *Proetidella* recently described by Ross (1967, Pl. 2, Figs. 8–18), from the Lexington Limestone of Kentucky. Both these species and *D. furubergensis* share similar glabellar shapes and pygidial proportions, the latter being proportionately shorter than in *Decoroproetus fearnsidesi* (Bancroft) (see Dean, 1963, Pl. 45, Fig. 3). The sculpture of discontinuous ridges of *D. furubergensis* is in contrast to that of *D. fearnsidesi* and many other species of *Decoroproetus,* where the ridges are continuous and cover the entire exoskeleton.

The length-breadth proportions of the pygidium, the number of axial rings (six) and the lack of the postaxial ridge in *D. furubergensis* invite comparison with species of *Cornuproetus (Lepidoproetus)* Erben, 1952, especially *C. (L). regulus* Haas, 1968 from the Lower Devonian of northwestern Turkey (see Haas 1968, Pl. 27, Figs. 15–22 and Text Fig. 9, p. 83). *C. (L). regulus* has an overall similar appearance to *D. furubergensis* but has a number of small differences, notably the wider (sag.) occipital ring, the broader cephalic border, the smaller number of pygidial axial rings (four) and the pygidial pleural ribs bending backwards less strongly. There is a great age difference between the two species, so that the similarity between them may be purely fortuitous. Conversely it may be due to a true phylogenetic

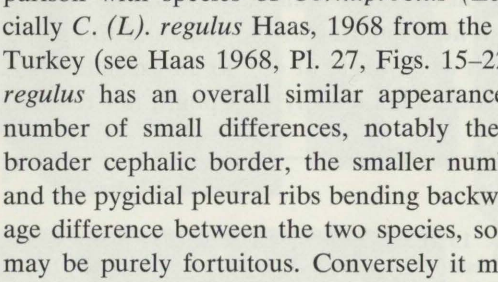

Fig. 4. Lateral and longitudinal profiles of the pygidia of *Decoroproetus furubergensis* sp. nov. (A and C) and *Decoroproetus solenotus* sp. nov. (B and D). The lateral profile is taken along the sagittal line, and the longitudinal profile along a transverse line crossing the first axial ring.

relationship, but evidence from the intervening Upper Ordovician and Silurian is needed before this can be demonstrated with any certainty.

Decoroproetus gyratus sp. nov.

Fig. 6, A, B, D, Fig. 7, M.

Derivation of the name. – From the Latin *gyratus,* turned around, referring to the arrangement of striae on the preglabellar field.

Holotype. – A cranidium (PMO 8702), Fig. 6, A, Fig. 7, M.

Material. – Besides the type, one cranidium (PMO 63296), Fig. 6, B, D.

Type Stratum and type locality. – Lower Chasmops Shale (4bα), shore section below the parking place to Fornebu Airport, Bærum near Oslo.

Occurrence. – Lower Chasmops Shale, the type locality and Bygdøy, Oslo–Asker Region.

Diagnosis. – Glabella with faint, non-impressed lateral furrows. Preglabellar field almost straight in lateral profile. Sculpture of dense, continuous striae, those on the anterior part of the preglabellar field arranged in a transversely elongated concentric pattern.

Description. – The cranidium has the sagittal length considerably greater than the palpebral width. The glabella is a little longer than broad in the holotype, narrowing forwards weakly to the bluntly rounded frontal lobe. The glabella is slightly constricted in front of the palpebral lobe, and in lateral profile slopes down gently from posterior to anterior in a weakly convex curve. In longitudinal profile it is quite strongly convex. Two pairs of lateral glabellar furrows are present on the holotype, interrupting the striated sculpture. (see Fig. 7, M). On the other cranidium (PMO 63296) the furrows are not discernible. 1p is a little anterior to the centre of the palpebral lobe, and is directed backwards at an angle of 45° to an exsagittal line. The furrow widens at mid length and tapers distally to a point, not reaching

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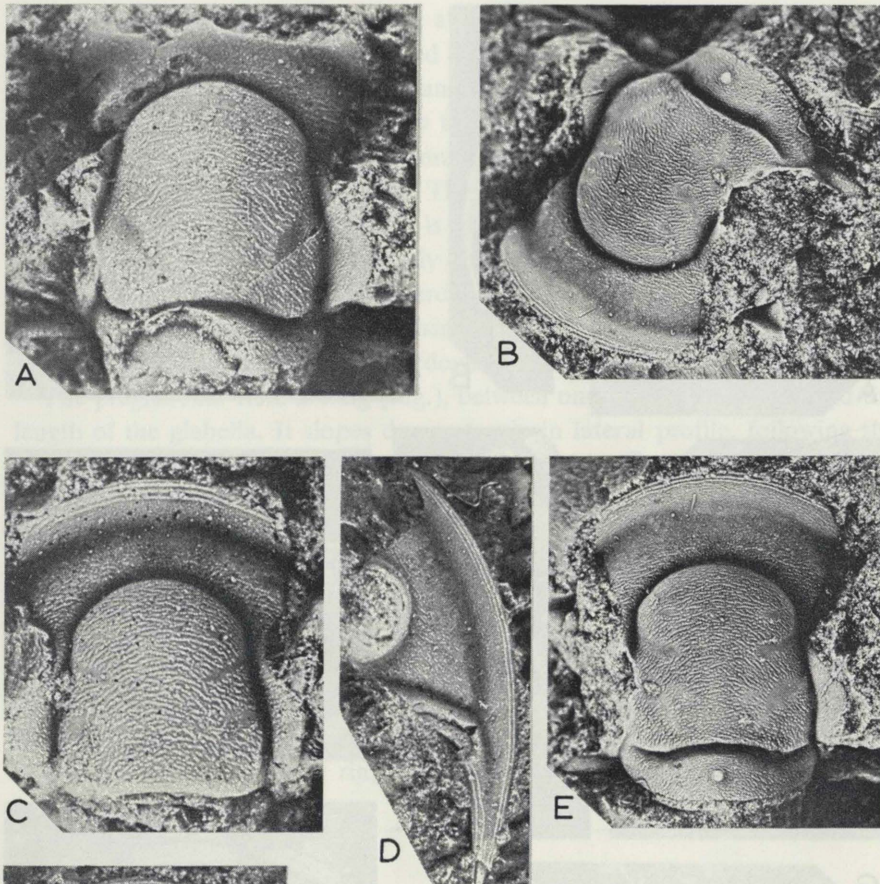
Fig. 5.
Decoroproetus furubergensis sp. nov.
A. C, F. Cranidia, dorsal view. A, × 15 (PMO 68283); C, × 9 (PMO 68504)); F, × 15 (PMO 8816). Probably Upper Chasmops Shale (4bγ), forest track between Nerby and Helgehagen, Lunner, Hadeland. Coll. L. Størmer, 1951.
B, E. Holotype, cranidium, × 4½ (PMO 8700). B, anterior oblique view. Cyclocrinus shale (4bγ), Furuberget, Nes-Hamar. Coll. O. Holtedahl, 1907.
D. Free cheek, dorsal view. × 7 (PMO 70462). Probably Upper Chasmops Limestone (4bδ), at the road, Lyngstad, South Granåsen, Gran, Hadeland. Coll. L. Størmer and G. Henningsmoen, 1941.
H. Cranidium, dorsal view. × 10 (PMO 70460). Other data as for D.
G, J, K. Pygidium, × 7 (PMO 8694). G, lateral view, J, dorsal view, K, posterior view. Upper Chasmops Shale (4bγ), Vestbråten, Røyse, Ringerike. Coll. J. Kiær, 1920.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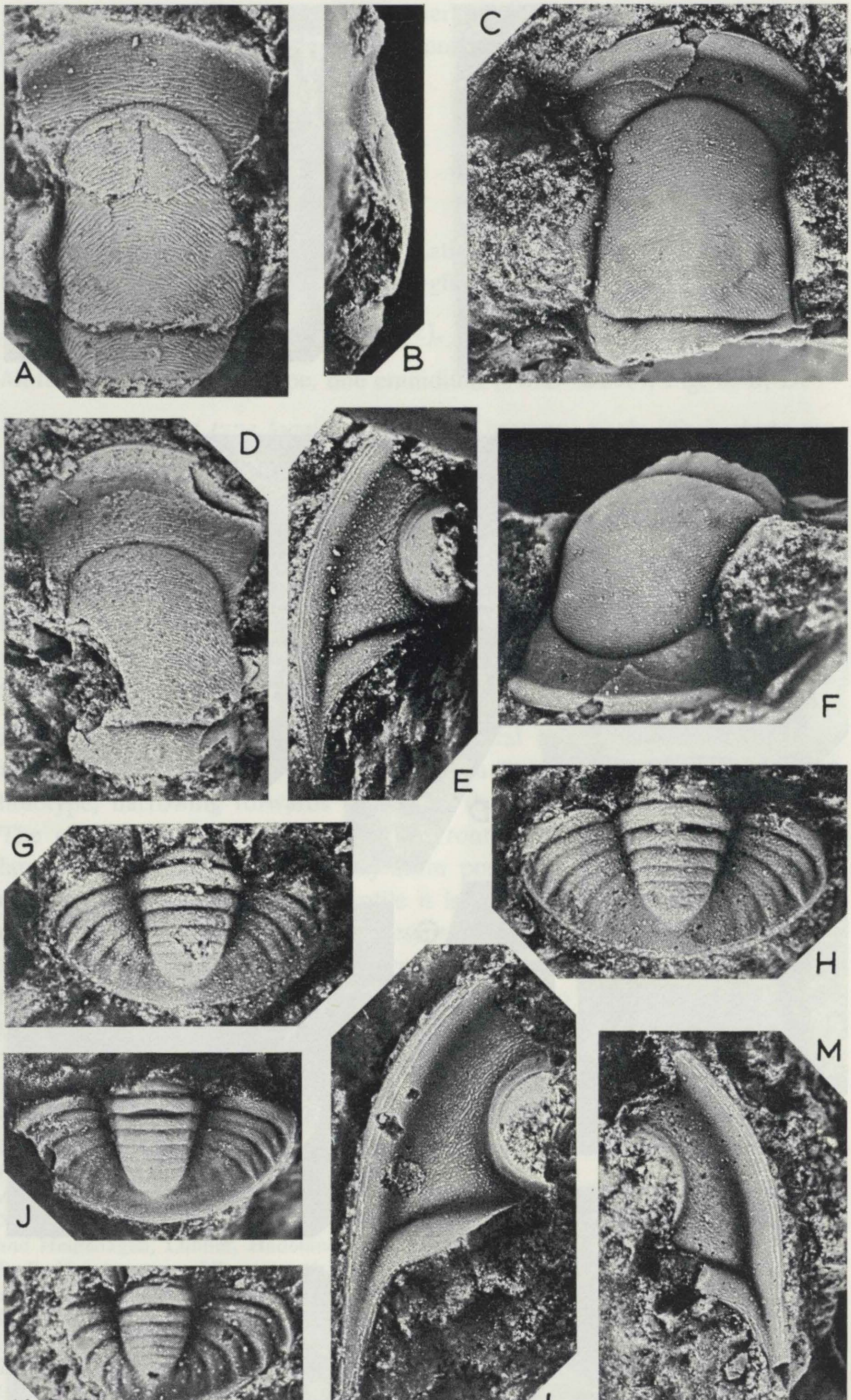
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the occipital furrow and extending about one third of the way inwards towards the sagittal line. 2p is situated opposite the anterior end of the palpebral lobe, and is directed inwards and slightly backwards. It widens a little distally and extends about half way towards the sagittal line.

The occipital furrow is deep, running transversely for most of its length, but bending forwards at either end. The occipital ring is a little shorter (sag.) than the preglabellar field, and it is about the same width as the glabella (trans.). It narrows only very slightly laterally, and lacks the lateral occipital lobes. A small, distinct median tubercle is present. In lateral profile the occipital ring is very weakly convex, rising up gently from the occipital furrow, and in longitudinal profile it bends down steeply at either end.

The preglabellar field is long (sag.), between one quarter and one third the length of the glabella. It slopes down steeply in lateral profile, following the same contour as the frontal lobe of the glabella, and is almost straight (see Fig. 6, B). The anterior border furrow is ill defined, represented by a change in slope between the downsloping preglabellar field and the wide, weakly convex anterior border.

The anterior branches of the facial sutures are strongly divergent, with beta forming a wide curve. An exsagittal line drawn backwards from beta falls on the outer part of the palpebral lobe. Gamma is close to the axial furrow, near the constriction of the glabella. The posterior branches of the facial sutures have epsilon and zeta as apparently one angle, close to the lateral end of the occipital ring. From here the posterior branches diverge

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Fig. 6.

Decoroproetus gyratus sp. nov.

A. Holotype, cranidium, × 7 (PMO 8702), dorsal view. Lower Chasmops Shale (4bα); shore section below the parking place to Fornebu Airport ,Bærum, Oslo. Coll. R. M. Owens, 1969.

B, D. Cranidium, × 7 (PMO 63296). B, dorsal view, D, lateral view. Lower Chasmops Shale (4bα), Bygdøy, Oslo.

Decoroproetus sp. A.

C, F. Cranidium, × 12½ (PMO 61018c). C, dorsal view, F, anterior oblique view. Upper Chasmops Limestone (subzone of *Tretaspis kiaeri*, 4bδ_2); western side of Frognøy, Lake Tyrifjorden, Ringerike. Coll. J. Kiær, 1914.

Decoroproetus furubergensis sp. nov.

E, Free cheek, dorsal view, × 8 (PMO 8693). Upper Chasmops Shale (4bγ), Vestbråten, Røyse, Ringerike. Coll. J. Kiær, 1920.

G, H. Pygidia, dorsal view. G, × 8 (PMO 68281); H, × 8 (PMO 70447). Probably Upper Chasmops Shale (4bγ), forest track between Nerby and Helgehagen, Lunner, Hadeland. Coll. L. Størmer, 1951.

J. Pygidium, dorsal view. × 4½ (PMO 20654). Other data as for E.

L, M. Free cheeks, dorsal view. L, × 8½ (PMO 68285); M, × 7 (PMO 68287). Other data as for G.

Decoroproetus solenotus sp. nov.

K. Pygidium, dorsal view. × 21 (PMO 8696). Upper Chasmops Limestone (4bδ_1), 1.7 m. below the top; N. Raudskjær, Asker. Coll. F. Nikolaisen, 1967.

strongly outwards. The palpebral lobe is large, approaching half the length of the glabella, backwardly placed and crescentic in outline. In longitudinal profile it rises up quite steeply from the axial furrow, but soon flattens out. The palpebral lobe is considerably below the height of the sagittal region of the glabella.

The entire cranidium has a sculpture of dense, continuous, raised striae, arranged in a Bertillon pattern. On the preglabellar field they are not so dense, and are arranged in a transversally elongated concentric pattern (see Fig. 6, A).

The remainder of the exoskeleton is unknown.

Dimensions (in millimetres). –

Specimen no.	L	L_1	L_2	W	δ–δ
Holotype PMO 8702	7.1	4.5	1.3	3.7	?5.0
PMO 63296	6.5	3.5	1.3	?3.2	

Discussion. – The two cranidia upon which this species is based are distinctive in the arrangement of the striae on the anterior part of the preglabellar field. The two specimens differ from one another in the distinctness of the lateral glabellar furrows, and on the holotype they are clearly indicated, while on the other specimen they are hardly discernible.

In its glabellar shape, *D. gyratus* is similar to *'Proetidella* sp. B' of Tripp (1967, Pl. 2, Figs. 15–16) from the Middle Ordovician Upper Stinchar Limestone of the Girvan district. The Girvan specimens are too badly preserved to ascertain whether they are conspecific with the Norwegian species.

Decoroproetus solenotus sp. nov.

Fig. 6, K and Fig. 7, A–K.

Derivation of the name. – From the Greek *solenotos,* channeled, alluding to the shallow depression running parallel to the anterior border.

Holotype. – A cranidium (PMO 70437), Fig. 7, B, C, K.

Material. – Besides the type, 3 cranidia, 3 free cheeks and 2 pygidia.

Type stratum and type locality. – Upper Chasmops Limestone ($4b\delta_1$), 1.7 metres below the top, N. Raudskjær, Asker.

Occurrence. – Upper Chasmops Limestone ($4b\delta_1$); Oslo–Asker and Ringerike districts.

Diagnosis. – Cephalon with a shallow depression running subparallel to the border; preglabellar field almost straight in lateral profile; eye socle well developed, with a distinct furrow at its lower margin; sculpture of very fine, discontinuous striae and minute granules.

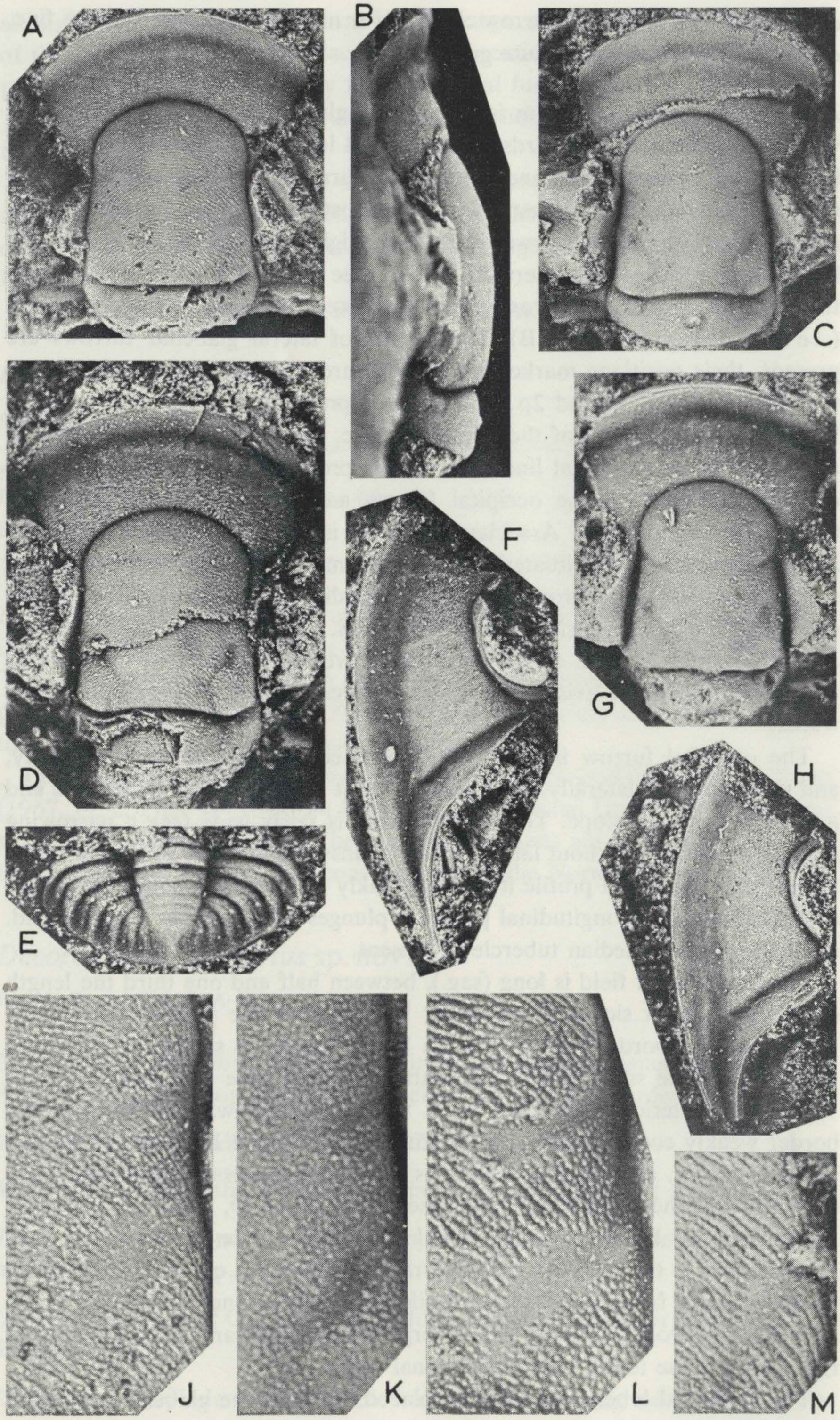
Description. – The cranidium is rather strongly vaulted, with the palpebral width approximately two thirds of the sagittal length. The glabella is defined by shallow, conjoined axial and preglabellar furrows, and is marginally longer than it is wide. From its widest point, at the posterolateral angles, the glabella narrows very gradually forwards and is slightly constricted laterally. In longitudinal profile it is moderately convex (see Fig. 3, D), and in lateral profile it slopes down gently from anterior to posterior, and is weakly convex (see Fig. 3, B and Fig. 7, B). Three pairs of lateral glabellar furrows are present, their positions marked by smooth areas in the glabellar sculpture (see Fig. 7, J, K). 1p and 2p are weakly impressed. 1p is situated more or less opposite the centre of the palpebral lobe, and is directed backwards at about 45° to an exsagittal line. It is widest proximally and narrows rapidly distally, not reaching the occipital furrow and extending about half way towards the sagittal line. Associated with 1p is a small, inconspicuous auxiliary impression. 2p is situated opposite gamma and is narrower and rather shorter than 1p, and is directed inwards and slightly backwards. It is weakly curved with the convex side facing backwards. 3p is inconspicuous, situated a short distance in front of 2p, near the anterolateral corner of the glabella and isolated from the axial furrow, and directed inwards and noticeably forwards.

The occipital furrow is rather deep, arched forwards weakly sagittally, and more strongly laterally. In lateral profile it has a deep anterior slope and a shallow posterior slope. The occipital ring is fairly wide (sag.), narrowing markedly laterally, without lateral lobes. Transversely it is a little wider than the glabella. In lateral profile it is very weakly convex, and slopes up noticeably backwards. In longitudinal profile it plunges down steeply at either end. A small, distinct, median tubercle is present.

The preglabellar field is long (sag.), between half and one third the length of the glabella. It slopes down rather steeply from the preglabellar furrow to the anterior border furrow, and its lateral profile is straight and follows more or less the same line as the glabellar profile (see Fig. 3, B and Fig. 7, B). The anterior border furrow is wide and shallow, with the anterior border weakly convex and slightly upturned. Running a little way inside the anterior border, and parallel with it, is a shallow depression, indicated by a dark band on the preglabellar field (see Fig. 7, A, C, D, and G).

The anterior branches of the facial sutures are strongly divergent, with gamma close to the glabella. Beta is a rather wide, open curve. The posterior branches of the facial sutures have epsilon and zeta as one angle, close to the axial furrow. From this point they diverge strongly outwards to cut the posterior margin close to the base of the genal spine.

The palpebral lobe is backwardly placed, close to the glabella and about half its length, and is subcrescentic in outline. In longitudinal profile it rises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up at angle of 35–40° (see Fig. 3, D), gradually flattening distally. The eye is reniform, rather large and mounted on a distinct eye socle, whose base is demarcated by a distinct furrow, which diverges markedly at either end from the upper margin of the eye socle.

From the eye, the field of the free cheek slopes down quite rapidly to the lateral border furrow. The latter, like the anterior border furrow, is shallow and rather wide. Outside it, lies the rather wide, upturned lateral border. The depression on the preglabellar field continues onto the free cheek, converging with the lateral border near the base of the genal spine (see Fig. 7, F, H). The posterior border furrow has a steep anterior slope and this terminates at the genal spine. The posterior border is rather narrow, and upturned. The genal spine is broad based and tapers rapidly backwards, and bears a wide median groove, produced by the merging of the lateral and posterior border furrows.

The cranidium has a sculpture of very fine, short raised striae, which are arched forwards sagittally on the glabella and occipital ring. They are almost reduced to granules on parts of the glabella and the preglabellar field. The regions of the anterior, lateral and posterior border furrows are almost smooth. On the cephalic border the sculpture is markedly granular. Distinct raised striae occur on the margins of the cephalon, running parallel with it.

The thorax is unknown, but two early holaspid pygidia belonging to this species posses one attached thoracic segment. This lacks the preannulus, and the pleuron has a deep, distinct pleural furrow. The distal end of the pleuron is turned backwards and is bluntly pointed.

Fig. 7.
Decoroproetus solenotus sp. nov.
A. Cranidium, dorsal view, × 10 (RM Ar 37442). ?Upper Chasmops Limestone (4bδ); Ringsåsen, Ringerike. Coll. G. Holm, 1877.
B, C. Holotype, cranidium (PMO 70437). B, lateral view, × 17, C, dorsal view, × 12½. Upper Chasmops Limestone (4 bδ_1), 1.7 m. below the top; N. Raudskjær, Asker. Coll. F. Nikolaisen, 1967.
D. Cranidium, dorsal view, × 7 (PMO 70497). Upper Chasmops Limestone (4bδ_1), close to the top; Kalvøya, N, E. Bærum. Coll. G. Henningsmoen, 1962.
E. Pygidium, dorsal view, × 22 (PMO 8695). Other data as for B.
F. Free cheek, dorsal view, × 7 (PMO 70494). Upper Chasmops Limestone (4bδ_1); 2 m. below the top, Terneholmen, Asker. Coll. F. Nikolaisen, 1967.
G. Cranidium, dorsal view, × 8 (PMO 70495). Other data as for F.
H. Free cheek, dorsal view, × 7½ (PMO 8703). Other data as for F.
H. Free cheek, dorsal view, × 7½ (PMO 8703). Other data as for F.
Detail of the lateral glabellar furrows of *Decoroproetus furubergensis, D. gyratus* and *D. solenotus.*
J, K. *Decoroproetus solenotus.* J, × 35 (RM Ar 37442), K, holotype, × 50 (PMO 70437). For other data see Fig. 7, A and B.
L. *Decoroproetus furubergensis,* holotype, × 18 (PMO 8700). For other data see Fig. 5, B.
M. *Decoroproetus furubergensis,* holotype, × 19 (PMO 8702). For other data see Fig. 6, A.

The early holaspid pygidium is of subparabolic outline, without a border. The axis is about one third of the width (trans.) of the pygidium anteriorly. It tapers backwards quite rapidly and terminates in a bluntly pointed end, which does not reach the posterior margin. A short postaxial ridge is present. The axis consists of five rings and a short end piece. In lateral profile the axis slopes down moderately rapidly towards the posterior (see Fig. 4, B), and each axial ring is weakly convex. The pleural areas have four pairs of ribs, with strong pleural and weak interpleural furrows, which turn strongly backwards distally. The pleural furrows deepen considerably distally, and possess a deep anterior slope and a rather shallow posterior slope. The interpleural furrows are narrow and shallow and are only immediately evident distally, although they can be traced inwards almost to the axial furrow.

Dimensions (in millimetres). –

Cranidia. Specimen no.	L	L_1	L_2	W	δ–δ
Holotype PMO 70437	3.6	2.0	0.8	1.8	2.3
PMO 70497	7.5	4.0	1.5	3.5	?4.8
PMO 70495	6.0	3.4	1.2	2.9	4.0
RM Ar. 37442	4.3	2.5	0.9	2.4	2.8

Pygidia. Specimen no.	A	A_1	X	Y
PMO 8695	1.0	0.7	1.7	0.5
PMO 8696	0.9	0.7	?1.8	0.5

Discussion. – The profile of the preglabellar field and glabella is close to that of *Decoroproetus matutinus* (Ruedemann) from the Middle Ordovician of New York State. In most other species of *Decoroproetus* the preglabellar field is concave or sigmoidal in profile. The only information available on the pygidium of *D. solenotus* is from two early holaspid specimens. These have a small number of axial rings (five) and a distinct postaxial ridge. They resemble the transitory and early holaspid pygidia of *Denemarkia frontalis* (see Erben 1966, Pl. 19, Figs. 1–4) and the pygidium of *Phaseolops sepositus* (see Whittington 1963, Pl. 5, Figs. 1–6). In all three a range of common pygidial features is evident; the backwardly turned pleural ribs, the deep pleural furrows and the small number of axial rings. Other parts of the exoskeleton do not correspond so well, but the glabellar outline and the strongly divergent anterior branches of the facial sutures are features shared by all three species. *Phaseolops sepositus* and *Denemarkia frontalis* show far greater similarities to one another than does either of them to *Decoroproetus solenotus*. The similarity of the pygidial and other features might suggest some relationship, but the age difference between the three species is great (*P. sepositus* Llanvirn, *D. solenotus,* Caradoc and *D. frontalis,* Lower Devonian) and makes any relationship highly unlikely. The resemblance of *Phaseolops sepositus* to undoubted proetids supports Whittington's (1963, p. 40) contention that it is one.

Decoroproetus sp. A

Fig. 6, C, F.

Material. – One cranidium (PMO 61018c), on the same piece of rock as *Frognaspis stoermeri* Nikolaisen (figd. Nikolaisen, 1965, Pl. 2, Fig. 4).

Horizon and Locality. – Upper Chasmops Limestone (4 bδ_2), subzone of *Tretaspis kiaeri;* western side of Frognøy Island, Lake Tyrifjorden, Ringerike.
Description. – The cranidium has the palpebral width about three-quarters of the sagittal length. The glabella is slightly longer (sag.) than it is wide (trans.) and is defined by narrow, distinct, conjoined axial and preglabellar furrows. It is widest at the posterolateral corners, and tapers gradually forwards to the anterolateral corners, with a bluntly angular frontal lobe. The glabella is slightly constricted opposite gamma, and is moderately convex in lateral and longitudinal profiles. Three pairs of lateral glabellar furrows are present, which are weakly impressed on the glabellar surface and interrupt the striated sculpture. 1 p is situated opposite the centre of the palpebral lobe and is directed backwards at about 45° to an exsattigal line. The proximal part is wide, while the distal part is rather narrow, and the whole furrow extends about two thirds of the way towards the sagittal line. 2p is situated opposite the anterior part of the palpebral lobe, and is about the same width as the distal part of 1p, and is directed backwards a little less strongly than 1p. 2p is about the same length as the proximal part of 1p. 3 p is situated just behind the anterolateral corner of the glabella, is about the same length as 2 p and is directed slightly forwards. There is an inconspicuous auxiliary impression associated with 1 p, situated between the proximal part of 1 p and the sagittal line.

The occipital furrow is rather narrow, and is deeper than the axial and preglabellar furrows. It widens slightly about half way beween the sagittal line and the lateral end. The occipital furrow runs transversely for most of its length, and curves forwards slightly at either end. It does not run into the axial furrow due to the fusion of the posterolateral corner of the glabella with the anterolateral corner of the occipital ring. The occipital ring is apparently of about the same width (sag.) as the preglabellar field, and is a little wider (trans.) than the glabella. It apparently maintains more or less the same width along its length (sag. and exsag.), and narrows slightly at the extreme lateral ends. There are no lateral occipital lobes, but there is a small, distinct median tubercle.

The preglabellar field is short (sag.), about one sixth the sagittal length of the glabella. The anterior border furrow is wide and shallow, its position being indicated by the change in slope between the downsloping preglabellar field and the upturned, weakly convex anterior border, which is about four fifths the length (sag.) of the preglabellar field.

The anterior branches of the facial sutures are quite strongly divergent, with gamma close to the axial furrow. Beta forms a wide curve, and an exsagittal line drawn backwards from it falls on the outer margin of the palpebral lobe. The posterior branches of the facial sutures have epsilon close to the axial furrow at the lateral end of the occipital ring. They diverge strongly on the posterior border, and presumably cut the posterior margin close to the base of the genal spine.

The palpebral lobe is rather narrow, crescentic in outline, nearly half the sagittal length of the glabella and backwardly placed. It bends up strongly from the axial furrow and flattens out distally, and is not elevated to the height of the sagittal region of the glabella.

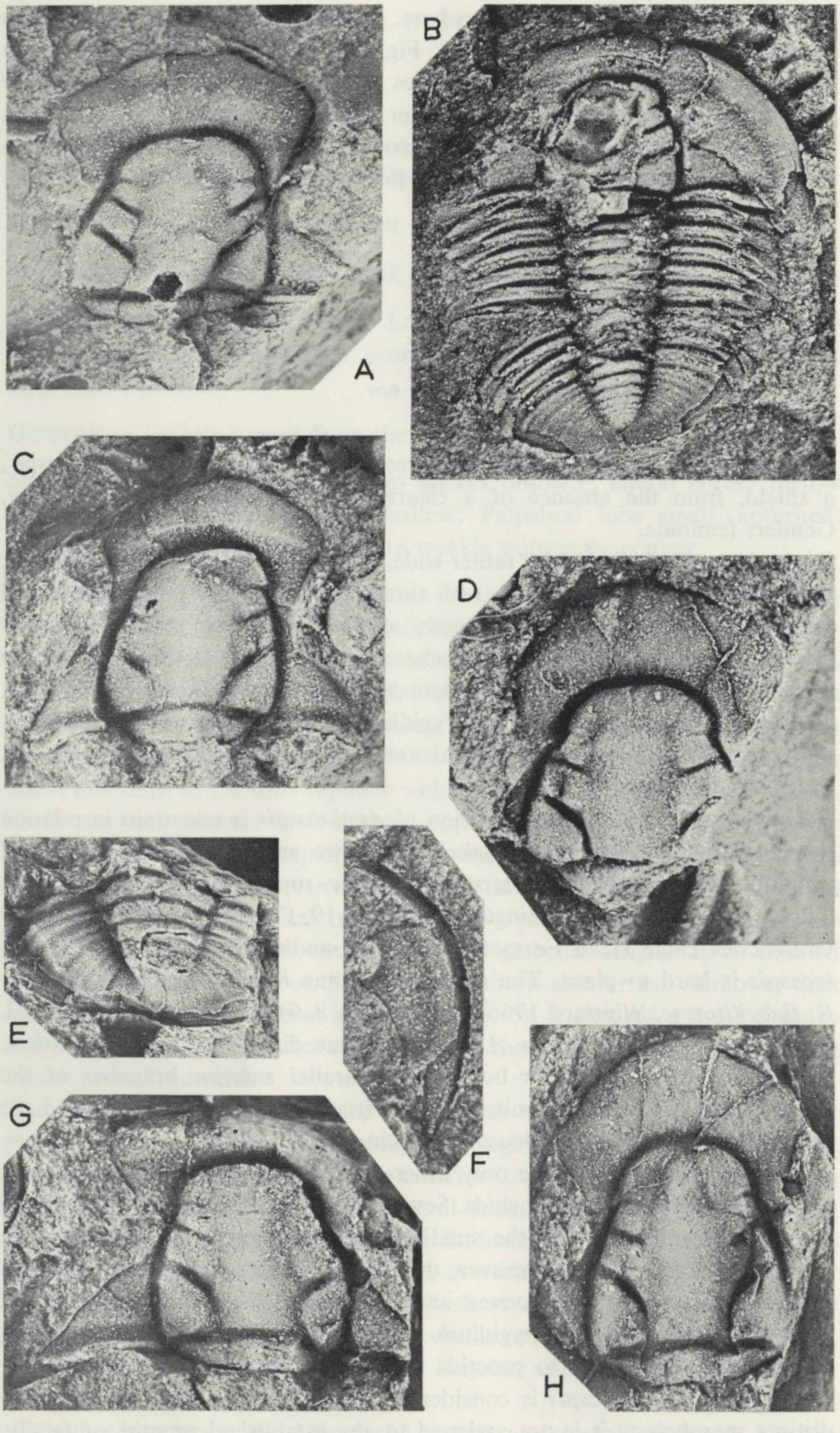
The cranidium has a sculpture of fine, raised striae, arranged in a Bertillon pattern on the glabella and occipital ring. On the preglabellar field they run transversely, on the anterior border inwards and slightly forwards and on the palpebral lobe, forwards and outwards. The striae are interspersed with rows of fine granules on parts of the cranidium, particularly on the lateral parts of the glabella.

Dimensions (in millimetres). –

Specimen no.	L	L_1	L_2	W	δ–δ
PMO 61018c	?3.6	2.4	0.4	2.2	2.7

Discussion. – This single cranidium is the youngest proetid known from the Middle Ordovician of the Oslo Region, and does not particularly resemble the other species described herein. It differs from them principially in the short preglabellar field and in its glabellar outline. These features are

Fig. 8.
Analocaspis ursina gen. et sp. nov.
A, C, D, G, H. Cranidia, dorsal view. A, × 7 (PMO 70451); C, × 7 (PMO 70450); D, × 7 (PMO 70449); G, × 7 (PMO 70453); H, × 6 (PMO 70454).
B. Holotype, a nearly complete exoskeleton, dorsal view, × 7 (PMO 8701).
E. Pygidium, dorsal view, × 6 (PMO).
F. Free cheek, dorsal view, × 9 (PMO 70449, on the same slab as D).
All from the Lower Chasmops Shale (4bα); Bjørnsvikveien, close to the syenite dyke, near Drammensveien at Slependen, Bærum, Oslo-Asker. E coll. R. M. Owens, 1969, all the rest coll. J. F. Bockelie, 1966.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comparable with species from elsewhere, particularly *'Proetus' kullsbergensis* Warburg, 1925 (see Warburg, Pl. 5, Fig. 24), from the Middle Ordovician Kullsberg Limestone and a new species of *Decoroproetus* from the Lower Ashgill of the British Isles. The former species differs from *D.* sp. A. in having the occipital ring markedly narrowing laterally, and the latter in having a more bluntly rounded frontal lobe of the glabella.

Subfamily UNCERTAIN

Genus *analocaspis* gen. nov.

Type species: *Analocaspis ursina* gen. et sp. nov.

Derivation of the name. – From the Greek *an,* no, *alox,* a furrow, and *aspis,* a shield, from the absence of a clearly marked anterior border furrow. Gender: feminine.
Diagnosis. – Cephalic border rather wide, weakly convex and poorly defined; Glabella of trapezoidal outline, with three pairs of deeply impressed lateral furrows; Preglabellar field extremely short (sag.); Eye small, forwardly placed; Anterior and posterior branches of facial suture both divergent, the posterior delimiting a small triangulate posterior portion of the fixed cheek; Thorax of at least nine segments; Pygidium of subparabolic outline, without a border; Axis of six rings, pleural areas with four or five pairs of ribs, which extend almost to the margin.
Discussion. – The taxonomic position of *Analocaspis* is uncertain in relation to other proetids. The deep glabellar furrows and the sagittally widened occipital ring can be compared with other supposed proetids, such as *'?Phaseolops* sp. ind.' (Whittington, 1965, Pl. 19, Figs. 1–5) from the Middle Ordovician Table Head Formation of Newfoundland, but which like *Analocaspis* is hard to place. The interesting genus *Rorringtonia* (type species *R. flabelliforme,* Whittard 1966, Pl. 50, Figs. 8–9) which may be a proetid, bears some resemblance to *Analocaspis,* but differs in several features, notably the narrow anterior border, the parallel anterior branches of the facial sutures, the larger number of rings (ten) on the pygidial axis and the larger number of pygidial pleural ribs (nine).
Apart from the proetids, the only other group to which *Analocaspis* shows any resemblance is the calymenids. Several features of *Analocaspis* are found in the calymenids, notably the small, forwardly placed eyes and the deep lateral glabellar furrows. However, the strongly divergent anterior branches of the facial sutures, the convex anterior border, the number of thoracic segments and the type of pygidium are all proetid rather than calymenid, and thus the similarities to proetids far outweigh those to calymenids. For these reasons *Analocaspis* is considered to be a proetid, but because of its distinct morphology it is not assigned to any established proetid subfamily.

Analocaspis ursina gen. et sp. nov.

Fig. 8, A–H.

Derivation of the name. – From the Latin *ursina,* pertaining to bears, alluding to the name of the type locality, Bjørnsvikveien ('Bears' Bay Road').

Holotype. – An almost complete specimen (PMO 8701), Fig. 8, B.

Material. – 9 cranidia, 1 free cheek and 1 pygidium.

Type stratum and type locality. – Lower Chasmops Shale (4bα), Bjørnsvikveien, close to the syenite dyke, near Drammensveien at Slependen, Bærum, Oslo-Asker district.

Occurrence. – Only known from the type locality.

Diagnosis. – Anterior border furrow almost obsolete; lateral border furrow more clearly defined, but very shallow; Palpebral lobe small, upturned; Posterior branch of the facial suture weakly outwardly convex.

Description. – The cephalon is rather weakly vaulted, more or less semicircular in outline with a poorly defined border. The glabella has a trapezoidal outline and is weakly convex in lateral and longitudinal profiles. It is defined by the deep, conjoined axial and preglabellar furrows, and tapers forwards quite rapidly from its widest point, just behind the lp furrows. Anteriorly it is bluntly truncated. At its widest (trans.) the glabella occupies about one third of the total cephalic width. Three pairs of deep lateral glabellar furrows are present. 1p is situated opposite epsilon. It is almost obsolete proximally, but deepens rapidly inwards and is bent backwards at an angle of between 45° and 50° from an exsagittal line. Posteriorly it shallows and runs into the occipital furrow, thereby partially isolating triangulate 1p lobes, which are about one third of the glabellar length. 2p is situated opposite the anterior part of the palpebral lobe, is shorter and shallower than 1p, and is bent backwards at a similar angle. 3p is situated a short distance in front of 2p, and is shorter and shallower than the other furrows, running almost straight inwards.
The occipital furrow is about the same depth as the axial and preglabellar furrows, and is arched gently forwards sagittally. In lateral profile the posterior slope is shallower than the anterior slope. The occipital ring widens sagittally, and is narrower at the lateral ends, and lacks lateral lobes. In longitudinal profile it slopes downwards from the sagittal region to the lateral extremities, and in lateral profile is weakly convex.

The preglabellar field is extremely short (sag.). The anterior border furrow is very poorly defined, and is invisible on some specimens (cf. Fig. 8, D and Fig. 8, H). The anterior border is rather wide, and is weakly convex in lateral profile.

The anterior branches of the facial sutures are strongly divergent. On the holotype and certain other specimens (e. g. Fig. 8, B, D), beta is a rounded curve, while on other specimens (e. g. Fig. 8, C, G), beta is markedly angular. This difference is probably the result of deformation. The posterior branches of the facial sutures run outwards and backwards from the palpebral lobes, to cut the posterior margin just inside the inner margin of the genal spine, producing a small triangulate posterior portion of the fixed cheek.

The palpebral lobe is well forwards, more or less opposite the 2p furrow. It is situated a little way out from the axial furrow, and is rather small and upturned. The eye is small and reniform. The free cheek is weakly convex in profile, sloping down gently from the eye to the weak, shallow, lateral border furrow. The lateral border is rather wide and weakly convex. The inner part of the posterior border furrow is of comparable depth to the axial furrow, but it rapidly widens and shallows laterally, so that outside the facial suture it is about the same depth as the lateral border furrow. The genal spine is short, broad based and flattened, without a median furrow.

The thorax has at least nine segments, but on the only near complete specimen available (the holotype) it is disarticulated between the sixth and seventh segments. The thoracic axis is weakly convex in longitudinal profile. Anteriorly it is about the same width as the pleural areas, but posteriorly it is rather wider. The axis narrows gently backwards so that the last ring is about three fifths as wide (trans.) as the first. The pleurae run almost straight outwards from the axial furrow, and curve gently backwards distally. Each pleuron has a rather deep, distinct, pleural furrow, which runs almost to the distal extremity. The distal end of the pleuron is pointed.

The pygidium is of subparabolic outline, without a border. Anteriorly the axis is just over one quarter of the pygidial width, and tapers quite rapidly backwards, terminating bluntly and not reaching the posterior margin. It consists of six rings and a short terminal piece. There is no postaxial ridge. The pleural areas have four to five pairs of ribs which bear narrow interpleural furrows and wider, deeper pleural furrows, both of which reach close to the pygidial margin. The pleural furrows divide each pleural rib into an anterior and posterior band of more or less equal width and convexity. The pygidial doublure is rather narrow and dorsally concave.

As far as can be seen, the entire exoskeleton is smooth.

Dimensions (in millimetres). –
Total length (sag.) of holotype (PMO 8701) – 8.1 mm.
Greatest width (trans.) of cephalon of holotype – c. 7.0 mm.
Length of thorax (sag.) of holotype – 2.9 mm.

Cranidia Specimen no.	L	L_1	L_2	W	δ–δ
Holotype PMO 8701	3.5	2.1	0.9	2.6	3.6
PMO 70449	?6.1	3.5	1.9	?4.0	4.0
PMO 70450	5.0	2.5	1.3	3.3	4.0
PMO 70451	5.5	3.1	1.5	3.8	4.1
PMO 70453	?5.5	3.3	?1.0	3.8	4.0
PMO 70454	7.8	4.5	2.4	4.5	4.7

Pygidia Specimen no.	A	A_1	X	Y
Holotype PMO 8701	1.8	1.3	4.0	1.2
PMO	3.7	2.9	?7.0	2.5

Discussion. – *Analocaspis ursina* is the only known species of the genus, and has only been found at the type locality, from where about a dozen specimens have been recovered. All are rather poorly preserved internal moulds, which have suffered some distortion. One specimen (PMO 70454) is proportionately longer and narrower than the other specimens, but these differences are probably due to distortion.

ACKNOWLEDGEMENTS. The author is deeply indebted to Dr. David L. Bruton, who kindly arranged the loan of specimens from the Paleontologisk Museum, Oslo, and who invited the author to work there in the autumn of 1969. The author is also very grateful for his inspired supervision and guidance during the preparation of this paper, and for critically reading through the manuscript. The manuscript was also read by Professors P. C. Sylvester-Bradley, H. B. Whittington and G. Henningsmoen, and Drs. V. Jaanusson and J. H. McD. Whitaker. The author extends his gratitude to all these for their helpful criticisms and suggestions for improvement. The author is entirely responsible, however, for all ideas expressed herein.
Dr. V. Jaanusson helped to trace extra specimens in the Naturhistoriska Riksmuseet, Stockholm, and Mr. F. Nikolaisen and Mr. F. Bockelie in the Paleontologisk Museum, Oslo.

The initial stages of the work were carried out in the Geologisch-Paläontologisch Institut der Universität, Bonn, where the author benefited from valuable discussions with Professor H. K. Erben and Dr. W. Haas.

Dr. W. T. Dean (personal communication) offered helpful suggestions on *Analocaspis ursina.*

This work was made possible by the help of scholarships from the Rheinisch-Friedrichs-Wilhelms Universität, Bonn, and from the University of Leicester, both of which are gratefully acknowledged.

Mrs. N. Farquharson kindly prepared the line drawings and the table.

8th May 1970

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The manuscript must be typewritten (carbon copy not acceptable) on one side of standard sized paper, double spaced, with an ample margin. The text must be clear and concise, and written preferably in English; however, Norwegian, Danish, Swedish, French, or German may be used. Manuscripts should be arranged in the following order: (1) Informative but brief title. (2) Author's name. (3) A short abstract, always in English, not exceeding 12 lines (910 letters and spaces), and starting with a repetition of 2 and 1 with a translation in parentheses of non-English titles. (4) The author's professional postal address and a dating of the manuscript. (5) The main text. Use three or fewer grades of headings. Instead of footnotes, insert paragraphs which can be composed in smaller type or use parentheses. Indicate in the left-hand margin the places for the insertion of Figures and Tables. All halftones will be printed in their proper place in the text. The words 'Fig.' ('Figs.') and 'Table' (unabbreviated) are to be capitalized. (6) List of references conforming with the examples given below. Abbreviations used should be consistent: necessary editorial changes will be made according to the *Suggestions to Authors of the Reports of the United States Geological Survey* (5th ed., 1958). (7) Figure captions on a separate sheet. Add an English caption below captions in other languages. (8) Tables, if any, with captions, numbered with arabic numerals.

ILLUSTRATIONS

Illustrations should be reducible to a maximum size of 11.8 × 19.8 cm or less. If not adjustable to the entire width of the type area, 11.8 cm, they must be considerably narrower. Line drawings (maps, sections, etc.) may occasionally be allowed to extend into the inner margin of the page by an additional 2.7 cm. Drawings are to be in black Indian ink. Letters should not be smaller than 1 mm after reduction for reproduction.
Photographs should be clear, sharply contrasted, and printed on white paper with glossy finish. Figures may be composed of several units (designated A, B, C, etc.) and mounted in such a way that each unit after reduction is separated by a space at least 1 mm broad. All units should be similar in tone. Illustrations should generally be termed Figures (not Plates) even if occasionally covering an entire page. All Figures should be marked with the author's name and the Figure number. Do not attach captions to the Figures. When not obvious, the top and bottom of Figures, and their scale, should be indicated.

REFERENCES

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Norsk Geologisk Tidsskrift

VOLUME 50 NUMBER 4

CONTENTS - *INNHOLD*

PAPERS - *AVHANDLINGER*

NOTES - *NOTISER*

Issued December 1970

A thesis entitled

EARLY PROETID TRILOBITES FROM NORTHERN EUROPE

Submitted for the degree of

DOCTOR OF PHILOSOPHY

in the

FACULTY OF SCIENCE of the

UNIVERSITY OF LEICESTER

by

ROBERT MAURICE OWENS BSc.

Volume 11. Plates

June
1971

LIST OF PLATES

22. D. jamesoni (Reed, 1914), D. mactaggarti (Begg, 1946), D. mactaggarti (Begg, 1946)?, D. aff. subornatus (Cooper & Kindle, 1936), D. pristinus sp. nov.
23. Decoroproetus pristinus sp. nov, D. sp. F, D. sp. G, D. sp. H Astroproetus reedi Begg, 1939.
24. Astroproetus reedi Begg, 1939, A. asteroideus (Begg, 1939), proetid, gen. et sp. indet., Cyphoproetus rotundatus (Begg, 1939), C. facetus Tripp, 1954, Rorringtonia flabelliforme Whittard, 1966 R. vetula (Reed, 1935).
25. Decoroproetus scrobiculatus sp nov.
26. Decoroproetus scrobiculatus sp. nov., D. sp. J, D. sp. K, D. sp. L, D.? sp. N.
27. Astroproetus amplus sp. nov., A. pseudolatifrons (Reed, 1904), Decoroproetus sp. M.
28. Astroproetus subtriangularis (Begg, 1950), A. cf. subtriangularis (Begg, 1950), A. interjectus (Reed, 1935), A. cf. interjectus (Reed, 1935), A. scoticus (Reed, 1941), A. sp. A, Warburgella pedina sp. nov.
29. Warburgella stokesi (Murchison, 1839), W. sp. A.
30. Warburgella bellula (Reed, 1917), Cyphoproetus aff. binodosus (Whittard, 1938), Ogmocybe trapeziceps gen. et sp. nov.
31. Cyphoproetus nasiger sp. nov., C. nasiger? sp. nov., Ogmocybe pharangis gen. et sp. nov., Cyphoproetus binodosus (Whittard, 1938), C. externus (Reed, 1935), C. strabismus sp. nov., Ogmocybe? sp. A.
32. Cyphoproetus strabismus sp. nov., C. depressus (Barrande, 1846), Rutellum malvernense gen et. sp. nov.
33. Proetus (Proetus) bravonii sp. nov.
34. Proetus (Proetus) concinnus (Dalman, 1828).
35. Proetus (Proetus) concinnus (Dalman, 1828), P. (P.) dudleyensis sp. nov.
36. Proetus (Proetus) fletcheri Salter, 1873, Proetus (Proetus) confossus sp. nov., P. (P.) obconicus Lindstrom, 1885.
37. Proetus (Proetus) confossus sp. nov., P. (P.) cf. obconicus Lindstrom, 1885, P. astringens sp. nov., P (P.) cf. bravonii sp. nov., P. latifrons (M'Coy).
38. Proetus latifrons (M'Coy, 1846), P. granulatus Lindstrom, 1885, P. falcatus sp. nov.
39. Proetus cf. latifrons (M'Coy, 1846), P. haverfordensis sp. nov., P. sp. A, P. sp. B, P. sp. C, P. sp. D, Crassiproetus? curtisi nom. nov.

40. *Schizoproetus tiro* sp. nov.

41. *Schizoproetus tiro* sp. nov., *S. tiro* sp. nov.?.

42. *Proetus ryckholti* Barrande, 1846, *P.* (*Coniproetus*) *condensus* Pribyl, 1965, *P.* (*P.*) *morinensis* Pribyl, 1946, *P.* (*C.*) *nasutus* sp. nov.

43. "*Proetus*"(=*Cornuproetus*?) *ramisulcatus* Nieszkowski, 1857/?, *Cornuproetus* (*Cornuproetus*) *intermedius* (Barrande, 1846), *C.* (*C.*) *peraticus* sp. nov.

44. *Cornuproetus* (*Cornuproetus*) *consobrinus* Pribyl, 1965, *C.* (*C.*) *venustus* (Barrande, 1846), *C.* (*C.*) *vertumnus* Prantl & Vanek, *C.* (*C.*) *reussi* (Hawle & Corda, 1847), *C.* (*Lodenicia*) *dentatulus* (Novak, 1890), *C.* (*Lepidoproetus*) *limatulus* Pribyl, 1966.

45. *Eremiproetus senex* Alberti, 1967, *Tropidocoryphe heothina* sp. nov., *Decoroproetus decorus decorus* (Barrande, 1846).

46. *Decoroproetus decorus* (Barrande, 1846) *quirinus* Prantl & Vanek, 1958, *D. decorus decorus* (Barrande, 1846), *Prantlia longifrons* (Lindstrom, 1885), *P. longula* (Hawle & Corda, 1847), *D. octonus* sp. nov., *Cyphoproetus strabismus* sp. nov., *C. depressus* (Barrande, 1846).

47. *Scharyia micropyga* (Hawle & Corda, 1847) *wenlockiana* Pribyl, 1967, *Scharyia* sp. A, *S. angusta* Pribyl, 1966, *Panarchaegonus whittardi* (Begg, 1939).

48. *Scharyia britannica* sp nov.

49. *Scharyia siljanensis* sp. nov., *S.* sp. B, *S.* sp C.

50. Stereoscan photographs of silicified specimens of *Stenoblepharum strasburgense* (Cooper, 1953).

51. Stereoscan photographs of silicified specimens of *Stenoblepharum strasburgense* (Cooper, 1953).

52. Stereoscan photographs of silicified specimens of *Decoroproetus pristinus* sp. nov.

PLATE 1.

Decoroproetus furubergensis sp. nov.

A, C, F. Cranidia, dorsal view. A: x 15 (PMO 68283); C: x 9 (PMO 68504); F: x 15 (PMO 8816). Probable Upper Chasmops Shale (4bγ), forest track between Nerby and Helgehagen, Lunner, Hadeland. Coll. L. Størmer, 1951.

B, E. HOLOTYPE. Cranidium, x 4½ (PMO 8700). B: anterior oblique view; E: dorsal view. Cyclocrinus shale (4bγ), Furuberget, Nes-Hamar. Coll. O. Holtedahl, 1907.

D. Free cheek, dorsal view, x 7 (PMO 70462). Probable Upper Chasmops Limestone (4bδ), at the road, Lyngstad, South Granasen, Gran, Hadeland. Coll. L. Størmer and G. Henningsmoen, 1941.

H. Cranidium, dorsal view, x 10 (PMO 70460). Other data as D.

G, J, K. Pygidium, x 7 (PMO 8694). G: lateral view; J: dorsal view; K. posterior view. Upper Chasmops Shale (4bγ), Vestbråten, Røise, Ringerike. Coll. J. Kiaer, 1920.

PLATE I

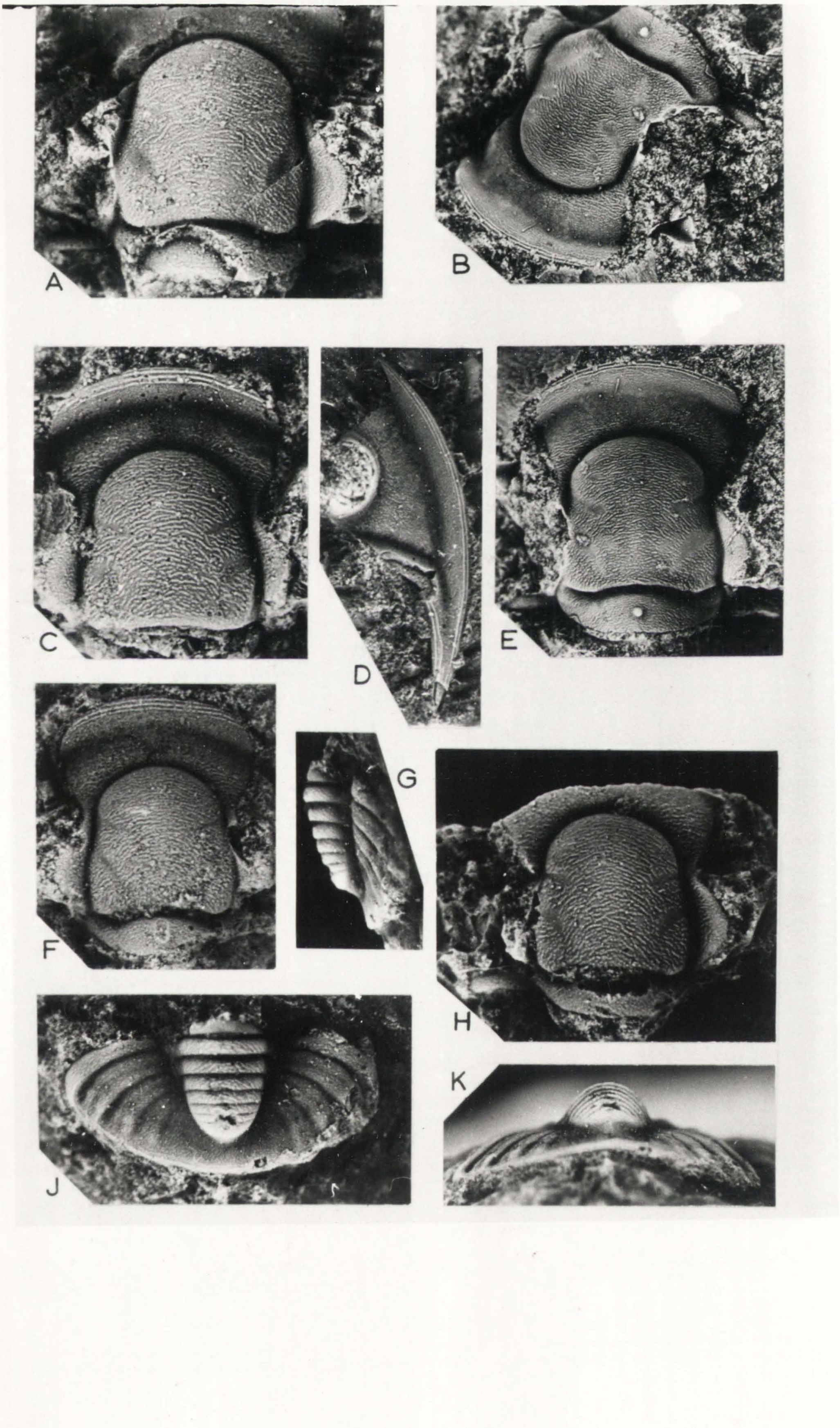

PLATE 2.

Decoroproetus *gyratus* sp. nov.

A. HOLOTYPE. Cranidium, x 7 (PMO 8702), dorsal view. Lower Chasmops Shale (4bα), Shore section below the parking place to Fornebu Airport, Baerum, Oslo. Coll. R.M. Owens, 1969.
B, D. Cranidium, x 7 (PMO 63296). B: dorsal view; D: lateral view. Lower Chasmops Shale (4bα), Bygdøy, Oslo.

Decoroproetus sp. A.

C, F. Cranidium, x 12½ (PMO 61018c). C: dorsal view; F: anterior oblique view. Upper Chasmops Limestone (subzone of Tretaspis kiaeri, 4bδ_2), western side of Frognøy, Lake Tyrifjorden, Ringerike. Coll. J. Kiaer, 1914.

Decoroproetus furubergensis sp. nov.

E. Free cheek, dorsal view, x 8 (PMO 8693). Upper Chasmops Shale (4bγ), Vestbråten, Røise, Ringerike. Coll. J. Kiaer, 1920.
G, H. Pygidia, dorsal view. G: x 8 (PMO 68281); H: x 8 (PMO 70447). Probable Upper Chasmops Shale (4bγ), forest track between Nerby and Helgehagen, Lunner, Hadeland. Coll. L. Størmer, 1951.
J. Pygidium, dorsal view, x 4½ (PMO 20654). Other data as E.
L, M. Free cheeks, dorsal view. L: x 8½ (PMO 68285); M: x 7 (PMO 68287). Other data as G.

Decoroproetus solenotus sp. nov.

K. Pygidium, dorsal view, x 21 (PMO 8696). Upper Chasmops Limestone (4bδ_1), 1.7 m. below the top, N. Raudskjaer, Asker. Coll. F. Nikolaisen, 1967.

PLATE 2

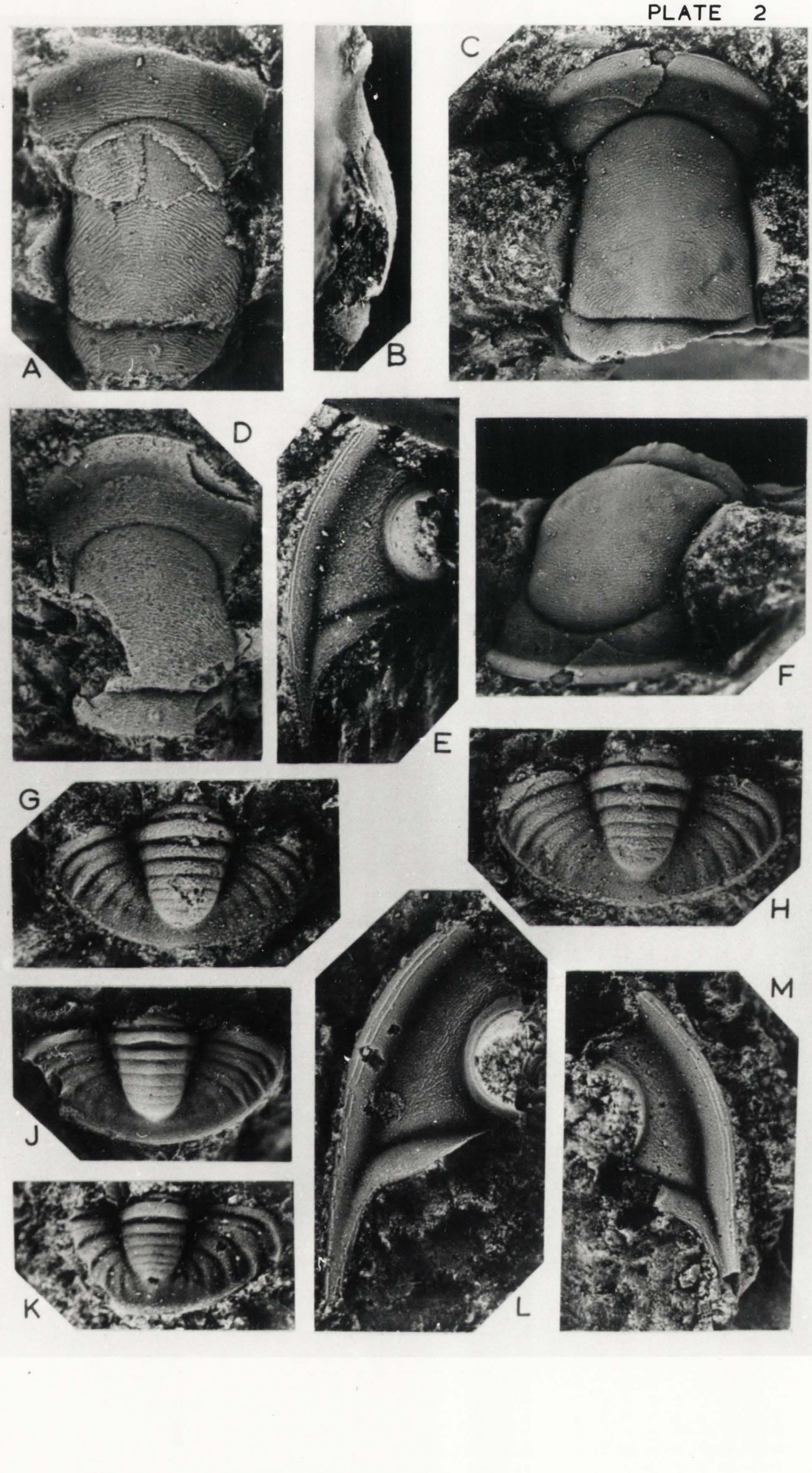

PLATE 3.

Decoroproetus solenotus sp. nov.

A. Cranidium, dorsal view, x 10 (RM Ar 37442).
? Upper Chasmops Limestone (4bδ), Ringsåsen, Ringerike.
Coll. G. Holm, 1877.

B, C. HOLOTYPE. Cranidium (PMO 70437). B: Lateral view, x 17; C: Dorsal view, x 12½. Upper Chasmops Limestone ($4b\delta_1$), 1.7 m. below the top, N. Raudskjaer, Asker. Coll. F. Nikolaisen, 1967.

D. Cranidium, dorsal view, x 7 (PMO 70497). Upper Chasmops Limestone ($4b\delta_1$), close to the top, Kalvøya, N.E. Baerum. Coll. G. Henningsmoen, 1962.

E. Pygidium, dorsal view, x 22 (PMO 8695). Other data as B.

F. Free cheek, dorsal view, x 7 (PMO 70494). Upper Chasmops Limestone ($4b\delta_1$), 2 m. below the top, Terneholmen. Coll. F. Nikolaisen, 1967.

G. Cranidium, dorsal view, x 8 (PMO 70495). Other data as F.

H. Free cheek, dorsal view, x 7½ (PMO 8703). Other data as F.

Details of the lateral glabellar furrows of Decoroproetus furubergensis, D. gyratus and D. solenotus.

J, K. Decoroproetus solenotus. J: x 35 (RM Ar 37442); K: HOLOTYPE, x 50 (PMO 70437). For other data see Pl.3, A and B.

L. Decoroproetus furubergensis, HOLOTYPE, x 18 (PMO 8700). For other data see Pl.1, B.

M. Decoroproetus gyratus, HOLOTYPE, x 19 (PMO 8702). For other data see Pl.2, A.

PLATE 3

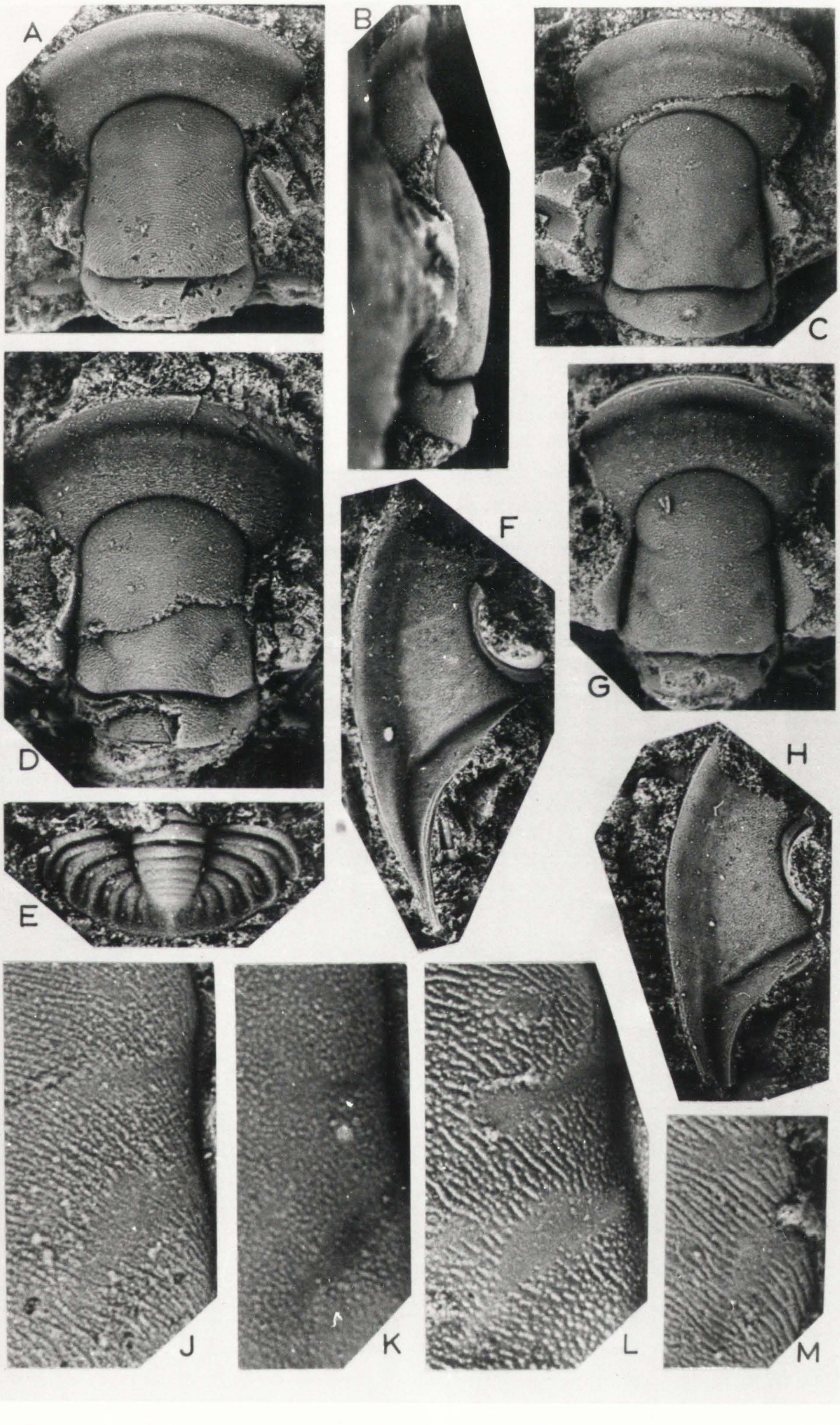

PLATE 4.

Analocaspis ursina gen. et sp. nov.

A, *C*, *D*, *G*, *H*. Cranidia, dorsal view. *A*: x 7 (PMO 70451); *C*: x 7 (PMO 70450); *D*: x 7 (PMO 70449); *G*: x 7 (PMO 70453); *H*: x 6 (PMO 70454).
B. HOLOTYPE, a nearly complete exoskeleton, dorsal view, x 7 (PMO 8701).
E. Pygidium, dorsal view, x 6 (PMO Coll.).
F. Free cheek, dorsal view, x 9 (PMO 70449, on the same slab as *D*).
All from the Lower Chasmops Shale (4bα), Bjørnsvikveien, close to the syenite dyke, near Drammensveien, Baerum, Oslo-Asker. *E* coll. R.M. Owens, 1969, all the rest coll. J.F. Bockelie, 1966.

PLATE 4

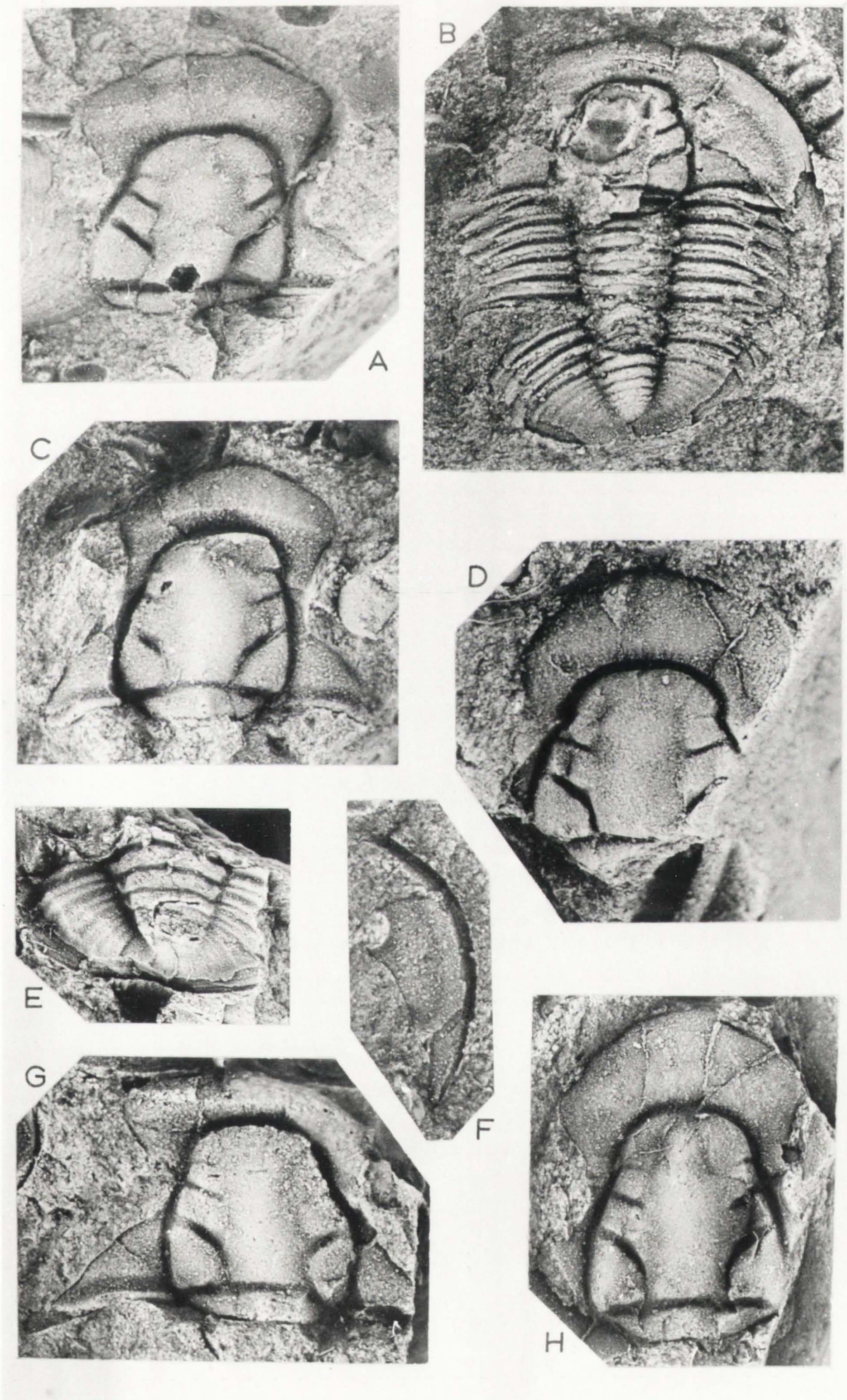

PLATE 5.

Proetus ainae Warburg, 1925

A, B, D, E. Cranidium, x 7 (S.G.U. Coll.). A: dorsal view; B: left anterior oblique view; E: left lateral view. Boda Limestone, Lissberg, Lake Siljan district, Sweden. Orig. Warburg, pl.5, fig.29.
C. Free cheek, x 5½ (S.G.U. Coll). Dorsal view. Boda Limestone, Lissberg. Orig. Warburg, pl.5, fig.27.
F. Cranidium, x 5½ (RM Ar 11482). Dorsal view. Probably Boda Limestone, Gulleråsen.
G. LECTOTYPE. Cranidium, x 6 (S.U. Coll.). Dorsal view. Boda Limestone, Lissberg. Orig. Warburg, pl.5, fig.25.
H, K, L. Pygidium, x 6 (RM Ar 11480). H: posterior view; K: dorsal view; L: left lateral view. Probably Boda Limestone, Gulleråsen.
I. Pygidium, x 9 (S.U. Coll.). Dorsal view. Boda Limestone, Lissberg. ?Orig. Warburg, pl.5, fig.30.

Proetus cf. ainae Warburg, 1925.

J. Free cheek, x 7½ (GSM 35636). Dorsal view. Ashgillian, Kildare Limestone, Chair of Kildare, Eire.

Ascetopeltis bockeliei gen. et sp. nov.

M. Incomplete exoskeleton, silicone cast taken from external mould, x 3½ (PMO 70467). Dorsal view. Tretaspis Series, probably Stage 5a, Lindøya (South of "Ant nest"). Coll. T. Faarlund, 1962.
N-O. Cranidium, x 7½ (PMO 8814). N: dorsal view; O: left lateral view. Tretaspis Series, Stage 5a, Jongskollen. Coll. J.F. Bockelie, 1966.

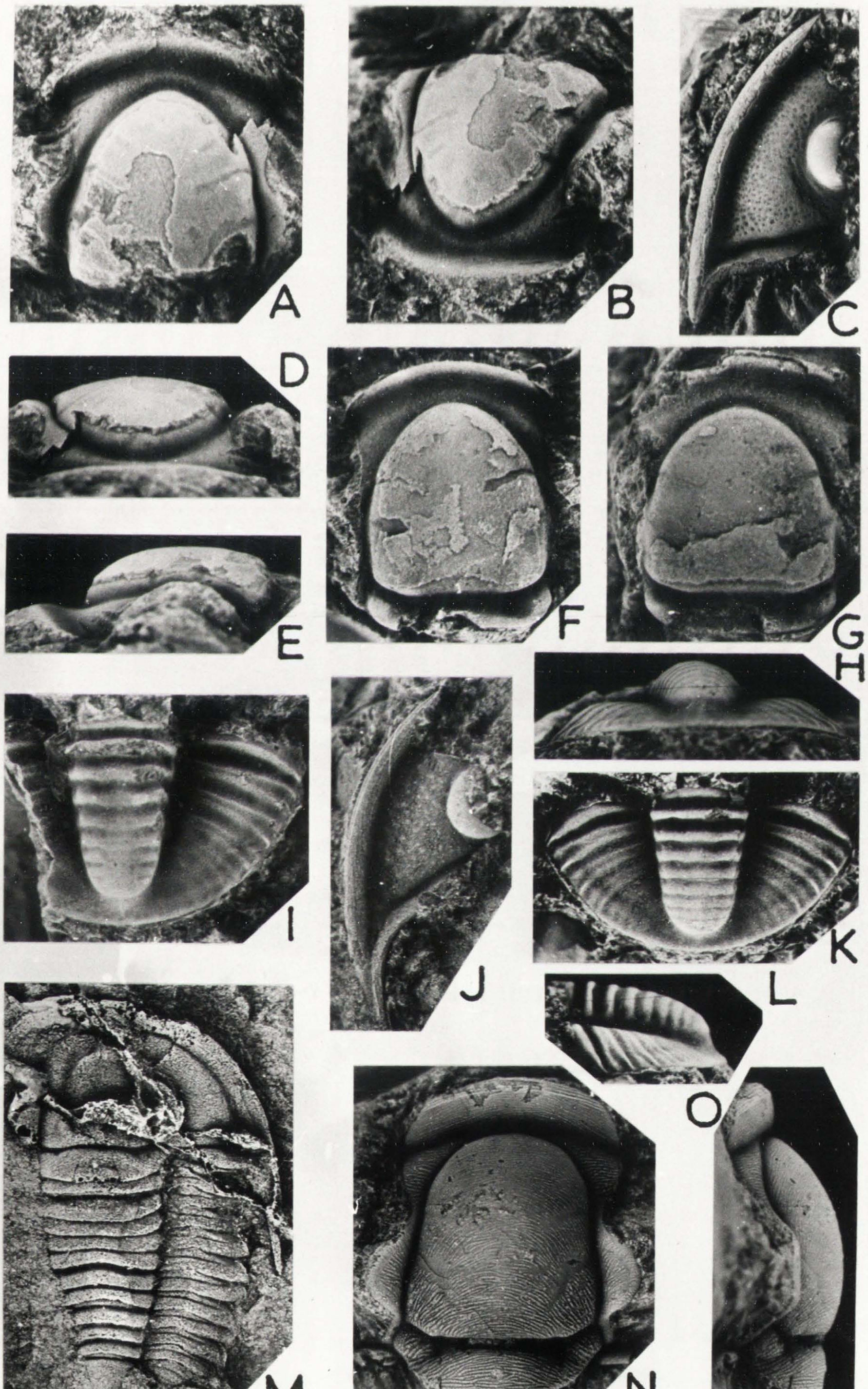
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PLATE 6.

Ascetopeltis bockeliei gen. et sp. nov.

A, G, J1-2. HOLOTYPE. Nearly complete, partially exfoliated exoskeleton (PMO 8408). A: x $3\frac{3}{4}$, dorsal view. Note trapezoidal rostral plate in front of glabella where anterior border has been damaged. The small cranidium seen on the right hand side, just behind the eighth pleura belongs to Xenocybe micrommata gen. et sp. nov. (see also pl.18). G: x 6, right anterior oblique view of cephalon. Note terrace lines on internal mould of doublure, and panderian opening on extreme right. J1-2: x 13, dorsal stereograph of posterior part of glabella. Note structure of surface sculpture with small granules, particularly on the lower left. Tretaspis Series, Stage 5a, Holmenskjaeret, Oslo-Asker district. Coll. J.F. Bockelie, 1965.

B. Free cheek, x 5 (PMO 8847). Ventral surface. Note terrace lines and panderian opening on doublure, also small pits and raised striations on external mould of field of free cheek. Tretaspis Series, Stage 5a, Jongskollen, near Slependen. Coll. J.F. Bockelie, 1966.

C. Cranidium, x 10 (PMO 8467). Dorsal view. Other data as A.

D, E. Pygidium, x 7 (PMO 70469). D: Dorsal view. Note incurving marginal terrace lines. E: Left lateral view. Horizon and locality as A. Coll. F. Nikolaisen, 1968.

F. Cranidium, x 18 (PMO 70430). Dorsal view. Note short longitudinal furrows on posterior edge of glabella. Other data as D.

H. Cranidium, x 7 (PMO 8862). Dorsal view. Note partially exfoliated occipital ring, showing transverse terrace lines of doublure. Tretaspis Series, probably Stage 5a, Nes Terasse 16, Nesbru, Asker. Coll. J.F. Bockelie, 1966.

PLATE 6

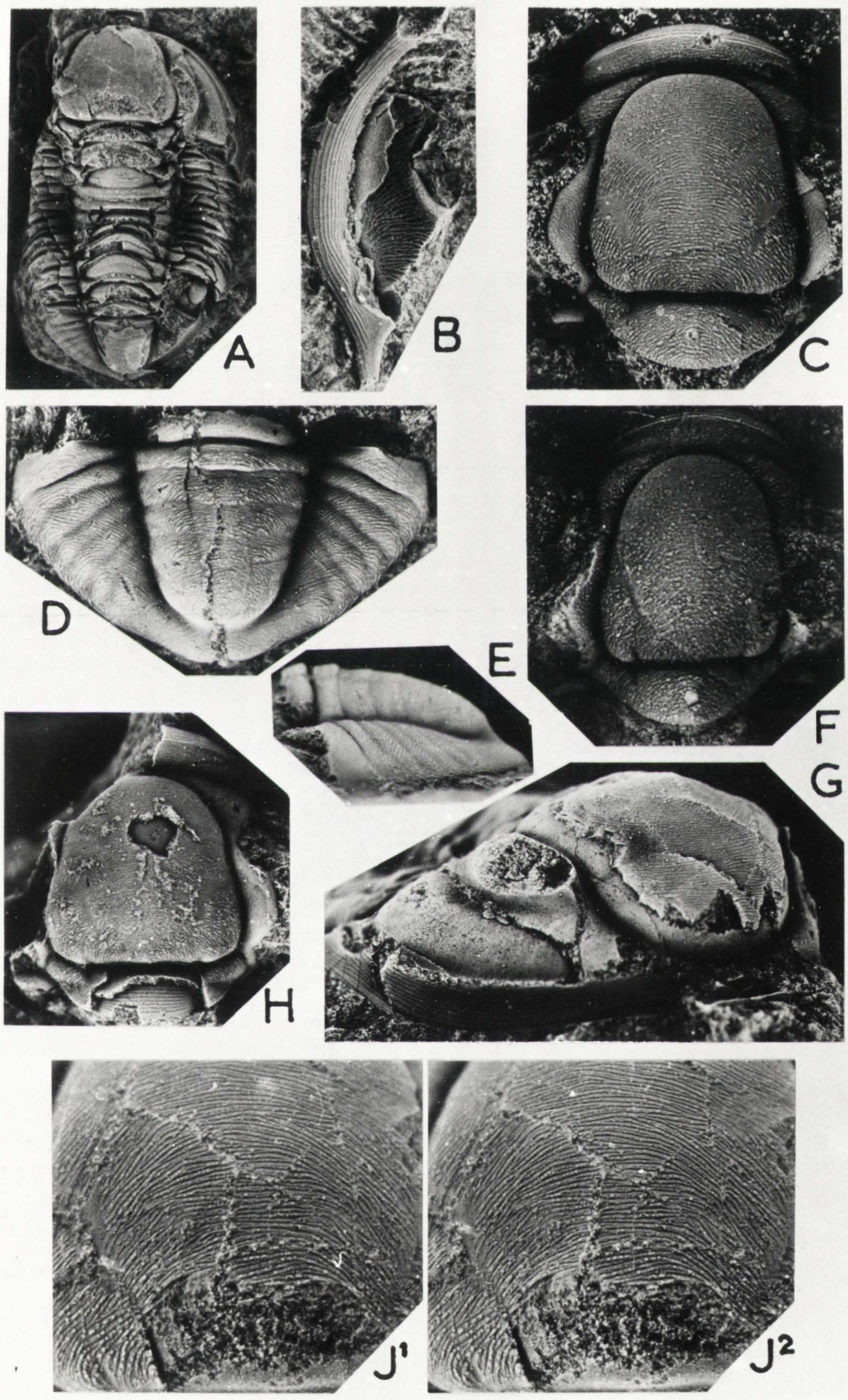

PLATE 7.

Ascetopeltis sp. A.

A. Cranidium, x 6½ (PMO 8858). Dorsal view. Note lateral glabellar furrows interrupting striated sculpture. Tretaspis Series, Stage 5a, Holmenskjaeret, Oslo-Asker district. Coll. J.F. Bockelie, 1966.

Ascetopeltis sp.

B, C, E. Pygidium, x 4½ (RM Ar 34812). B: Dorsal view; C: Posterior view; E: Left lateral view. Note projection on anterior margin of articulating facet. Porkuni Stage, Estonia. Coll. G. Holm, 1883.

Ascetopeltis lepta gen. et sp. nov.

D, G, I. HOLOTYPE. Cranidium (PMO 70498). D: Dorsal view, x 17; G: Left lateral view, x 14½; I: Anterior view, x 14½. Other data as A.

F. Cranidium, x 9 (PMO 70489). Dorsal view. Horizon and locality as A; Coll. J.F. Bockelie, 1965.

Ascetopeltis bockeliei gen. et sp. nov.

H. Pygidium, x 10 (RM Ar 17830). Dorsal view. Red Jonstorp Formation, Rödbergsudden, Östergötland.

J. Pygidium, x 7 (RM Ar 23075). Dorsal view. Boda Limestone, off-reef facies, erratic block No.41, Hultersta, Öland. Coll. G. Andersson, 1893.

Ascetopeltis bockeliei? gen. et sp. nov.

L. Free cheek, x 10½ (RM Ar 43444). Dorsal view. Red Jonstorp Formation, Gulleråsen-Sanden, stream section. Coll. O. Isberg.

Proetid free cheek, indet.

K. Free cheek, x 10½ (RM Ar 43741). Dorsal view. Kullsberg Limestone, Kullsberg.

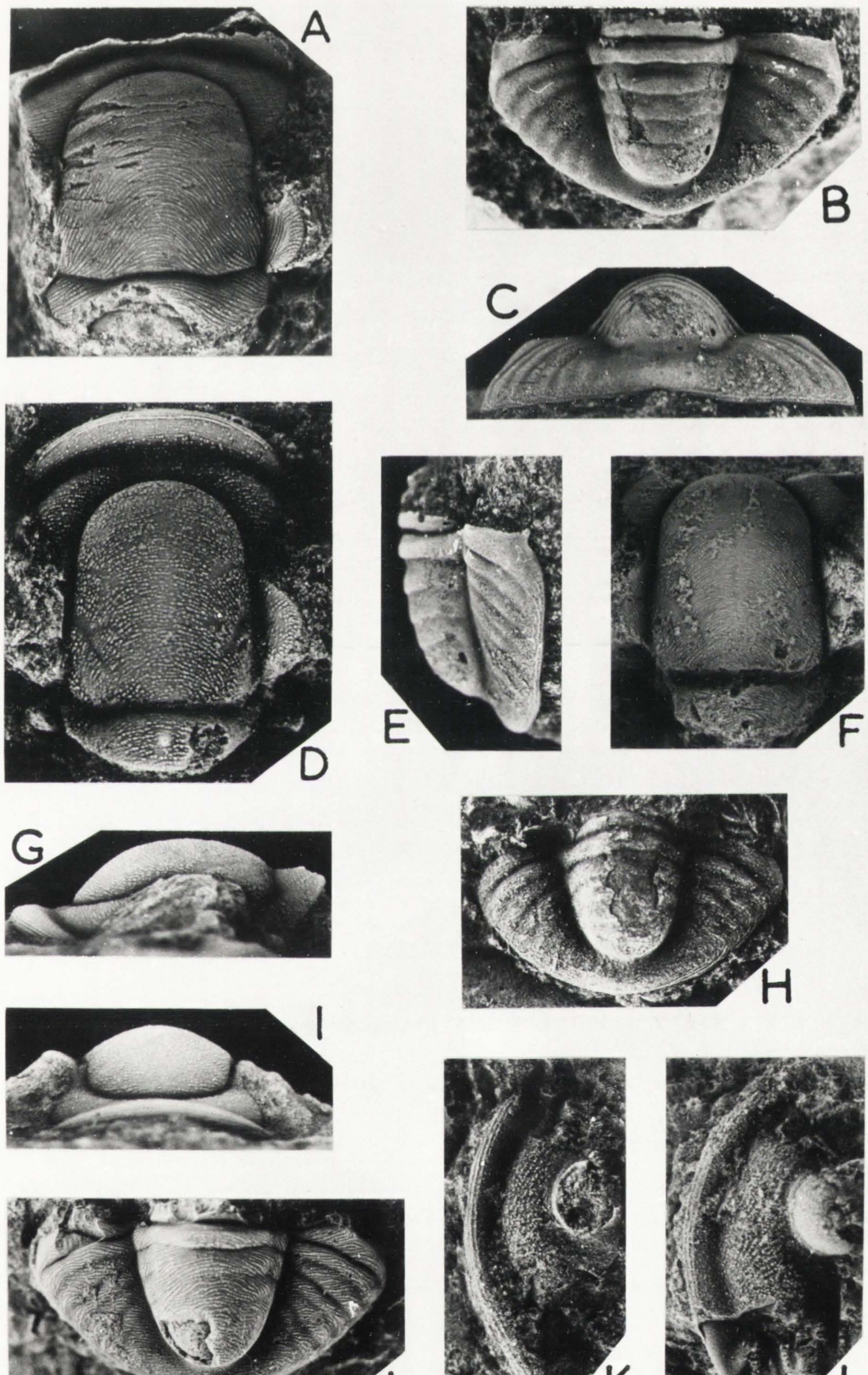
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PLATE 8.

Ascetopeltis sp.

A, B, D. Cranidium, x 5 (RM Ar 34441). A: dorsal view; B: right lateral view; D: right anterior oblique view. Porkuni Stage, Estonia. Coll. G. Linnarsson, 1872.

Ascetopeltis bockeliei? gen. et sp. nov.

C, E, F, G. Incomplete cephalon, internal mould, x 6 (RM Ar 34414). C: dorsal view; E: right lateral view; F: right anterior oblique view. Note small pits on the free and fixed cheeks; G: anterior view. Porkuni Stage, Nõmküla, at the railway, Estonia. Coll. G. Holm, 1883.

Ascetopeltis? sp.

H, J. Pygidium, x 7½ (UM D 79). H: left lateral view; J: dorsal view. Boda Limestone, Östbjörka. Orig. Warburg, 1925, pl.5, fig.64.
K. Pygidium, x 13½ (UM D 64). Dorsal view. Boda Limestone, Klittberg. Orig. Warburg, 1925, pl.5, fig.37. Coll. O. Isberg.

Decoroproetus brevifons (Angelin, 1854).

I. Partially complete exoskeleton, x 2 (S.G.U. Coll., unnumbered). Dorsal view. Red Jonstorp Formation, Bestorp, Västergötland. Orig. Linnarsson 1869, pl.2, fig.29. Coll. G. Linnarsson.
L. Incomplete cephalon, x 6½ (RM Ar 15258). Dorsal view. Red Jonstorp Formation, Mösseberg, Bestorp, Västergötland.
M. Cranidium, x 4 (RM Ar 15254). Dorsal view. Jonstorp Formation (Oglunda Limestone?), Ålleberg, Västergötland. Coll. J.W. Dalman, 1827. Labelled as "Orig". (of Angelin, 1854, pl.33, fig.18a).

Decoroproetus asellus (Esmark, 1833).

N. HOLOTYPE. Partially complete exoskeleton, preserved in pyrrhotite, x 4½ (PMO 56442). Dorsal view. Tretaspis Series, Stage 4cα, Trosviken ved Brevik. Orig. Esmark, 1833, pl.7, fig.5.

PLATE 8

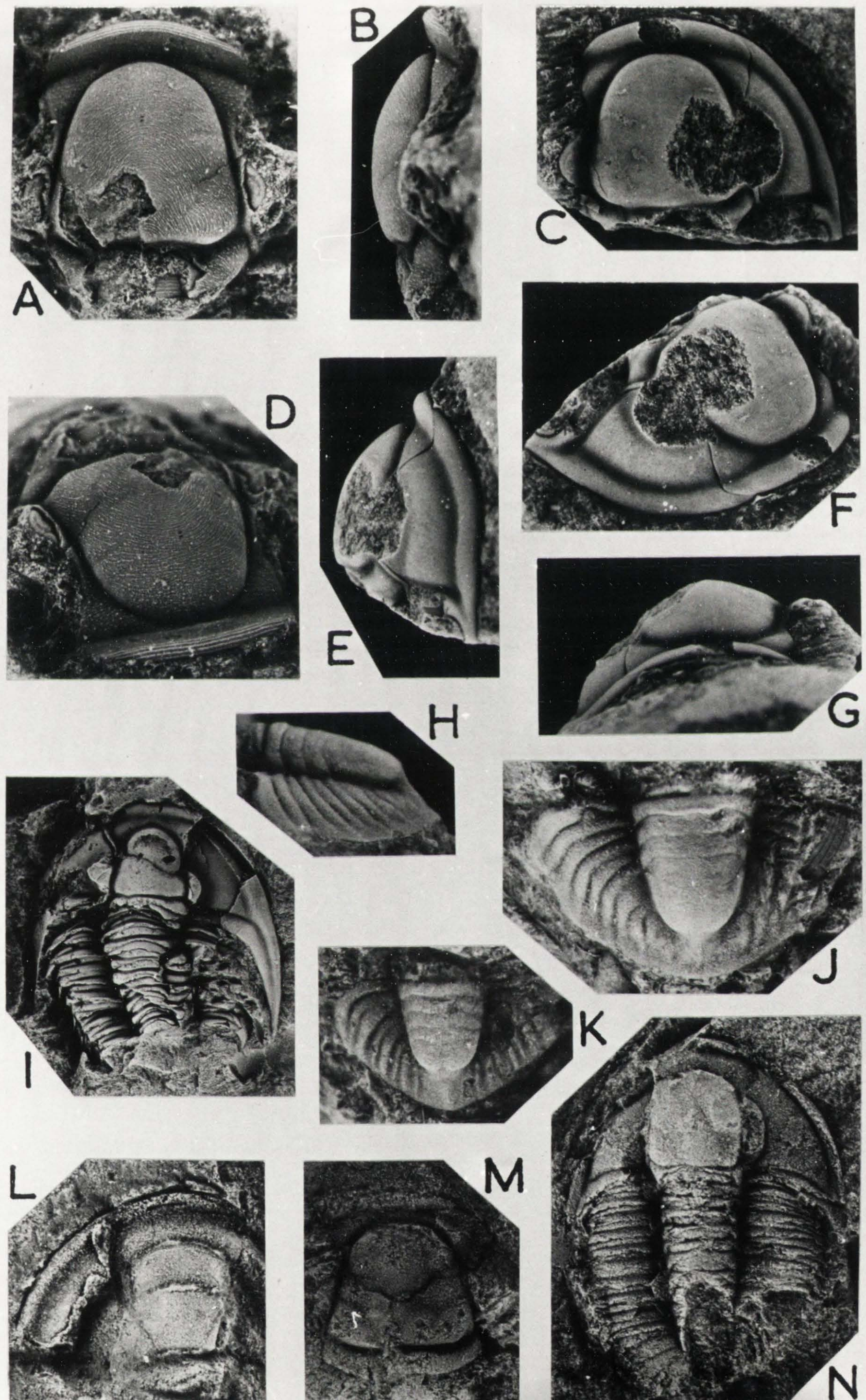

PLATE 9.

Decoroproetus sp. B.

A. Cranidium, x 8 (RM Ar 15255). Dorsal view. Jonstorp Formation, Ålleberg, Västergötland. Labelled as "Orig". (of Angelin, 1854), pl.33, fig.18a).
B. Free cheek, x 4½ (RM Ar 15252). Dorsal view. Jonstorp Formation, Mösseberg, Bestorp, Västergötland. Coll. G. Linnarsson.
C. Pygidium, x 8. Dorsal view. On same slab as B.

Decoroproetus brevifons (Angelin, 1854).

D. Cranidium, internal mould, x 7½ (RM Ar 15257). Red Jonstorp Formation, Mösseberg, Bestorp, Västergötland.

Decoroproetus evexus sp. nov.

E. Free cheek, x 5½ (PMO 8849). Dorsal view. Tretaspis Series, Stage 5a, Nes Terasse 10, c.10-20m. S.E. of house, Nesbru, Oslo-Asker district. Coll. J.F. Bockelie, 1966.
F. Cranidium, x 6 (PMO 70479). Dorsal view. Other data as E.
G. HOLOTYPE. Cranidium, x 6 (PMO 70439). Dorsal view. Tretaspis Series, Stage 5a, Øvre Nes bathing place, Oslo-Asker district. Coll. J.F. Bockelie, 1966.
H. Small cranidium, x 14 (PMO 70476). Dorsal view. Other data as E.
I. Pygidium, x 8 (PMO 70475). Dorsal view. Other data as F.
J. Free cheek, x 6½ (PMO 70473). Dorsal view. Other data as F.

PLATE 9

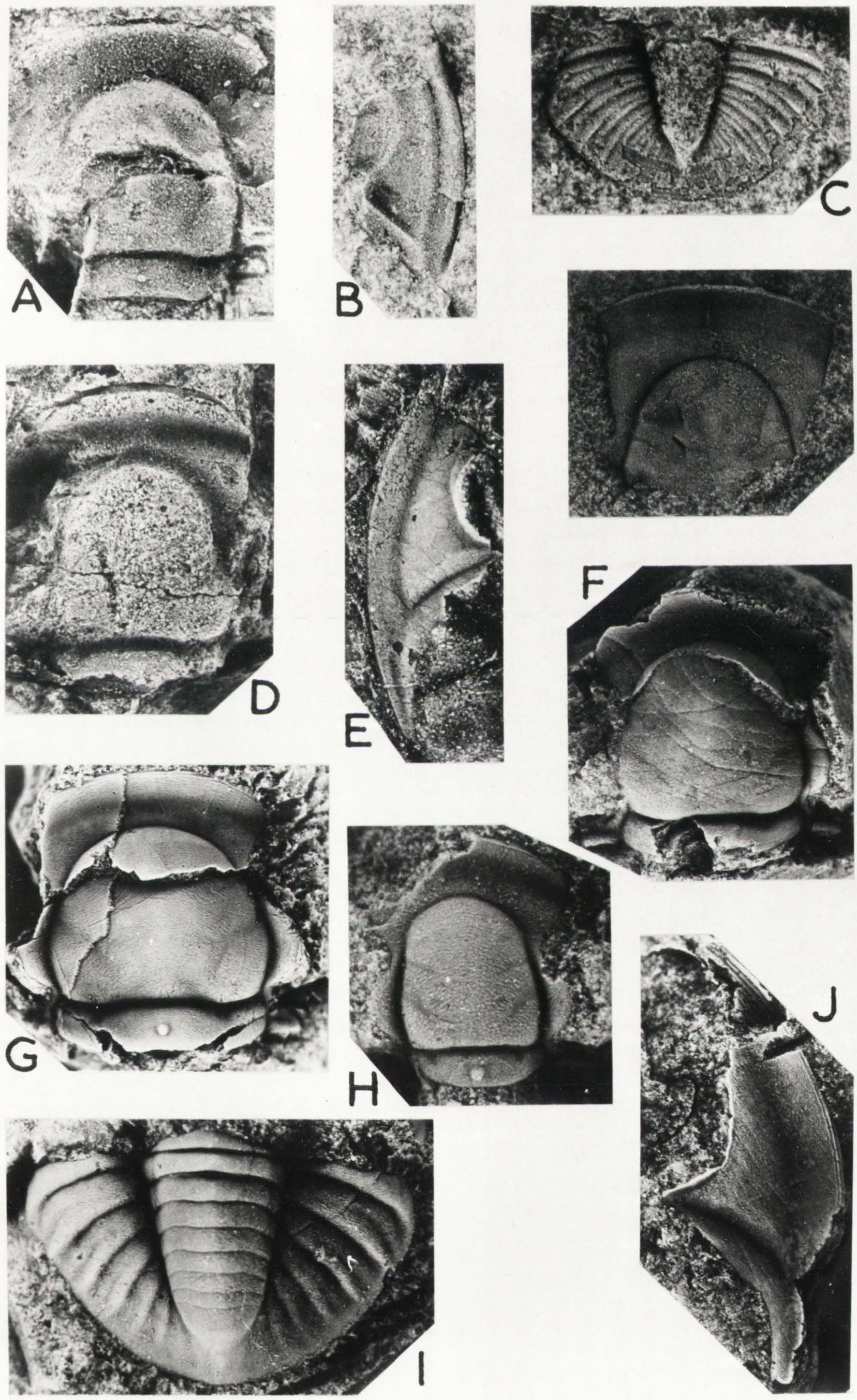

PLATE 10.

<u>Decoroproetus</u> <u>furubergensis</u> Owens, 1970.

<u>A</u>. Cranidium, x 12½ (RM Ar 23074). Dorsal view. Viruan, Macrourus Limestone (erratic block), Eriksore, Oland.
<u>B</u>. Free cheek, x 9½ (RM Ar 23741). Dorsal view. Viruan, Macrourus Limestone (erratic block), Kraketorp, Oland.
<u>C</u>. Pygidium, x 8½ (RM Ar 23656). Dorsal view. Other data as <u>A</u>.
<u>D</u>, <u>E</u>, <u>H</u>. Pygidium, x 6½ (RM Ar 23920). <u>D</u>: left lateral view; <u>E</u>: Dorsal view; <u>H</u>: posterior view. Other data as <u>A</u>.
<u>F</u>. Cranidium, x 8½ (RM Ar 23670). Dorsal view: note shallow longitudinal furrows on the posterior edge of glabella. Also transverse terrace lines on the mould of the ventral surface of the doublure. Other data as <u>A</u>.
<u>G</u>. Small cranidium, x 12 (RM Ar 23671). Dorsal view. Other data as A.

<u>Decoroproetus</u> <u>papyraceus</u> (Törnquist, 1884).

<u>I</u>. Free cheek, x 10 (RM Ar 47557). Dorsal view. Fjäcka Shale, road section N. of Gullerasen-Sanden. Coll. R.M. Owens 1969).
<u>J</u>. Cranidium, x 9½ (RM Ar 47558). Dorsal view. Other data as <u>I</u>.
<u>M</u>. Ventral surface of incomplete cranidium, photographed under alcohol, x 9 (RM Ar 10875). Note paired muscle areas on axis, Fjäcka Shale, Draggå bro.
<u>N</u>. Cranidium, x 11 (RM Ar 47559). Dorsal view. Other data as <u>I</u>.
<u>O</u>. Small pygidium, x 24 (RM Ar 11582). Dorsal view. Fjacka Shale, Dalarne.

<u>Decoroproetus</u> <u>modestus</u> (Törnquist, 1884).

<u>K</u>. HOLOTYPE, almost complete exoskeleton, x 3 (S.G.U. Coll., unnumbered). Dorsal view. Boda Limestone, Kallholn.
<u>L</u>. Nearly complete thorax, x 4 (RM Ar 10859). Bodá Limestone, Osmundsberget.

PLATE 10

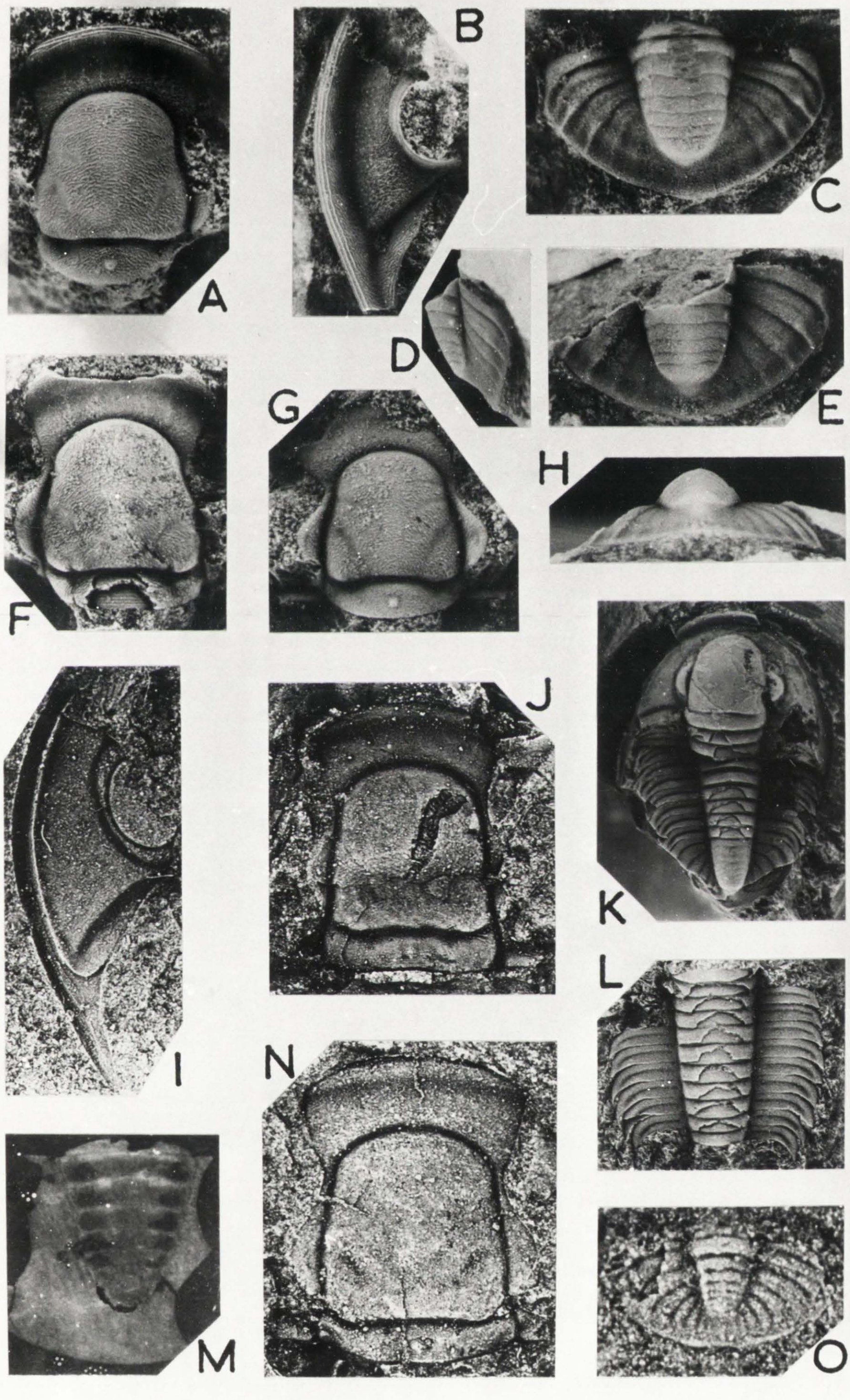

PLATE 11.

Decoroproetus papyraceus (Tornquist, 1884).

A. LECTOTYPE. Cranidium, x 12 (LO 597T). Dorsal view. Fjacka Shale, Fjacka. Orig. Tornquist 1884, pl.2, fig.4.
B. Free cheek, x 8 (LO 599t). Dorsal view. Fjacka Shale, Draggan. Orig. Tornquist, pl.2, fig.6.
D. Pygidium, x 7 (LO 598t). Dorsal view. Fjacka Shale, Draggan. Orig. Tornquist, pl.2, fig.5.
G. Pygidium, x 9 (RM Ar 47560). Dorsal view. Other data as pl.10, I.
O. Pygidium, x 3½ (RM Ar 10890). Dorsal view. Fjacka Shale, Vikarbyn.

Decoroproetus remotus (Warburg, 1925).

C. Cranidium, x 11 (RM Ar 47497a). Dorsal view. Boda Limestone, Kallholn. Coll. O. Isberg.
E, F, P. HOLOTYPE. Cranidium, x 8 (UM D 52). E: left lateral view; F: dorsal view; P: anterior view. Boda Limestone, Kallholn. Orig. Warburg pl.5, fig.7. Coll. O. Isberg.
H. Free cheek, x 12½ (RM Ar 47504). Dorsal view. Boda Limestone, Kallholn. Coll. O. Isberg.
I. Small cranidium, x 14 (RM Ar 47497b). Dorsal view. Other data as C.
J. Free cheek, x 4½ (RM Ar 43863). Dorsal view. Boda Limestone, Östbjörka. Coll. O. Isberg, 1913.

Decoroproetus sp. C.

K. Pygidium, x 4½ (LO 3118t). Dorsal view. Viruan, Kullsberg Limestone, Kullsberg. Orig. Warburg pl.5, fig.63.

Decoroproetus sp. D.

L. Free cheek, x 10 (RM Ar 43433). Dorsal view. Boda Limestone, Boda Church. Coll. O. Isberg, 1912.
M, N. Cranidium, x 11 (RM Ar 10896). M: right lateral view; N: dorsal view. Boda Limestone, Boda. Coll. G. Holm, 1880.

PLATE II

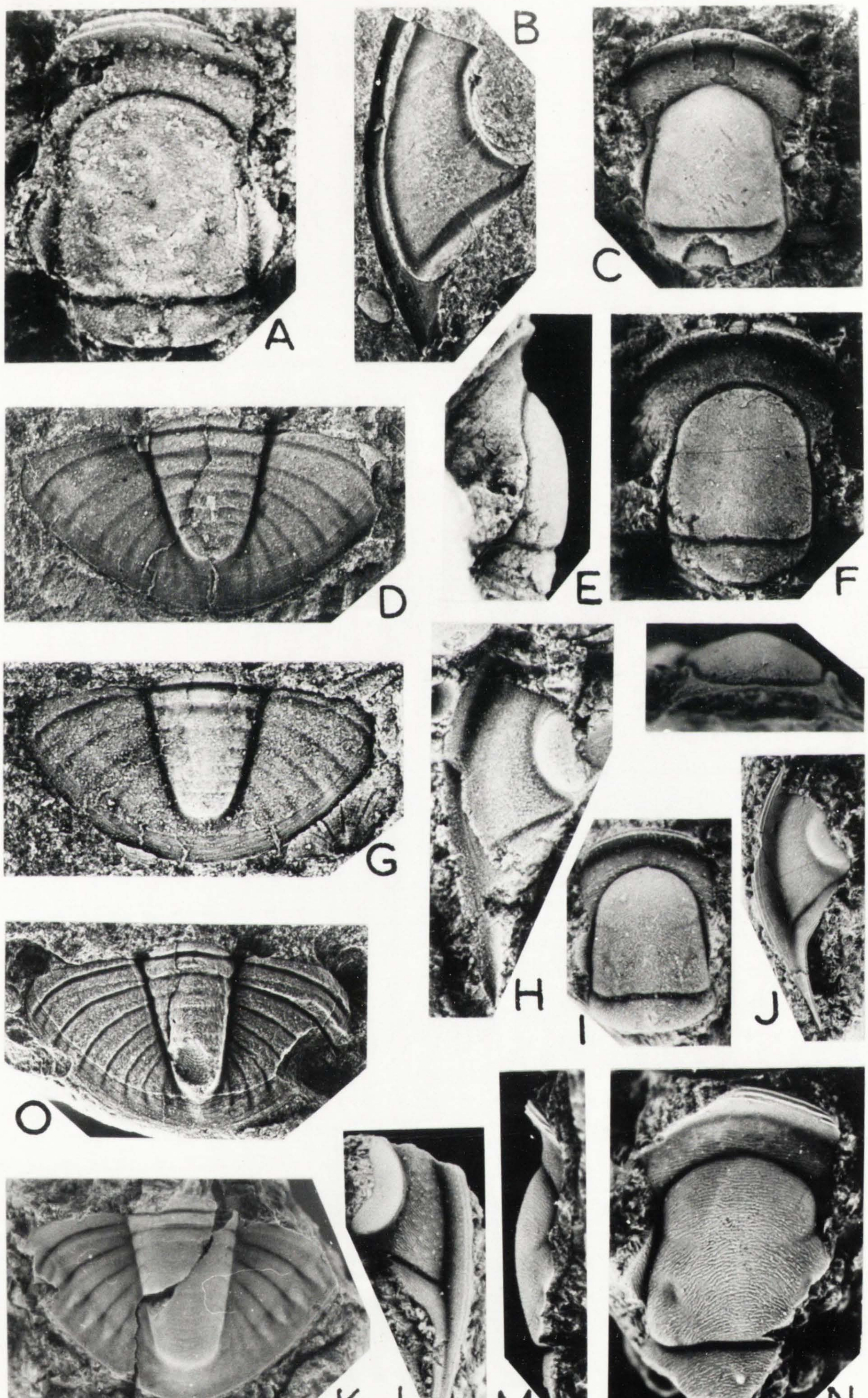

PLATE 12.

Isbergia planifrons Warburg, 1925.

A, B, F. Almost complete exoskeleton, x 15 (RM Ar 5253). A: dorsal view; B: left lateral view - note facets on eye; F: anterior view. Boda Limestone, Arfvet. Coll. G. Holm, 1880.
C, D. Cranidium x 15 (S.G.U. Coll.). C: dorsal view; D: left lateral view. Boda Limestone, Osmundsberget. Orig. Warburg pl.5, figs.54-55. Coll. von-Schalensee, 1883.
E. Cranidium x 15 (PMO 20842). Dorsal view. Latex cast from external mould. Tretaspis Series, Stage 5a, Stavnestangen, Ringerike. Coll. J. Kiaer, 1894.
I. Cranidium x 20 (LO 3119t). Dorsal view. Note weak lateral glabellar furrows. Boda Limestone, locality unknown. Orig. Warburg, pl.5, figs.56-57.
K. Pygidium x 15 (UM D 74). Dorsal view. Boda Limestone, Östbjörka. Orig. Warburg pl.5, fig.58. Coll. O. Isberg.
N. Pygidium x 17½ (PMO 20777a). Dorsal view. For other data see E.

Isbergia parvula Warburg, 1925.

G, H, J, M. HOLOTYPE. Cephalon x 19 (UM D 73). G: dorsal view; H: anterior view; J: anterior oblique view; M: left lateral view. Boda Limestone, Kallholn. Orig. Warburg pl.5, figs.51-53. Coll. O. Isberg.
P. Cranidium x 15½ (UM D 72). Dorsal view. Boda Limestone, Kallholn. Orig. Warburg. pl.5, figs.49-50. Coll. O. Isberg.

Decoroproetus? scanicus (Olin, 1906).

O. HOLOTYPE. Cranidium x 14½ (LO 1940T). Dorsal view, cast from external mould. Tretaspis Series, Röstånga, Scania. Orig. Olin, pl.2, fig.17.

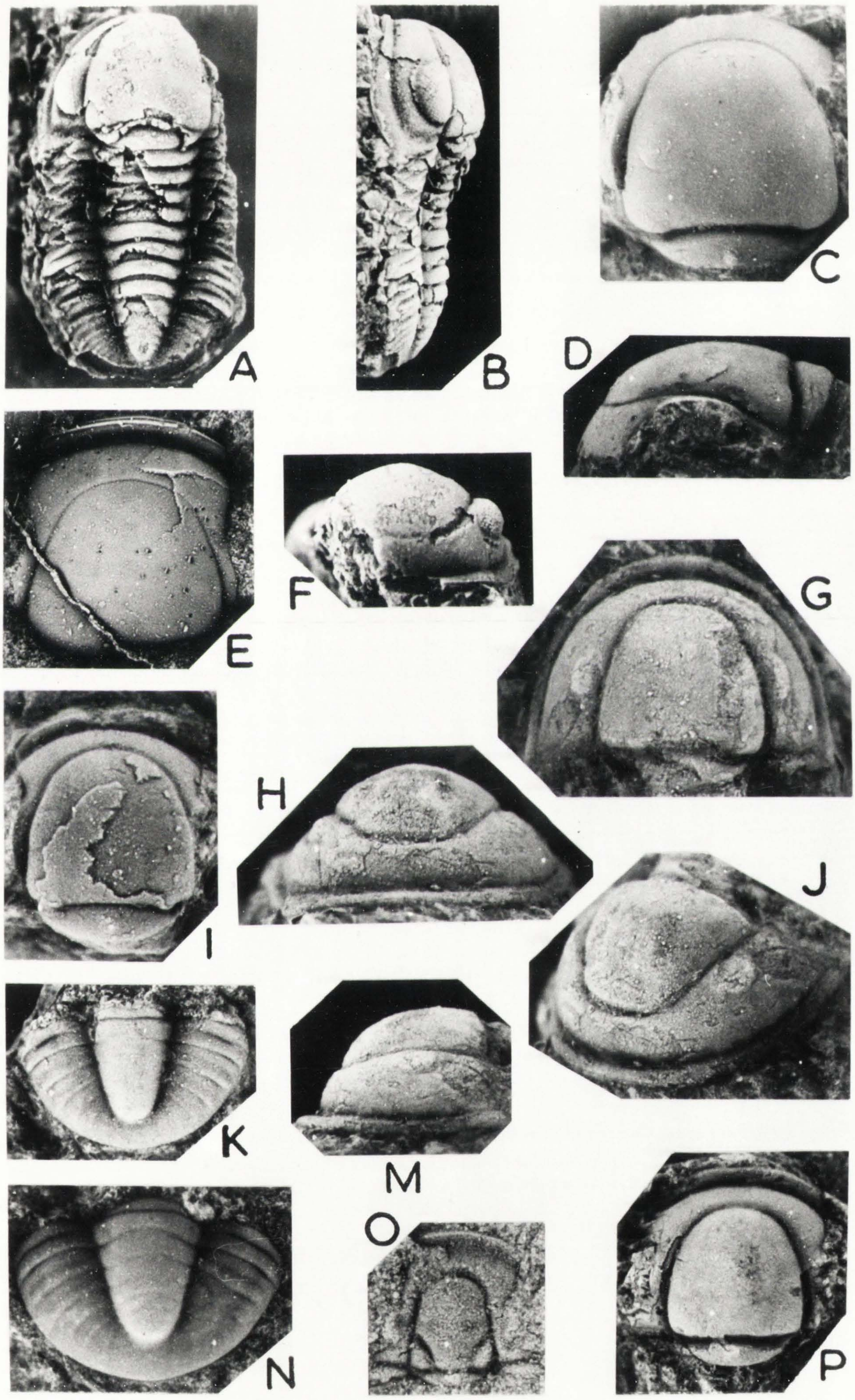
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PLATE 13.

Kallholnia dapsilis gen. et sp. nov.

A, B, D. HOLOTYPE. Complete exoskeleton (RM Ar 47518). A: x $11\frac{1}{2}$ dorsal view; B: x $11\frac{1}{2}$ right lateral view; D: x 32 right lateral view, enlarged to show facets on eye.

C, E, F. Almost complete exoskeleton (RM Ar 47556). C: x 8 dorsal view; E: x $62\frac{1}{2}$ steroscan photograph of eye. Note numerous convex facets; F: x 11 anterior view. Note median occipital tubercle as highest point of animal.

G, I, J. Hypostome x 25 (RM Ar 46812r). G: dorsal view; I: right lateral view; J: anterior view.

All the above are from Boda Limestone, Kallholn.

Kallholnia sp. A.

H, K, L, M. Cranidium x 13 (RM Ar 19169). H: left lateral view; K: anterior view; L: dorsal view; M: anterior oblique view. Macrourus Limestone (erratic block), Eriksöre, Öland.

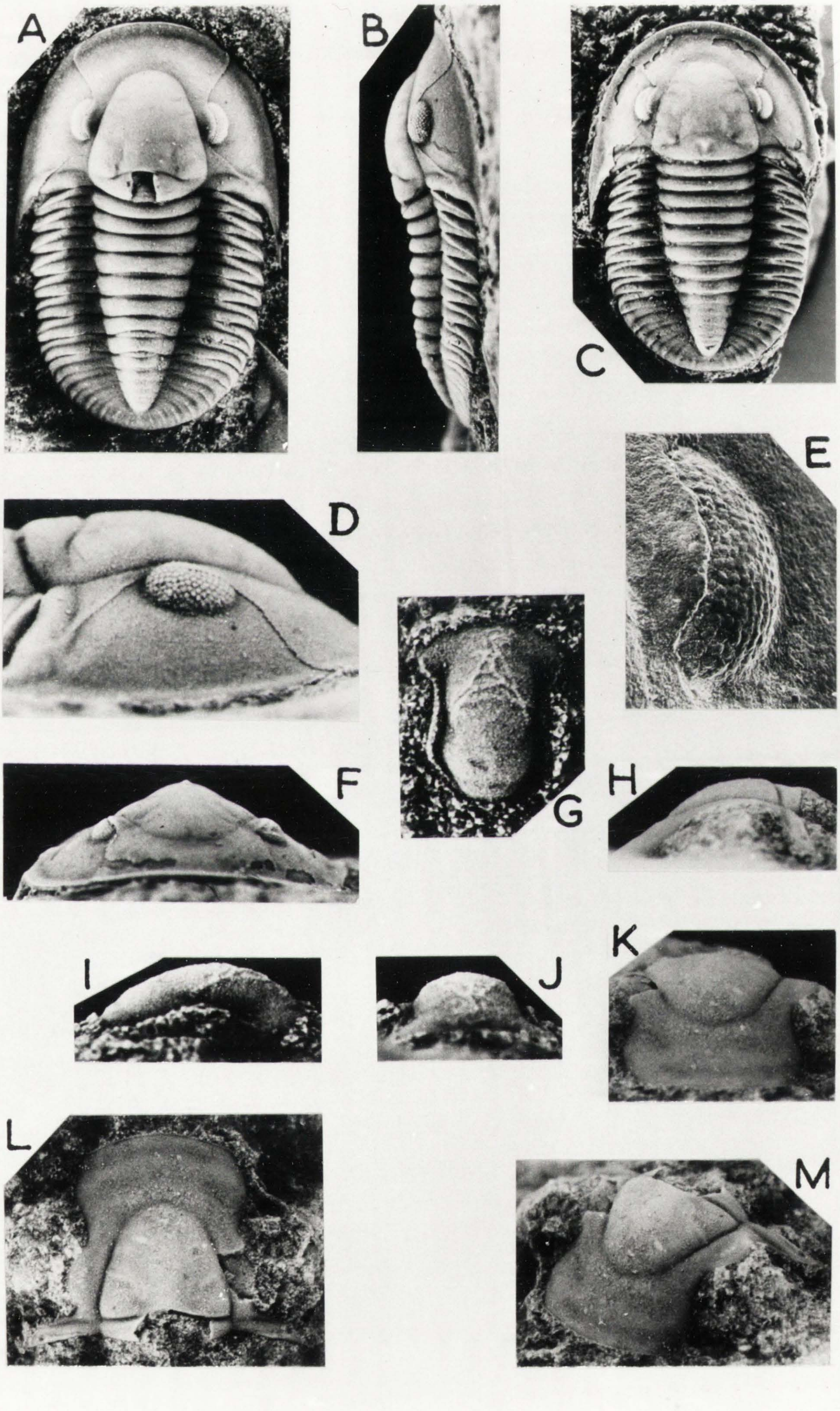
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PLATE 14.

Stenoblepharum warburgae (Přibyl, 1964).

A, *B*, *E*. LECTOTYPE. Nearly complete, partially exfoliated exoskeleton (UM D 53). *A*: x 4¼ dorsal view; *B*: x 4¼ right lateral view; *E*: x 8½ anterior view showing mould of rostral plate where border has been damaged. Boda Limestone, Kallholn. Orig. Warburg, pl.5, fig.8.

C. Nearly complete, partially exfoliated exoskeleton, x 4½ (UM D 54). Dorsal view. Boda Limestone, Kallholn. Orig. Warburg, pl.5, figs.9-10.

D. Free cheek x 5½ (UM D 55). Dorsal view. Boda Limestone, Kallholn. Orig. Warburg, pl.5, fig.12.

F - *H*. Pygidium with 6 attached thoracic segments. x 4¼ (RM Ar 47505). *F*: posterior view; *G*: dorsal view; *H*: left lateral view. Boda Limestone, Kallholn.

I, *J*, *L*. Incomplete cephalon x 9 (RM Ar 10828). *I*: dorsal view; *J*: left lateral view; *L*: anterior oblique view. Boda Limestone, Dalarne. Orig. Warburg, pl.5, fig.11.

K. Pygidium x 10 (RM Ar 45815). Dorsal view. Boda Limestone, Kallholn.

N, *M*. Incomplete cephalon x 6½ (RM Ar 10825). *N*: left lateral view; *M*: dorsal view. Boda Limestone, Östbjörka. Orig. Warburg, pl.5, figs.19-20.

PLATE 14

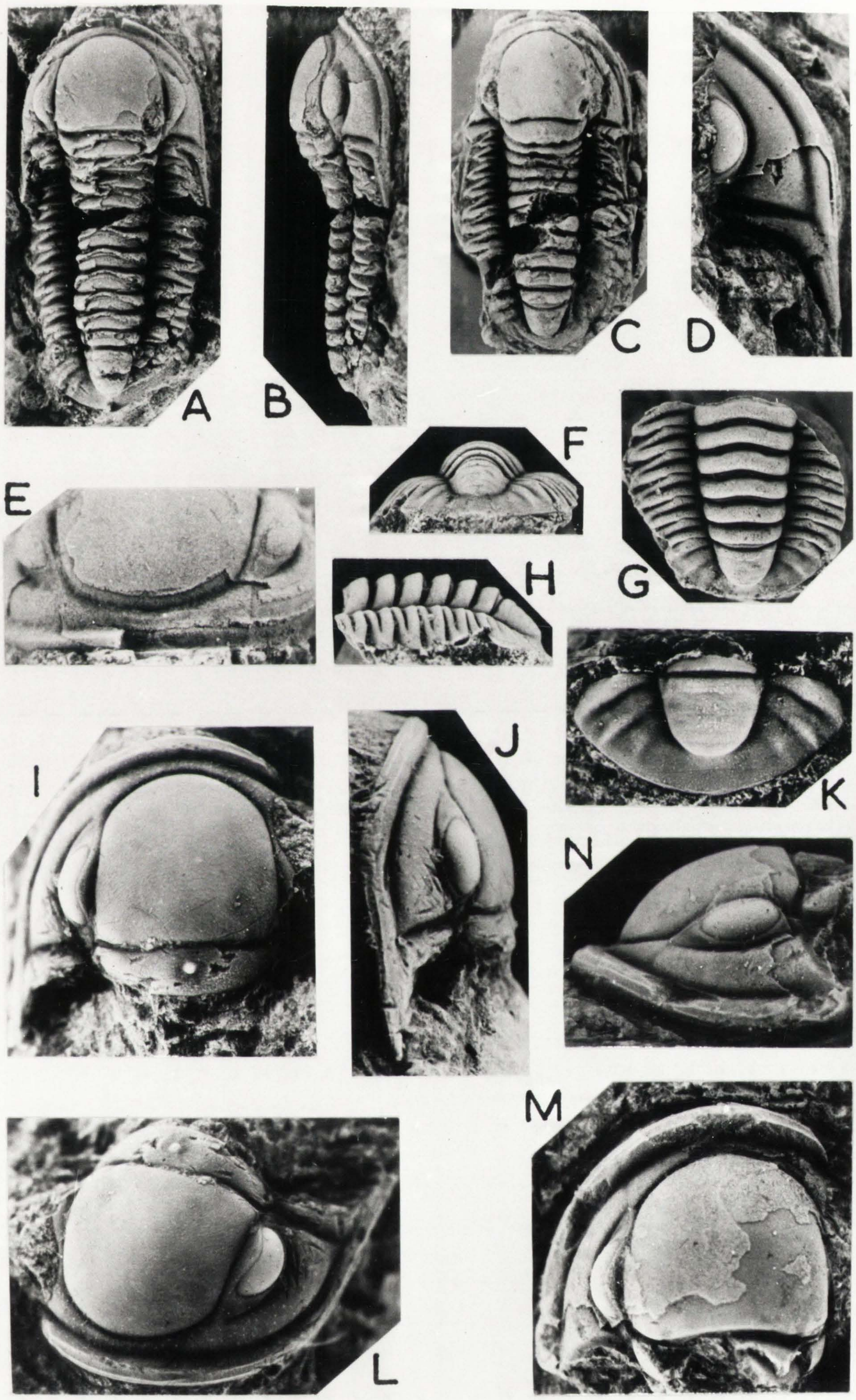


PLATE 15.

Stenoblepharum norvegicum gen. et sp. nov.

A. - C. HOLOTYPE. Cranidium x 9½ (PMO 70435). A: dorsal view; B: left lateral view; C: anterior oblique view. Tretaspis series, Stage 5a, Holmenskjaeret, Oslo-Asker district, Coll. J.F. Bockelie, 1965.

D, F, G. Pygidium x 14 (PMO 70470). D: dorsal view; F: posterior view; G: left lateral view. Tretaspis series, Stage 5a, Holmenskjaeret, Oslo-Asker district. Coll. F. Nikolaisen, 1968.

E. Cranidium x 9 (PMO 70484). Dorsal view. For other data, see A.

H. Cranidium x 13½ (PMO 8410). Dorsal view. Note impressed adaxial part of 1p. Horizon and locality as A. Coll. J.F. Bockelie, 1966.

I. Pygidium x 13½ (PMO 8857). Dorsal view. For other data, see H.

J. Cranidium x 8 (PMO 8413). Dorsal view. Horizon and locality as A. Coll. J.F. Bockelie, 1966.

K. Free cheek x 10 (PMO 70428). Dorsal view. Other data as for G.

L. Cranidium x 8 (RM Ar 10879). Dorsal view. Boda Limestone, Gryssen, Dalarna. Coll. G. Holm, 1880.

PLATE 15

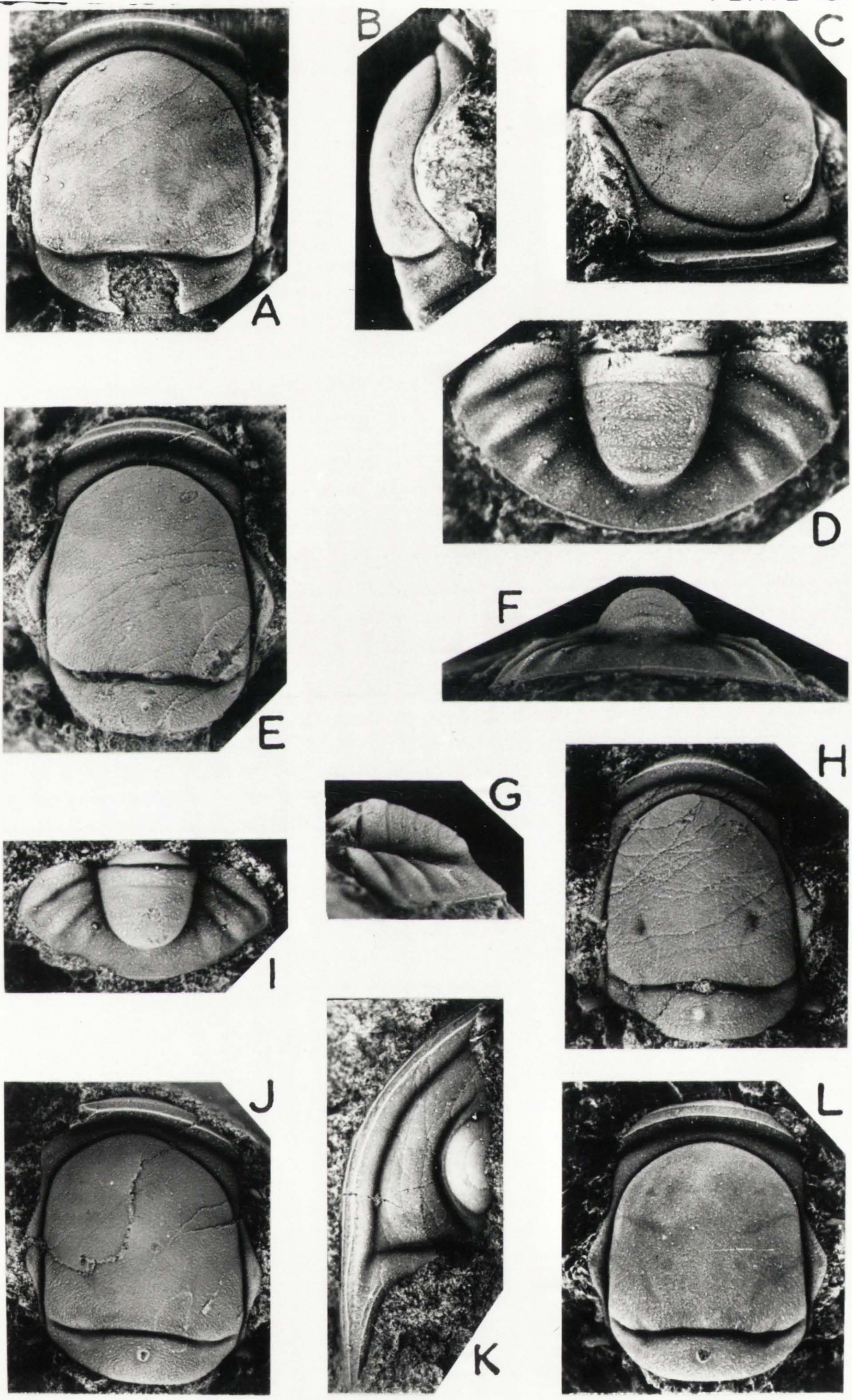


PLATE 16.

Stenoblepharum kullsbergense (Warburg, 1925).

A, B, F, H. HOLOTYPE. Cranidium x 9½ (UM D 61). A: dorsal view; B: left lateral view; F: anterior view; H: anterior oblique view. Kullsberg Limestone, Kullsberg. Orig. Warburg, pl.5, fig.24.

C, D, E. Pygidium x 12 (UM D 62). C: right lateral view; D: dorsal view; E: posterior view. Kullsberg Limestone, Kullsberg. Orig. Warburg, pl.5, fig.25.

G. Cranidium x 8 (RM Ar 10884). Dorsal view. Kullsberg Limestone, Kullsberg. Coll. G. Holm, 1880.

I. Cranidium x 10 (RM Ar 43740). Dorsal view. Kullsberg Limestone, Kullsberg. Coll. O. Isberg.

J. Free cheek x 15 (RM Ar 47506). Dorsal view. Kullsberg Limestone, Kullsberg. Coll. O. Isberg, 1913.

K. Pygidium x 10 (RM Ar 43394). Dorsal view. Kullsberg Limestone, Amtjärn. Coll. O. Isberg.

M. Pygidium x 12½ (UM D 1376a). Dorsal view. Kullsberg Limestone, Kullsberg. Coll. E. Warburg.

Stenoblepharum pentagonoides (Warburg, 1925).

L. Cranidium x 3½ (RM Ar 10861). Dorsal view. Boda Limestone, Osmundsberget, Lake Siljan district.

O - R. HOLOTYPE. Cranidium x 5½ (RM Ar 10838). O: anterior oblique view; P: left lateral view; Q: dorsal view; R: anterior view. Boda Limestone, Unskarsheden. Orig. Warburg, pl.5, fig.22.

PLATE 16

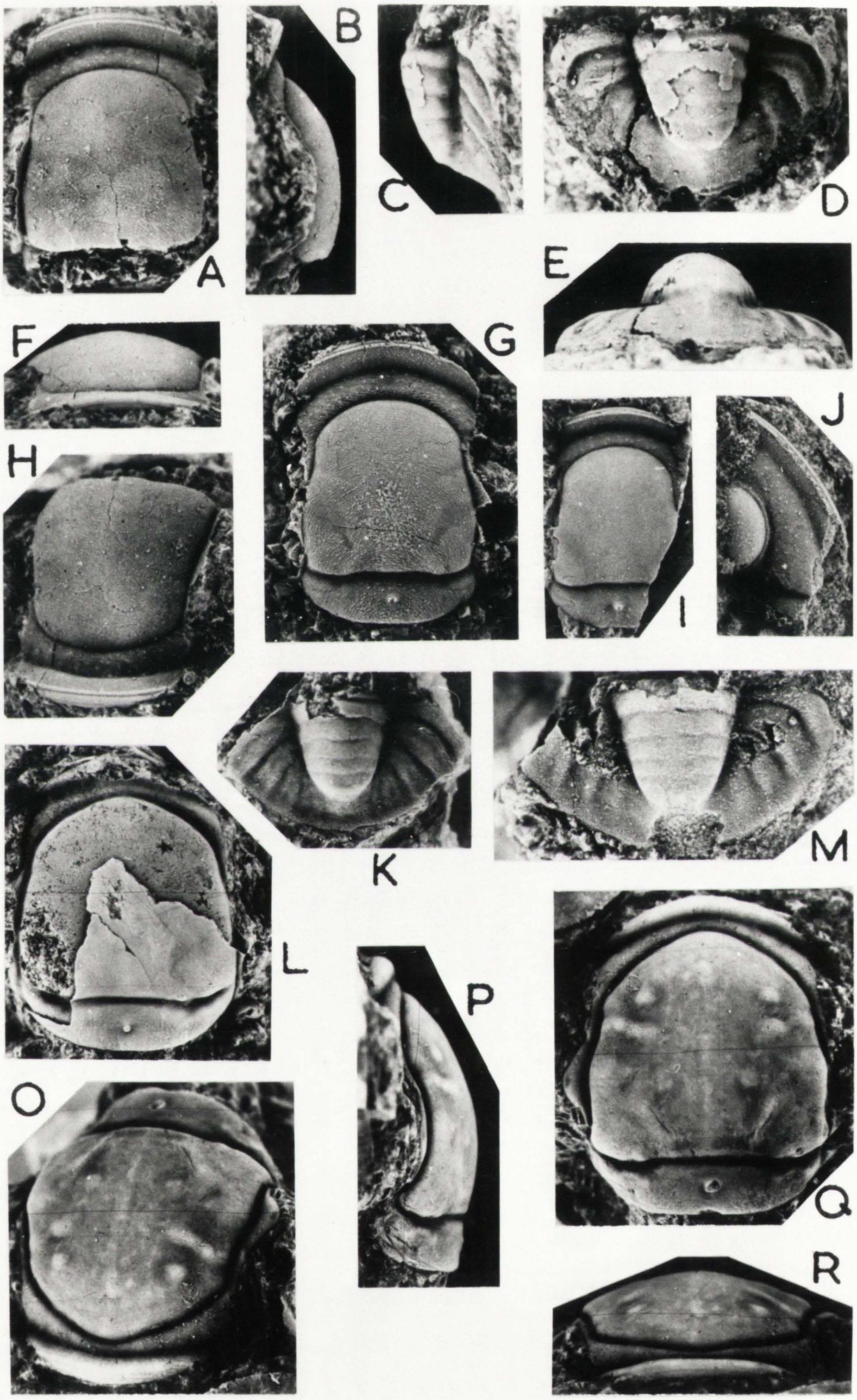


PLATE 17.

Parvigena parvigena (Warburg, 1925).

A, D, G, H. HOLOTYPE. Cephalon with three attached thoracic segments x 10 (UM D 63). A: dorsal view; D: anterior oblique view; G: left lateral view. Note lower margin of eye socle reaching close to the lateral margin. H: anterior view. Boda Limestone, Kallholn. Coll. O. Isberg. Orig. Warburg, pl.5, figs. 32-33.

Parvigena striata gen. et sp. nov.

B. Cranidium x 5½ (RM Ar 10822). Dorsal view. Boda Limestone, Dalarna.

C, E. Cranidium x 7 (RM Ar 47495). C: dorsal view; E: left lateral view. Boda Limestone, Kallholn, Lake Siljan district, Dalarna.

F. HOLOTYPE. Cranidium x 8 (UM D 60). Dorsal view. Boda Limestone, Kallholn. Orig. Warburg, pl.5, fig.23.

Eremiproetus agellus sp. nov.

I, L. HOLOTYPE. Cranidium x 8½ (PMO 55817). I: left lateral view; L: dorsal view; Tretaspis series, Stage 5a, Nøstset, Saelabon, Ringerike. Coll. J. Kiaer, 1916.

K. Pygidium x 7½ (S.G.U. Coll.). Dorsal view. Boda Limestone, Kallholn. Coll. P. Thorslund, 1935.

J. Cranidium x 6 (RM Ar 10821). Dorsal view. Boda Limestone, Dalarna.

M. Pygidium x 9 (UM D 58). Dorsal view. Boda Limestone, Kallholn. Orig. Warburg, pl.5, fig.17.

N. Pygidium x 7½ (UM D 57). Dorsal view. Note broad doublure with prominent terrace lines. Boda Limestone, Kallholn. Orig. Warburg, pl.5, fig.14.

PLATE 17

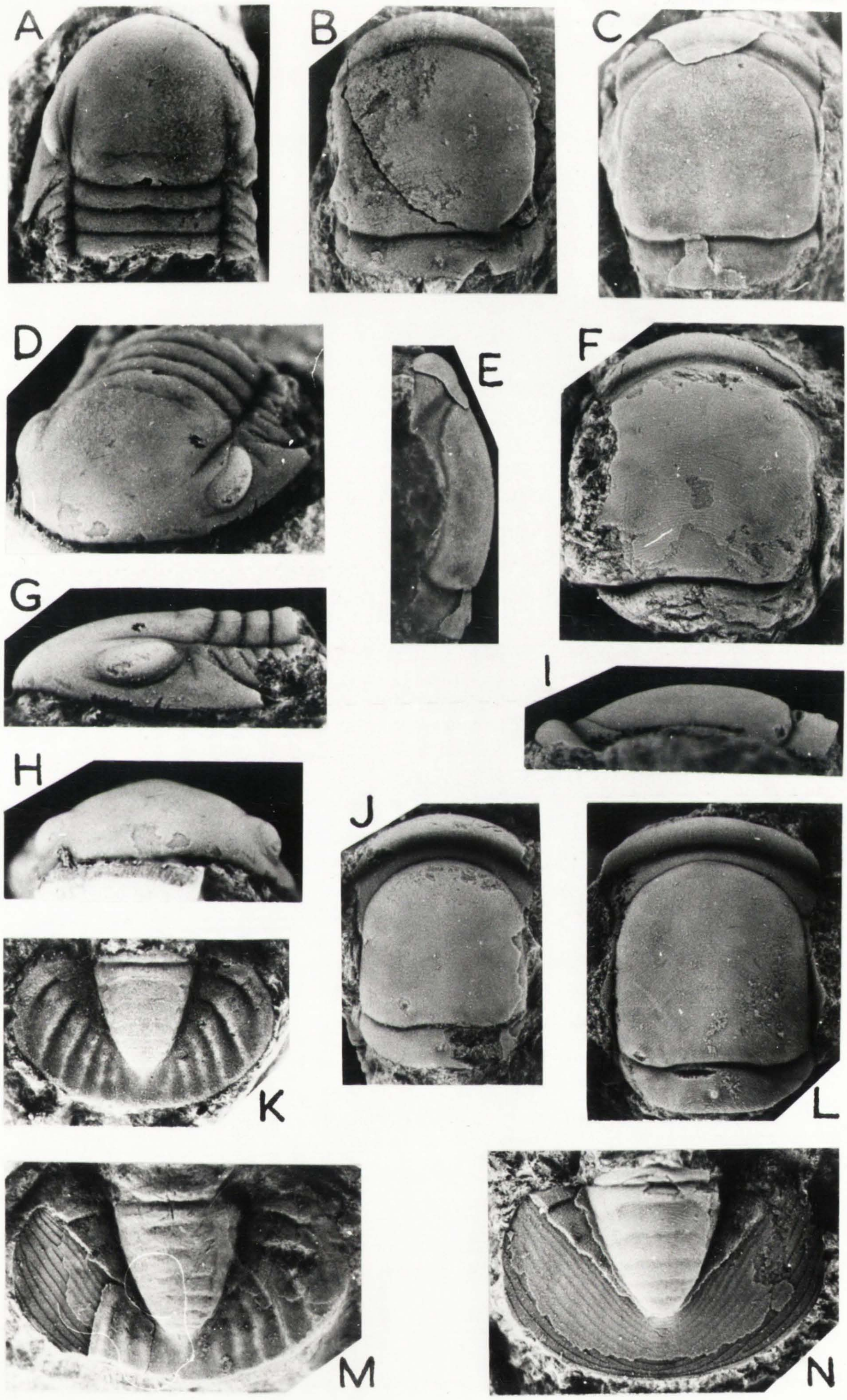


PLATE 18.

Eremiproetus agellus sp. nov.

A. Pygidium x 9 (PMO 70424). Dorsal view. Tretaspis series, Stage 5a, Holmenskjaeret, Oslo-Asker district. Coll. D.L. Bruton, J.F. Bockelie and F. Nikolaisen, 1966.

B. Free cheek x 5 (PMO 20777). Dorsal view. Tretaspis series, Stage 5a, Stavnestangen, Ringerike. Coll. J. Kiaer, 1894.

D. Pygidium x 4½ (PMO 20778). Dorsal view. For other data, see B.

K. Cranidium x 5 (PMO 20779). Dorsal view. For other data, see B.

? Eremiproetus agellus sp. nov.

J. Small cranidium x 18 (PMO 8427). Dorsal view. Tretaspis series, Stage 5a, Holmenskjaeret, Oslo-Asker district. Coll. J.F. Bockelie, 1965.

Xenocybe micrommata gen. et sp. nov.

C. Free cheek x 6 (PMO 8832). Dorsal view. Tretaspis series, Stage 5a, Holmenskjaeret, Oslo-Asker district. Coll. J.F. Bockelie, 1966.

E, F. HOLOTYPE. Cranidium x 13 (PMO 8831). E: right lateral view; F: dorsal view. Tretaspis series, Stage 5a, Holmenskjaeret, Oslo-Asker district.

G. Cranidium x 11 (PMO 13336). Dorsal view. Note partially exfoliated occipital ring, showing mould of transverse terrace lines on ventral side of doublure. For other data, see B.

H. Free cheek x 8¼ (PMO 8833). Dorsal view. For other data, see C.

L. Incomplete cranidium x 18 (PMO 8854). Dorsal view. For other data, see C.

Indetermined proetid hypostome.

I. x 13 (UM D 59). Dorsal view. Boda Limestone, Kallholn. Orig. Warburg, pl5, fig.21. Coll. O. Isberg.

PLATE 18

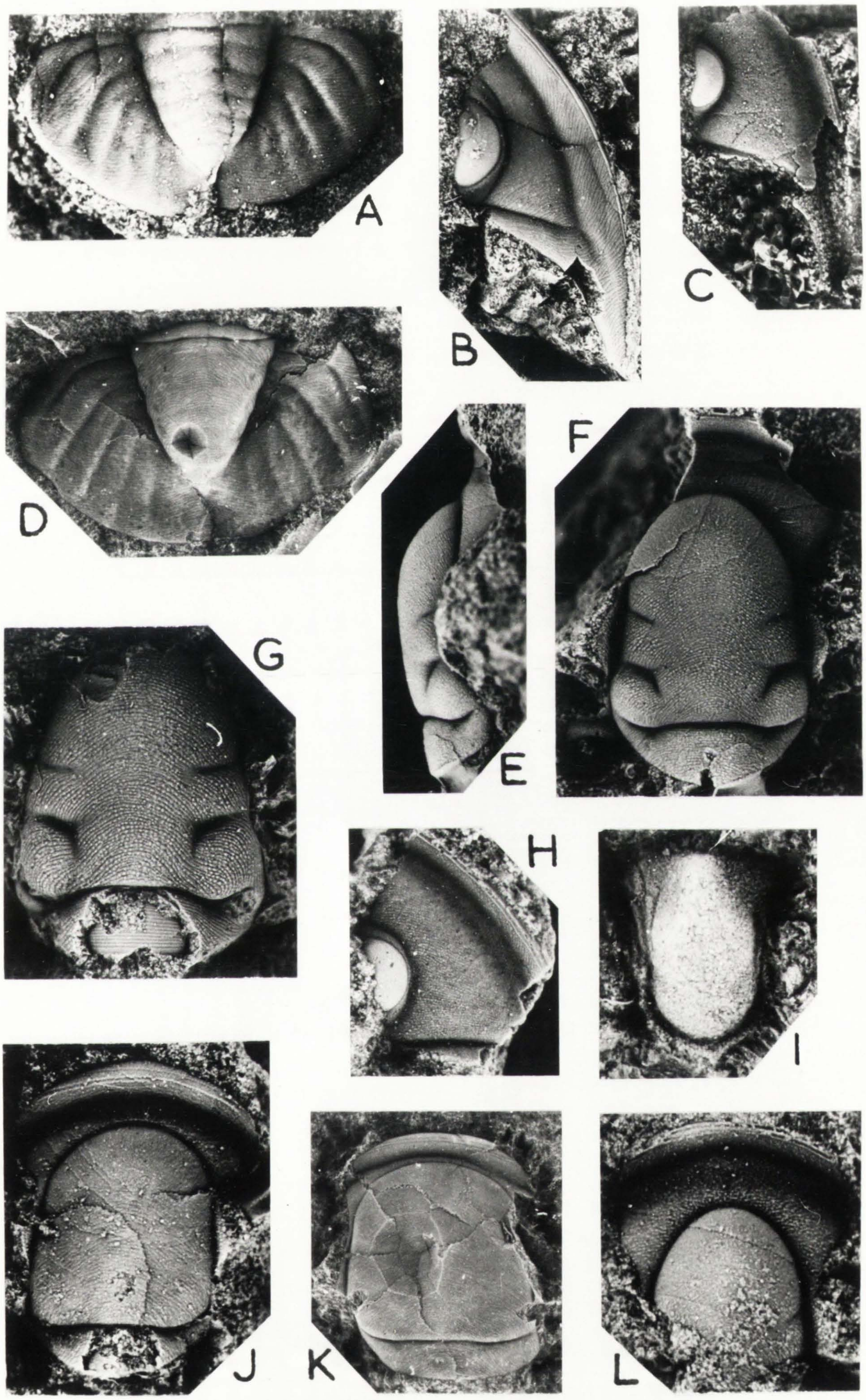


PLATE 19.

Proetus berwynensis (Whittington, 1966).

1 - 2. x $3\frac{1}{2}$ (BM 59355). Dorsal stereograph of latex cast taken from external mould. Ashgill, Ddolhir Beds, Cynwyd, $2\frac{1}{2}$ miles S.W. of Corwen, Merioneth. Parrott coll.

Proetus cf. berwynensis (Whittington, 1966).

3. Free cheek, x $7\frac{1}{2}$ (BM It 8851). Dorsal view. Silicone cast taken from external mould. Ashgill (? Cautleyan), Quarry on east side of dingle, Robestone Wathen, Pembrokeshire (SN 083162).
4. Free cheek, internal mould, x 7 (BM It 8852). Dorsal view. For other data, see 3.
5. Pygidium, internal mould, x 7 (BM It 8853). Dorsal view. For other data, see 3.
6. Pygidium, internal mould, x $6\frac{1}{2}$ (BM In 54446). Dorsal view. Caradoc? Tre Wern Quarry, 1200' N. of Fron, $1\frac{1}{2}$ miles W. of Whitland, Carmarthenshire.
7. Cranidium, internal mould, x 5 (BM It 8854). Dorsal view. For other data, see 3.
8. Pygidium, internal mould, x 8 (GSM Pr 213). 'Bala Limestone', Bron haul, between Morfa-Bâch and Cresswell.
15. Cranidium, internal mould, x 9 (BM It 8855). Dorsal view. For other data, see 3.

Ascetopeltis barkingensis gen. et sp. nov.

9, 10, 12, 13. HOLOTYPE. Cranidium, x 6 (SMC A 43029). 9: dorsal view; 10: left lateral view; 12: anterior view; 13: anterior oblique view. Ashgill, Barking, Dent, N.W. Yorkshire.
11, 18. Pygidium, x 6 (SMC A 43030). 11: lateral view; 18: dorsal view. For other data, see 9.
14. Cranidium, x 5 (SMC A 43031). Dorsal view. Note transverse terrace lines on mould of ventral surface of doublure of occipital ring. For other data, see 9.
19. Incomplete pygidium, x 6 (SMC A 43034). Dorsal view. For other data, see 9.

Paraproetus girvanensis (Nicholson and Etheridge, 1879).

16. LECTOTYPE. Complete, partially exfoliated exoskeleton, x $2\frac{1}{4}$ (BM In 21926). Dorsal view. Ashgill, late Rawtheyan, Upper Drummuck Group, Thraive Glen, Girvan. Coll. Mrs. Gray. Orig. Nicholson and Etheridge, pl.12, fig.10.
17. Cranidium, silicone cast taken from external mould, x 9 (SMC A 43155). Dorsal view. Ashgill, Hirnantian Stage, "Mucronatus Beds", N.N.E. of Sheepfold, S.W. of Torver Beck, near Coniston. Coll. J.E. Marr.
20 - 22. Complete specimen, x $2\frac{1}{2}$ (BM In 21915). 20: internal mould, dorsal view; 21-22: Silicone cast of external mould, dorsal stereograph. Note rows of granules on posterior edge of occipital ring and thoracic axial rings. Ashgill, late Rawtheyan Stage, Upper Drummuck Group, Thraive Glen, Girvan. Coll. Mrs. Gray. Orig. Reed, pl.11, fig.3.

PLATE 19

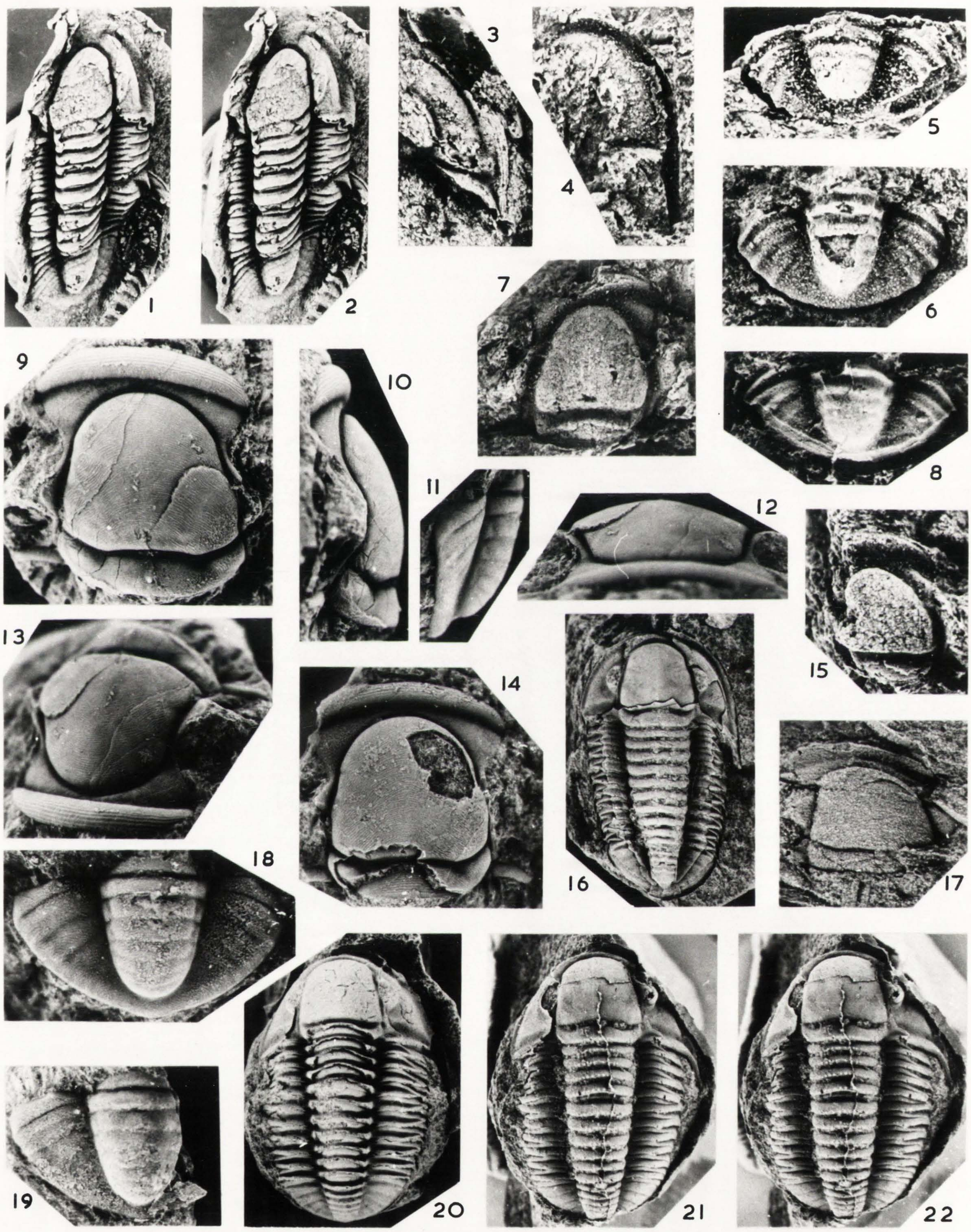


PLATE 20.

Paraproetus girvanensis (Nicholson and Etheridge, 1879).

1 - 2. Complete internal mould, x 2½ (BM In 21914). 1: Dorsal view of thorax and pygidium; 2: Dorsal view of cephalon and part of thorax. Ashgill, late Rawtheyan Stage, Upper Drummuck Group, Thraive Glen, Girvan. Coll. Mrs. Gray. Orig. Reed, pl.11, figs.2,2a.

4 - 10. Complete, partially enrolled individual, x 2¼ (GSM 35612). 4: Right lateral view; 5,6: Dorsal stereograph of cephalon; 7,8: Anterior oblique stereograph of cephalon; 9,10: Dorsal stereograph of pygidium and posterior part of thorax. Ashgill, late Rawtheyan Stage, Thraive Glen, Girvan. Orig. Nicholson and Etheridge, pl.12, figs.7a-d.

13 - 14. Distorted cephalon, x 2½ (HM A 3689). Dorsal stereograph. Ashgill, late Rawtheyan Stage, Upper Drummuck Group, Starfish Bed, No.2, Ladyburn, near Girvan. Orig. Begg, 1945, pl.1, figs.1-2, holotype of Proetus scobiei Begg. Coll. J.L. Begg.

15. Cranidium, internal mould, x 4 (BM It 8856). Dorsal view. Ashgill, temporary exposure in Dynana Farmyard, ¾ mile NNE. of Llanystumdwy, Caernarvonshire. (481396). Coll. S.F. Morris, 1968.

16. Distorted cranidium, internal mould, x 6½ (SMC 36051). Dorsal view. Ashgill, Hirnantian Stage, lower "Mucronatus Beds", waterfall on right side of Ashgill Beck, S.W. of Ashgill Quarry, Torner. Coll. J.T. Temple.

17. Cephalon with parts of seven attached thoracic segments, x 3½ (BM It 8857). Dorsal view. For other data see 15.

18. Pygidium, internal mould, x 8½ (SMC A 36002). Dorsal view. For other data see 16.

19. Incomplete cephalon, internal mould, x 3 (BM It 8858). Dorsal view. For other data see 15.

20. Cranidium, internal mould, x 5 (SMC 30649). Dorsal view. For other data see 15.

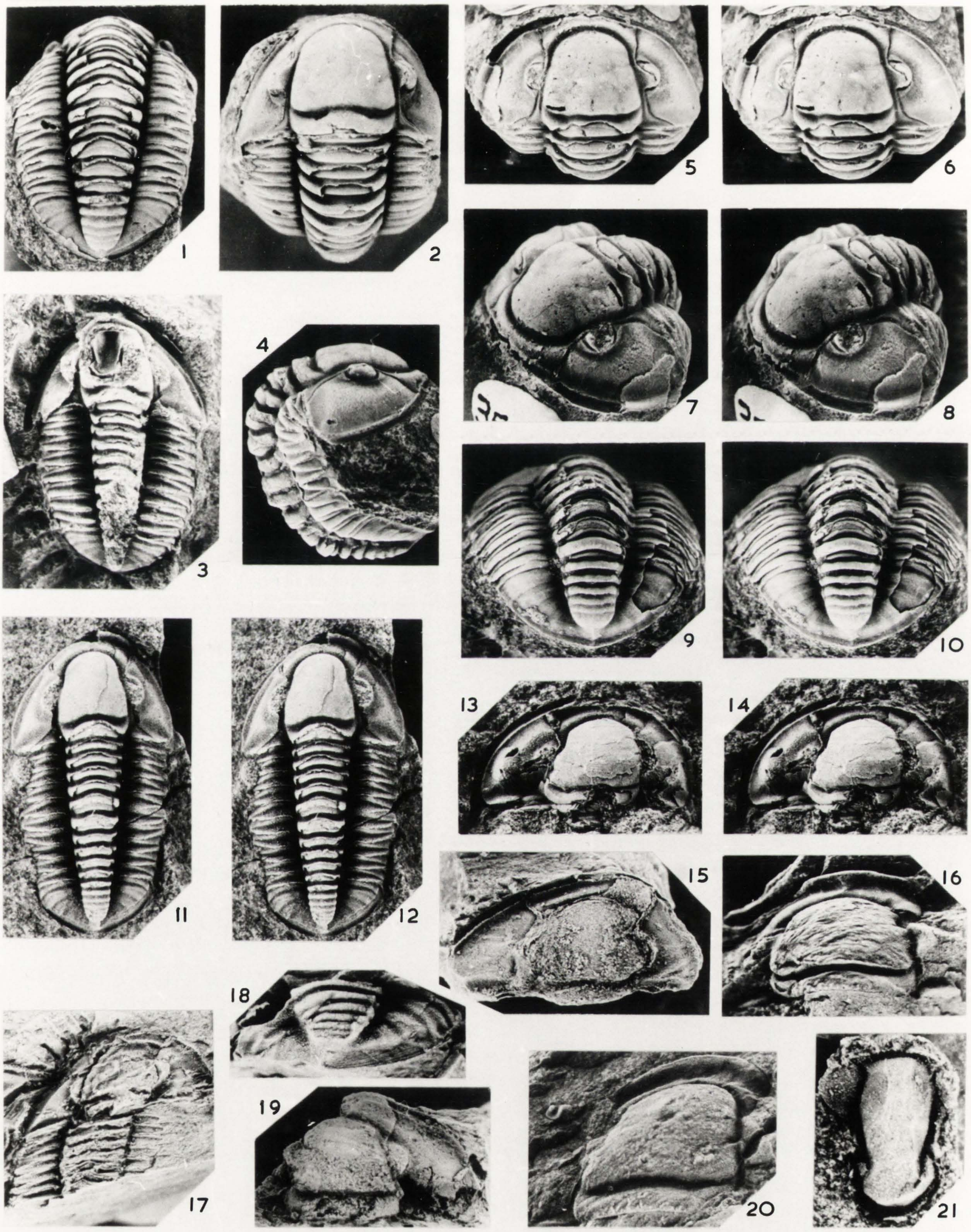
Paraproetus procerus (Nicholson and Etheridge, 1879).

3. Complete internal mould, showing external mould of hypostome, x 4 (BM In 21943). Dorsal view. Ashgill, late Rawtheyan. Upper Drummuck Group, Thraive Glen, Girvan. Orig. Reed, pl.11, fig.6.

11 - 12. Complete internal mould, HOLOTYPE, x 4 (BM In 21942). Dorsal stereograph. Ashgill, late Rawtheyan, Upper Drummuck Group, Thraive Glen, Girvan. Orig. Nicholson and Etheridge, pl.12, fig.11. Coll. Mrs. Gray.

21. Hypostome, internal mould, from specimen in Fig.3, x 11. Orig. Reed, pl.11, fig.6a.

PLATE 20



26. Free cheek, x $3\frac{1}{2}$ (GSM PJ 3616). Dorsal view. For other data see 20.

Decoroproetus fearnsidesi (Bancroft, 1949).

22 - 23. HOLOTYPE. Silicone cast from complete external mould, x $2\frac{1}{4}$ (BM In 42083). Dorsal stereograph. Caradoc, Harnagian Stage, Reuscholithus reuschi zone, section in old cartway near Southern end of Smeathen Wood, near Horderley. Orig. Bancroft, 1949, pl.10, fig.23.

27. Complete exoskeleton, x $3\frac{3}{4}$ (BM I 3199). Dorsal view. Caradoc, probably Harnagian Stage,"flank of Longmynd, near Horderley". Brodie coll.

29. Small thorax and pygidium, x 5 (BM In 51454). Dorsal view. Caradoc. Harnagian Stage, cartway section near S. end of Smeathen Wood, near Horderley. (Bancroft loc. W.5). Orig. Dean, 1963, pl.45, fig.8. Coll. W.T. Dean.

? Decoroproetus fearnsidesi (Bancroft, 1949)

24. Cranidium, internal mould, x 10 (GSM 35616). Caradoc. ? Harnagian Stage. Probably from Horderley district.

Decoroproetus piriceps (Ingham, 1970).

25. Cranidium, internal mould, laterally compressed. x $6\frac{1}{2}$ (SMC A 28945). Ashgill, Cautleyan Stage, Sally Brow, near Murthwaite, Westmorland, loc. SB.3, King and Williams, 1948.

Decoroproetus irregularis (Kielan, 1960).

28. Incomplete cephalon, with parts of 7 attached thoracic segments. Silicone cast from external mould, x $2\frac{1}{2}$ (SMC 39017). Ashgill, Rawtheyan Stage, Upper calcareous shales below Wharfe Conglomerate, Austwick Beck, just below Wharfe Mill Dam, near Austwick, Yorkshire.

30. Cephalon, with parts of 6 attached thoracic segments. Silicone cast from external mould, x 4 (SMC 39018). Dorsal view. For other data see 28.

PLATE 21.

Decoroproetus avioclivalis sp. nov.

1. HOLOTYPE cranidium, x $5\frac{1}{2}$ (BM It 8827). Dorsal view. Ashgill, Birdshill limestone, Quarry 200 yds. N.W. of Birdshill Farm, $1\frac{1}{2}$ miles W.N.W. of Llandeilo. Coll. W.T. Dean, 1959.

2. Cranidium, x $9\frac{1}{2}$ (BM It 8828). Dorsal view. For other data see 1.

3. Free cheek, x 3 (BM It 8829). Dorsal view. For other data see 1.

4 - 5. Pygidium, x 7 (BM It 8830). 4: Dorsal view; 5: Left lateral view. For other data see 1.

6 - 7. Free cheeks. 6: x 4 (BM It 8831); 7: x 5 (BM It 8832). For other data see 1.

9. Cranidium, x 6 (BM It 8833). Dorsal view. For other data see 1.

11. Pygidium, x $3\frac{1}{2}$ (BM It 8834). Dorsal view. For other data see 1.

Decoroproetus calvus (Whittard, 1961).

8, 15. Cranidium, internal mould, x $6\frac{1}{2}$ (IC Murchison Mus. 5359). 8: Lateral view; 15: Dorsal view. Caradoc, Soudleyan Stage, Gaerfawr Grits, Moel-y-garth, Welshpool. Wade coll.

10, 16. Cranidium, x $6\frac{1}{2}$ (BM It 8835). 10: Left lateral view; 16: Dorsal view. Caradoc, ? Marshbrookian Stage, Crûg quarry, N. of Llandeilo.

12, 13. Pygidium, x 5 (BM It 8836). 12: Dorsal view; 13: Right lateral view. For other data see 10.

14. Free cheek, x 4 (BM It 8837). Dorsal view. For other data see 10.

17, 18. HOLOTYPE cranidium, internal mould, x $3\frac{1}{2}$ (GSM 87169). 17: Left lateral view; 18: Dorsal view. Caradoc, Soudleyan Stage, tuffaceous band in Whittery Shales of Whittery Quarry. Orig. Whittard, 1961, pl.24, fig.15.

19. Cranidium, internal mould x 5 (BM In 54644). Dorsal view. Caradoc, Lower Longvillian Stage, B. typa zone, loc. E.3, Harthwaite sike, east of Dufton, Westmorland. Orig. Dean, 1962, pl.17, fig.8, holotype of Proetidella? marri Dean.

20, 21. Cranidium, x $6\frac{1}{2}$ (GSM PJ 3617). 20: Right lateral view; 21: Dorsal view. Caradoc, Lower Longvillian Stage, Harthwaite sike, east of Dufton, Westmorland.

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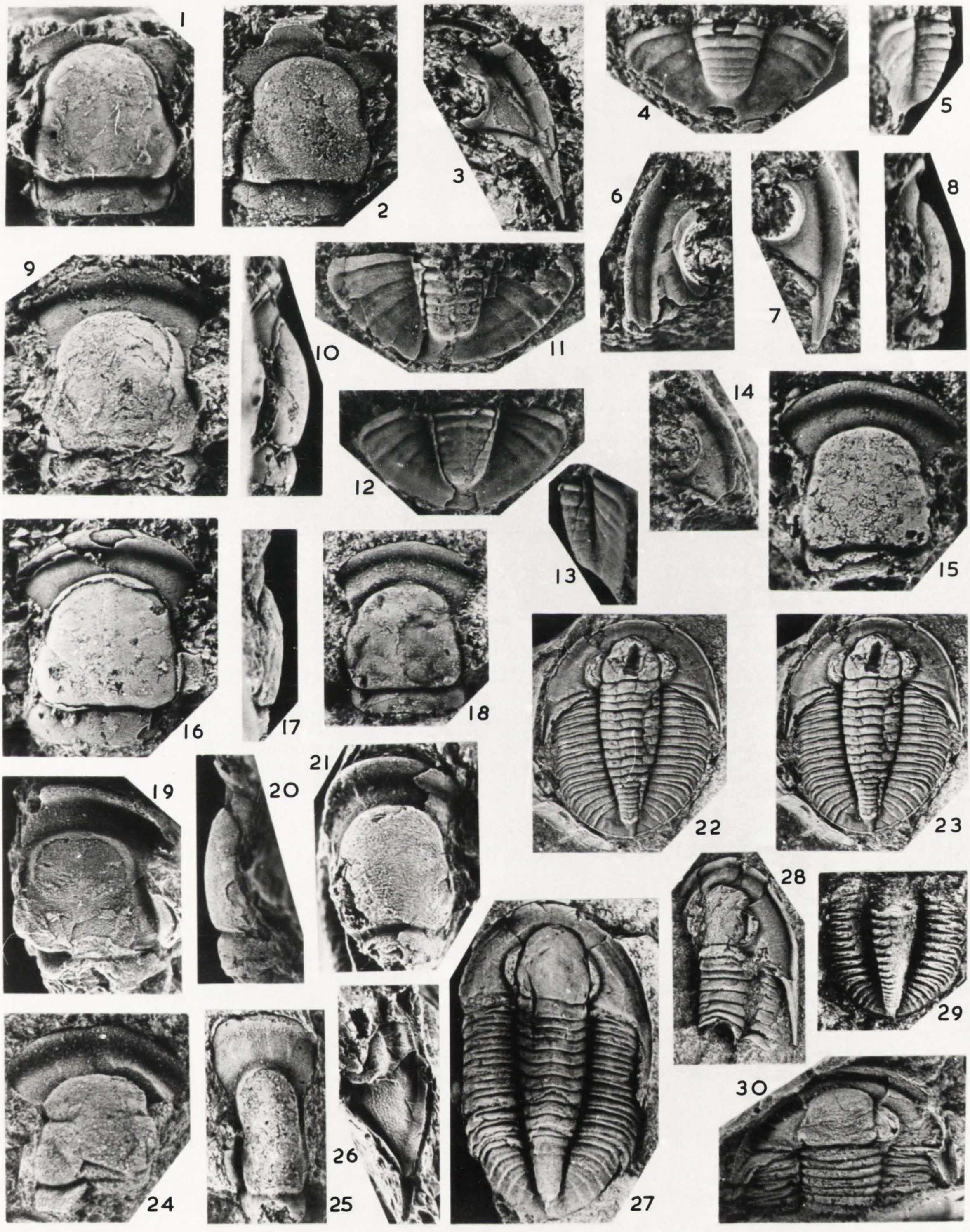
PLATE 21



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20, 25,-27. Cranidium. (SMC A 31744). 20: Left lateral view, x 7; 25: Dorsal view, x 6½; 26: Anterior view, x 6½; 27: Anterior oblique view, x 7. Ashgill, probably Cautleyan Stage, Keisley limestone, Keisley, Westmorland. Coll. W.B.R. King.

21. Cranidium, x 7½ (SMC A 9598). Dorsal view. For other data see 15.

22. Free cheek, x 4 (BM It 8859). Dorsal view. Ashgill, probably Cautleyan Stage, Keisley limestone, Keisley, Westmorland. Coll. R.M. Owens, 1966.

23. Free cheek, x 7 (SMC A 9595). Dorsal view. For other data see 15.

Decroproetus pristinus sp. nov.

19. Isolated silicified cranidium, x 18 (BM It 8860). Dorsal view. Llandeilo series, quarry west of Pen-y-banc, 300 yds. S. of Llangwm Farm, N.W. of Llandeilo.

24. Free cheek, x 9½ (SMC A 46911). Dorsal view. Upper Llandeilo, 80 yds. N. of Nant, 1 mile north of Llanrhaiadr-ym-Mochnant. Orig. MacGregor, pl.116, fig.12. Coll. A.R. MacGregor.

28, 29. HOLOTYPE cranidium, internal mould, x 7½ (SMC A 46912). 28: Dorsal view; 29: Left lateral view. Upper Llandeilo, 200 yds. NNW. of Nant, 1 mile north of Llanrhaiadr-um-Mochnant, Montgomeryshire. Orig. MacGregor, pl.116, fig.13. Coll. A.R. MacGregor.

30. Cranidium, internal mould, x 7½ (NMW 63.459.G52). Horizon and locality as 24. Coll. A.R. MacGregor.

PLATE 22.

Decoroproetus jamesoni (Reed, 1914).

1 - 4. HOLOTYPE, complete specimen, x 5 (BM In 21971). 1-2: Internal mould, dorsal stereograph. 3: Silicone cast from external mould, dorsal view; 4: Internal mould, left lateral view. Caradoc, Balclatchie Group, Balclatchie, Girvan. Orig. Reed, 1914, pl.4, fig.8. Coll. Mrs. Gray.

5, 7, 8. Incomplete cephalon, with parts of 4 attached thoracic segments, x 4 (HM A 4122). 5: Anterior oblique view; 7: Right lateral view; 8: Dorsal view. Caradoc, Balclatchie Group, Balclatchie, Girvan. Orig. Begg 1951, pl.1, fig.1, holotype of Proetus balclatchiensis, Begg. Coll. J.L. Begg.

6, 9. Cephalon, silicone cast from external mould, x 5 (HM 4123). 6: Dorsal view; 9: Left lateral view. Caradoc, Balclatchie Group, Balclatchie, Girvan. Orig. Begg 1951, pl.1, fig.2, holotype of Proetus trefoileum Begg. Coll. J.L. Begg.

12. Cranidium, x 13½ (HM A 4124a). Dorsal view. Caradoc, Balclatchie Group, Balclatchie, Girvan. Orig. Begg 1951, pl.1, fig.3. Coll. J.L. Begg.

13. Cranidium, internal mould, x 12½ (HM A 3692). Dorsal view. Caradoc, Balclatchie Group, Dow Hill, near Girvan. Orig. Begg, 1946, pl.3, fig.3, holotype of Proetus ardmillanensis. Begg. Coll. J.L. Begg.

14. Cranidium, x 8 (BM In 37547). Dorsal view. Caradoc. Balclatchie Group, Balclatchie, Girvan. Orig. Reed, 1940, pl.8, fig.1, holotype of Proetus vicinus Reed (non Hawle and Corda).

Decoroproetus mactaggarti (Begg, 1946).

10. Complete internal mould, by 3¾ (BM In 21944). Dorsal view. Ashgill, late Rawtheyan Stage, Upper Drummuck Group, Starfish Bed No.1, Thraive Glen, Girvan. Coll. Mrs. Gray.

11. Complete internal mould, x 5¼ (BM In 40922). Dorsal view. For other data see 10.

16 - 17. Complete internal mould, HOLOTYPE, x 3 (HM A 3961). Dorsal stereograph. Ashgill, late Rawtheyan Stage, Upper Drummuck Group, Starfish Bed a few feet above No.3 Lady Burn, near Girvan. Orig. Begg, 1946, pl.3, figs.1-2. Coll. J.L. Begg.

Decoroproetus mactaggarti (Begg, 1946)?

18. Incomplete internal mould, x 5 (HM A1088). Dorsal view. Ashgill, late Rawtheyan Stage, Upper Drummuck Group, Starfish Bed No.2, Lady Burn, Girvan. Coll. J.L. Begg.

Decoroproetus aff. subornatus (Cooper and Kindle, 1936).

15. Cranidium, x 6½ (SMC A 9596). Dorsal view. Ashgill, probably Cautleyan Stage, limestone dyke, railway cutting 2000' S. of Horton-in-Ribblesdale Station, Yorkshire. Coll. W.B.R. King.

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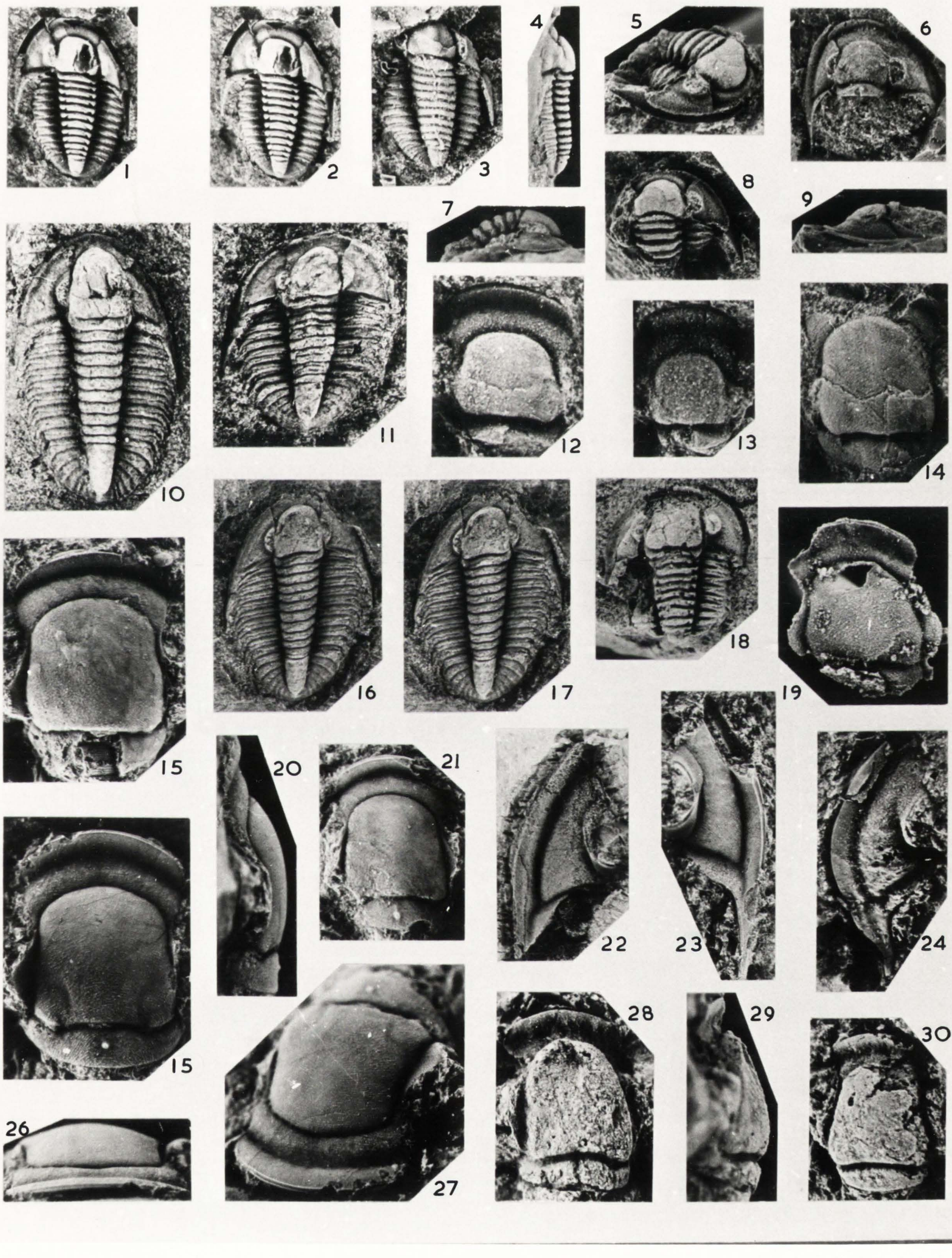
PLATE 22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Astropoetus reedi Begg, 1939.

20. Incomplete exoskeleton, internal mould, x $2\frac{1}{2}$ (BM In 43102). Dorsal view, showing external mould of hypostome where glabella has been damaged. Ashgill, Upper Drummuck Group, Starfish Bed No.1, Thraive Glen, Girvan. Coll. Mrs. Gray.

21 - 23. Holotype. Complete internal mould, x 3 (HM A 1082). 21-22: Dorsal stereograph. Note mould of transversely elongated rostral plate; 23: Right lateral view. Ashgill, Upper Drummuck Group, Starfish Bed No.2, Ladyburn, Girvan. Orig. Begg, 1939, pl.6, fig.2. Coll. J.L. Begg.

24 - 25. Complete exoskeleton, x 4 (BM In 21917). 24: Internal mould, dorsal view; 25: silicone cast from external mould. For other data see 20.

PLATE 23.

Decoroproetus pristinus sp. nov.

1. Free cheek, x 12 (BM It 8861). Dorsal view of isolated silicified specimen. For other data see pl.22, fig.19.

2. Complete internal mould, x 4½ (OUM B 257). Probably Llandeilo series. Locality unknown.

3. Complete internal mould, x 5 (OUM B 256). Probably Llandeilo series. Locality unknown.

4, 5. Small pygidium, x 54 (BM It 8862). Dorsal stereograph. Llandeilo series, Quarry N.W. of Keeper's Lodge, Dynevor Park, Llandeilo.

6, 7. Small pygidium, x 54½ (BM It 8863). Dorsal stereograph. For other data see 4.

8, 9. Small cranidium, x 26½ (BM It 8864). Dorsal stereograph. For other data see 4.

10, 11. Small cranidium, x 58 (BM It 8865). Dorsal stereograph. Llandeilo series, Cwm Agol.

12. Pygidium, x 8 (SMC A 53010). Dorsal view. Horizon and locality as pl.22, fig.24. Orig. MacGregor, pl.116, fig.11. Coll. A.R. MacGregor.

19. Free cheek, x 7½ (on same slab as pl.23, fig.12). Dorsal view.

Decoroproetus sp. G.

13. Pygidium, internal mould, x 14 (HM A 6784 a). Dorsal view. Caradoc, UpperStinchar Limestone, Aldons, near Girvan. Orig. Tripp, 1967, pl.2, fig.17. Coll. R.P. Tripp.

17. Cranidium, internal mould, x 16½ (HM A 6782). Dorsal view. Horizon and locality as Fig.13. Orig. Tripp, 1967, pl.2, fig.15. Coll. R.P. Tripp.

18. Cranidium, internal mould, x 16½ (HM A 6783a). Dorsal view. Horizon and locality as fig.13. Orig. Tripp, 1967, pl.2, fig.16. Coll. R.P. Tripp.

Decoroproetus sp. H.

14. Free cheek, internal mould, x 14, (BM It 8843). Ashgill, by S.E. bank of Stockdale Beck, just below the junction with Brow Gill, Long Sleddale, Westmorland. Coll. W.T. Dean, 1962.

Decoroproetus sp. F.

15. Free cheek, x 20 (HM A 6781a). Dorsal view. Caradoc, Upper Stinchar Limestone, Auchensoul, near Girvan. Orig. Tripp, 1967, pl.2, fig.14. Coll. R.P. Tripp.

16. Cranidium, internal mould, x 17½ (HM A 6780). Dorsal view. Horizon and locality as fig.15. Orig. Tripp, 1967, pl.2, fig.13. Coll. R.P. Tripp.

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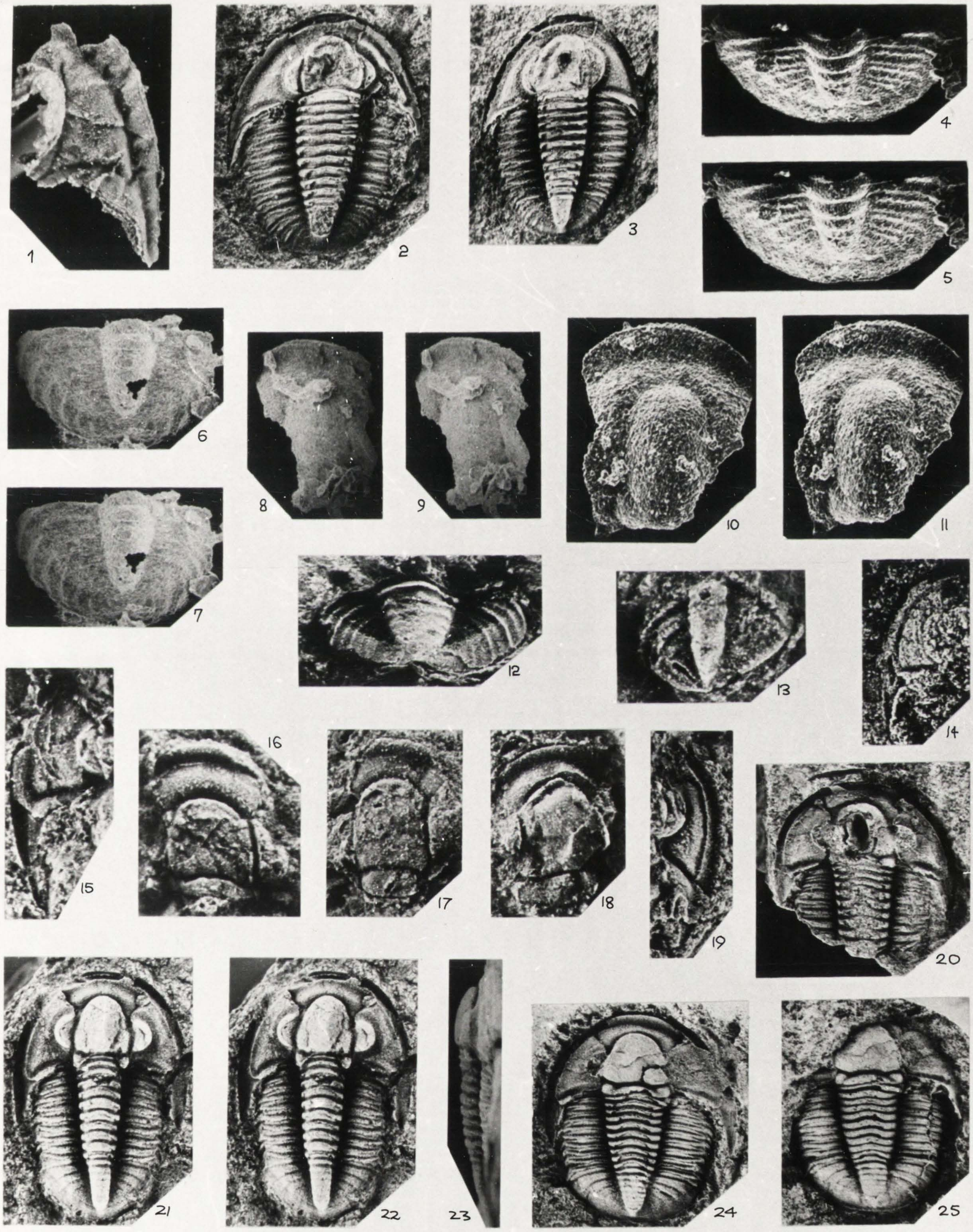
PLATE 23



Dorsal view. Caradoc, Balclatchie Group, Balclatchie, Girvan. Coll. Mrs. Gray.

25, 26. **HOLOTYPE** cranidium, internal mould, x 15 (BM In 36959). 25: Left lateral view; 26: Dorsal view. Caradoc, Balclatchie Group, Balclatchie, Girvan. Coll. Mrs. Gray. Orig. Reed, 1935, pl.2, fig.16.

Cyphoproetus facetus Tripp, 1954.

18 - 20, 23. **PARATYPE**, incomplete cephalon with parts of 5 thoracic segments, internal mould, x $3\frac{1}{2}$ (HM 3904a). 18: Left lateral view; 19-20: Dorsal stereograph; 23: Anterior oblique view. Caradoc, Craighead (Kiln) Mudstones, Craighead Quarry, near Girvan. Orig. Tripp, 1954, pl.3, fig.14. Coll. R.P. Tripp.

21: Cranidium, internal mould, x $10\frac{1}{2}$ (HM 3906a). Dorsal view. Horizon and locality as 18. Counterpart of orig. Tripp, 1954, pl.3, fig.17. Coll. R.P. Tripp.

24. Pygidium, internal mould, x 15 (BM In 52681). Dorsal view. Horizon and locality as 18. Coll. R.P. Tripp.

PLATE 24.

Astroproetus reedi Begg, 1939.

1. Complete internal mould, x $2\frac{1}{2}$ (BM In 40839). Dorsal view. For other data see pl.23, fig.20

2 - 3. Cephalon with 8 thoracic segments, internal mould, x $3\frac{1}{4}$ (HM A 3821). Dorsal stereograph. Orig. Begg, 1950, pl.14, figs.1,2, holotype of Proetus fardenensis Begg. Coll. J.L. Begg.

Astroproetus asteroideus (Begg, 1939).

5 - 6. HOLOTYPE. Almost complete internal mould, x 7 (HM A 1080). 4: Dorsal view; 5: Right lateral view. Ashgill, late Rawtheyan Stage, Upper Drummuck Group, Starfish Bed No.2, Ladyburn, Girvan. Orig. Begg 1939, pl.6, fig.1. Coll. J.L. Begg. R

7. Incomplete internal mould, x $4\frac{1}{2}$ (HM A 1081). Dorsal view. Horizon and locality as for 5.

8. Complete internal mould, x $2\frac{1}{4}$ (BM In 21945). Dorsal view. For other data see pl.24, fig.20.

4. Complete internal mould, x 2 (BM In 46895). Dorsal view. For other data see pl.23, fig.20.

Proetid, gen. et sp. indet.

9. Internal mould of poorly preserved cephalon, x $4\frac{1}{2}$ (SMC A 30941). Ashgill, Slade Beds, Haverfordwest district, Pembrokeshire. Coll. Turnbull.

Cyphoproetus rotundatus (Begg, 1939).

10, 11, 16, 17. HOLOTYPE, incomplete internal mould (HM A 1084). 10: Dorsal view, x $3\frac{1}{2}$; 11: Right lateral view, x 4. Note the preannulus on the thoracic axial rings. 16: Anterior oblique view, x $3\frac{1}{2}$; 17: Posterior view, showing pygidium, x $3\frac{1}{2}$. For horizon and locality see 5. Orig. Begg, 1939, pl.6, figs.5-6. Coll. J.L. Begg.

12, 14. PARATYPE. Almost complete internal mould, x 4 (HM A 1085). 12: Dorsal view; 14: Posterior view, showing pygidium. For horizon and locality see 5. Orig. Begg, 1939, pl.6, fig.4. Coll. J.L. Begg.

Rorringtonia flabelliforme, Whittard, 1966.

13. HOLOTYPE, latex cast from external mould, x $4\frac{1}{2}$ (GSM 102447). Dorsal view. Caradoc, Rorrington Beds, 70 yds. N. 20° W. of Bridge over Grey Grass Dingle, Rorrington. Orig. Whittard, pl.50, fig.8.

22. PARATYPE. Internal mould, with some exoskeleton remaining, x 7 (GSM 102448). Dorsal view. Caradoc, Rorrington Beds, tributary to Lower Wood Brook, 300 yds. S. 35° E. of Desert. Orig. Whittard, pl.50, fig.9.

Rorringtonia vetula (Reed, 1935).

15. Incomplete cranidium, internal mould, x 15 (BM In 37491).

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PLATE 24

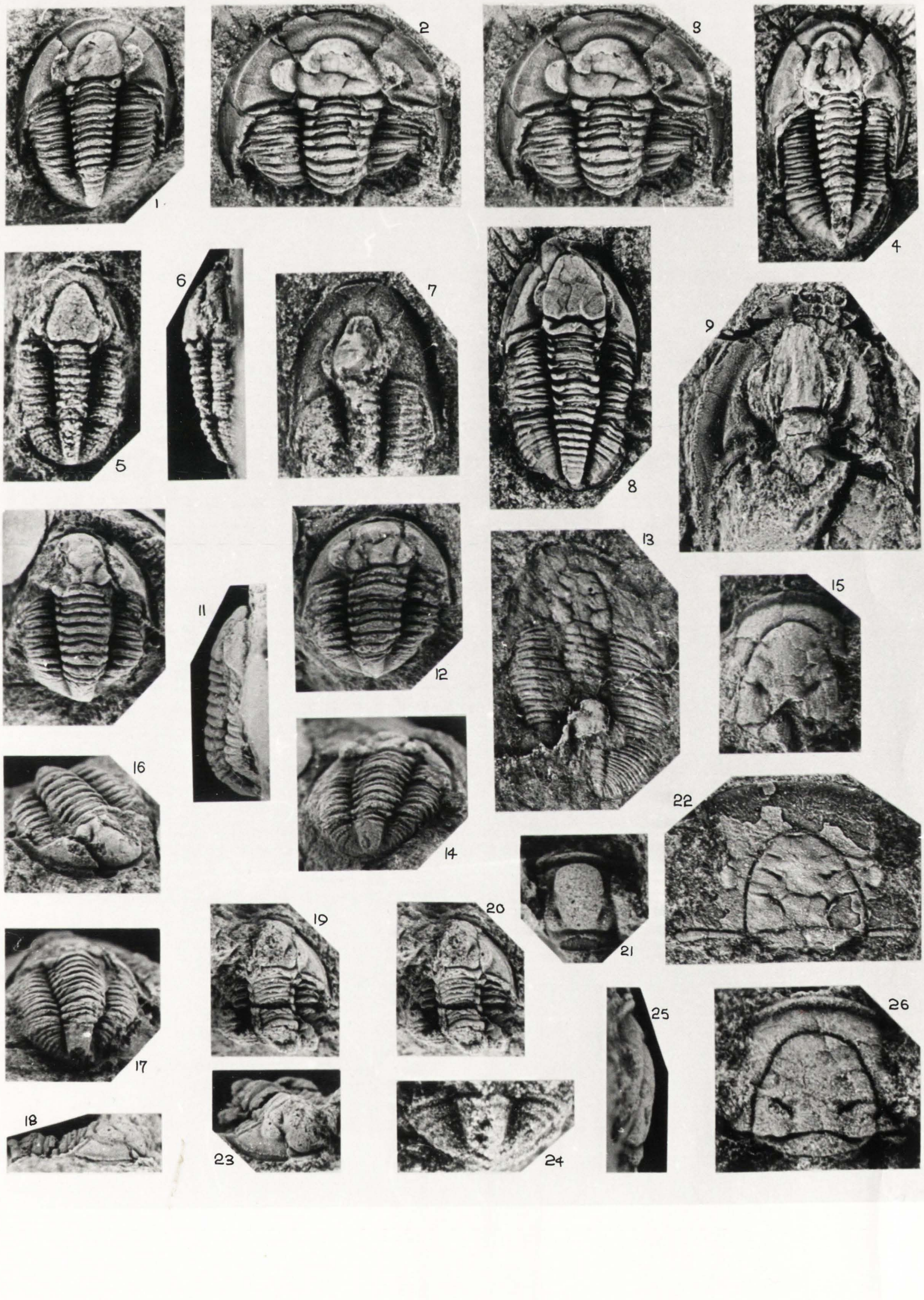

PLATE 25.

Decoroproetus scrobiculatus sp. nov.

1, 2, 5, 8. HOLOTYPE. Cranidium, internal mould, (BM It 8844). 1: dorsal view, x 4½; 2: lateral view, x 5; 5: anterior oblique view, x 4½; 8: anterior view, x 4½. Basal Ludlow bipartite Limestone, nilssoni-scanicus zone Bluecaster, Cautley (Rickards 10C. 1D). Coll. T. Fletcher, 1970.

3. Hypostome, internal mould, x 12 (HUR ID/27). Dorsal view. Horizon and locality as 1. Coll. R.B. Rickards.

4. Small cranidium, internal mould, x 19 (HUR ID/143). Dorsal view. For other data, see 3.

6. Incomplete pygidium, x 4 (HUR ID/279). Dorsal view. For other data, see 3.

7. Small cranidium, x 21½ (HUR ID/20b). Dorsal view. For other data, see 3.

9. Small pygidium, x 18 (HUR ID/266). Dorsal view. For other data, see 3.

10. Cranidium. Silicone cast taken from external mould, x 6 (HUR ID/119). Dorsal view. For other data, see 3.

11. Free cheek, silicone cast taken from external mould, x 4 (HUR ID/241). Dorsal view. For other data, see 3.

12, 13, 16. Hypostome, internal mould, x 8½ (HUR ID/276). 12: anterior view; 13: left lateral view; 16 dorsal view. For other data, see 3.

14. Cranidium, silicone cast from external mould, x 5½ (HUR ID/78). Dorsal view. For other data, see 3.

15. Free cheek, internal mould, x 4 (HUR ID/147). Dorsal view. For other data, see 3.

17. Pygidium, internal mould, x 4 (HUR ID/272). Dorsal view. For other data, see 3.

18. Pygidium, internal mould, x 4 (SMC A 38993). Dorsal view. Lower Ludlow, Middle Coldwell Beds, "Delops obtusicaudatus Beds", N.N.W. of Narthwaite, Cautley district. Coll. J.E. Marr.

PLATE 25

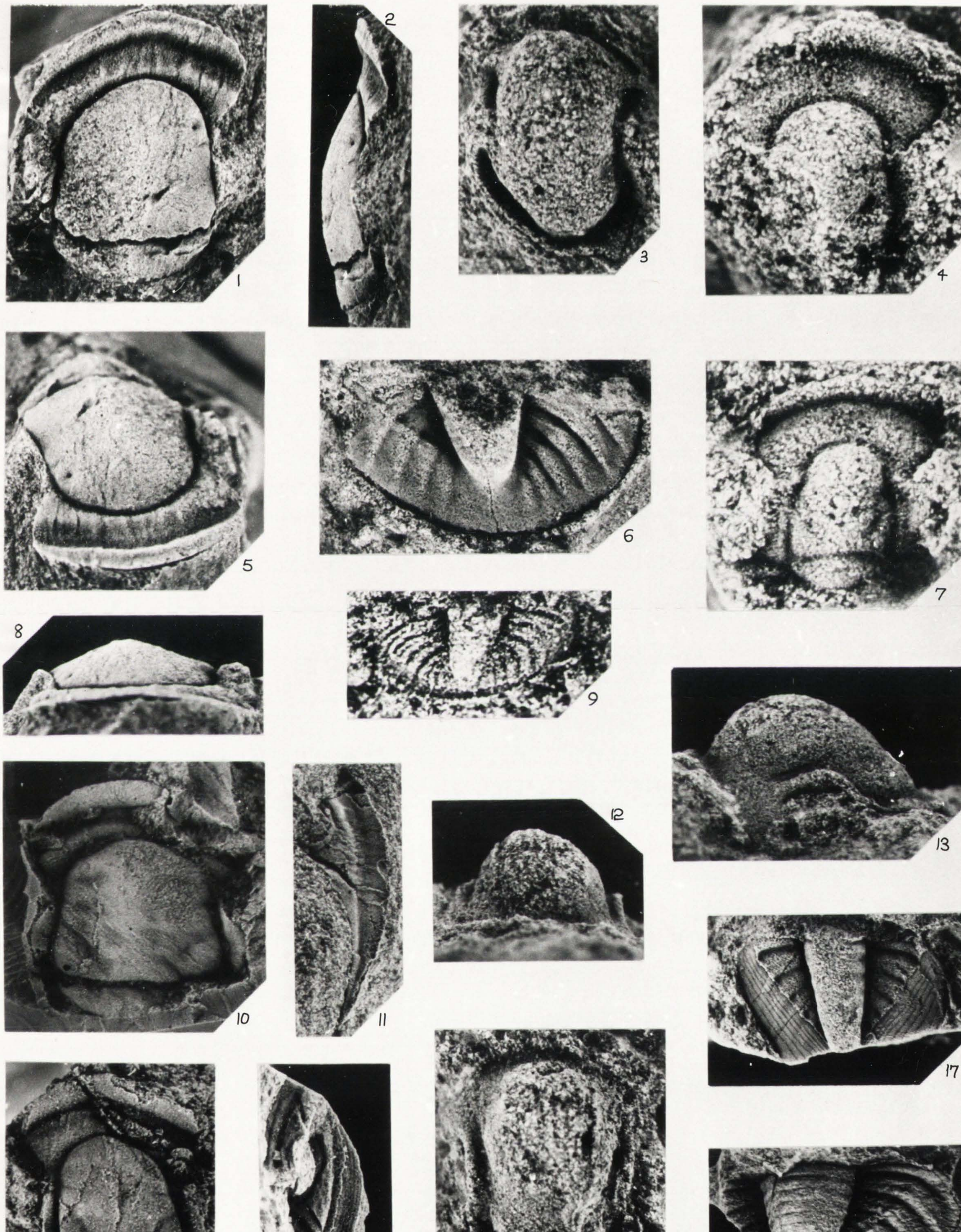

PLATE 26.

Decoroproetus scrobiculatus sp. nov.

1. Cranidium, x 5 (TCD 9610). Dorsal view. High Wenlock, shelly mudstones above last record of C. lundgreni and below first G. nassa-dubius graptolites, Trewern brook, west of Glyn Farm, Long Mountain (SJ 33035/31167). Coll. D. Palmer.

2. Cranidium, x $4\frac{1}{2}$ (TCD 9611). Dorsal view. For other data see 1.

3. Incomplete cephalon with parts of 7 thoracic segments, x $2\frac{3}{4}$ (TCD 9612). Dorsal view. For other data see 1.

4. Pygidium, x $5\frac{1}{2}$ (TCD 9613). Dorsal view. For other data see 1.

5. Incomplete cranidium, with part of the external surface remaining, x $6\frac{1}{2}$ (LO 2844T). Dorsal view. Wenlock series, Svedstorp, Scania, Sweden. Orig. Hede 1915, pl.4, fig.23.

6. Incomplete cranidium, x 6 (LO 2843b). Dorsal view. Horizon and locality as 5. Orig. Hede, 1915, pl.4, fig.22.

9. Cranidium, silicone cast from external mould, x 10 (HUR ID/94). Dorsal view. Basal Ludlow bipartite limestone, nilssoni-scanicus zone, Bluecaster, Cautley (Rickards loc. 1D). Coll. R.B. Rickards.

10. Incomplete pygidium, preserved in pyrite, x 12 (LO 2845t). Dorsal view. Horizon and locality as 5. Orig. Hede, 1915, pl.4, fig.24.

Decoroproetus sp. J.

7, 8. Cranidium, with external surface preserved, x 6 (GSM 55472). 7: Dorsal view; 8: Right lateral view. Upper Llandovery, Purple shales, limestone band rich in Barrandella linguifer, Minsterley-Habberley lane, 1/6 mile from the Shrewsbury main road. Orig. Whittard, 1938, pl.3, fig.5.

Decoroproetus sp. K.

11. Incomplete thorax, with part of the pygidium, internal mould, x 5 (P.D. Lane coll). Dorsal view. Upper Llandovery, C_1, Llandovery. Coll. P.D. Lane.

18. Almost complete specimen, silicone cast taken from external mould, x $2\frac{3}{4}$ (P.D. Lane coll). Dorsal view. Other data as 11.

Decoroproetus sp. L.

12. Free cheek, x 10 (GSM Da 4912). Dorsal view. Wenlock Shale, road cutting near Martley, Abberley Hills.

15, 16. Pygidium, silicone cast from external mould, x $5\frac{1}{2}$ (GSM Da 4912). 15: Dorsal view; 16 Right lateral view. Other data as 12.

Decoroproetus ? sp. N.

13, 14. Cranidium, silicone cast, from external mould, x $8\frac{1}{2}$ (SMC 38902). 13: Dorsal view; 14: Left lateral view. Upper Llandovery, Browgill Beds, Phacops elegans zone, 410 yds. S. of spring in Copple Bank Wood, Crummackdale, near Austwick, Yorkshire.

17. Pygidium, internal mould, x 8 (SMC 38833). Horizon as 13, boulder 1000 yds. S. of Crummack Farm, near Austwick.

PLATE 26

PLATE 27.

Astroproetus amplus sp. nov.

1 - 4. HOLOTYPE, almost complete internal mould, x 2 (BM In 58601). 1: Dorsal view; 2: Right lateral view; 3: Anterior oblique view; 4: Anterior view. Lower Llandovery, Mulloch Hill Group, Mulloch Hill, near Girvan. Coll. Mrs. Gray.

6. Cranidium, internal mould, x 3 (BM In 21961). Dorsal view. Lower Llandovery, Mulloch Hill Group, Craigens, Girvan. Orig. Reed, pl.11, fig.13. Coll. Mrs. Gray.

7. Almost complete internal mould, disarticulated between 4th and 5th thoracic segments, x 1.75 (BM In 42682). Other data as 1.

8. Pygidium, internal mould, x 3 (BM In 21950). Dorsal view. Horizon and locality as 1. Orig. Reed, pl.11, fig.9, figd. as "Proetus pseudolatifrons".

Astroproetus pseudolatifrons (Reed, 1904).

5. Pygidium, internal mould, x 4 (BM In 21946). Dorsal view. Upper Llandovery, Camregan Group, Camregan Wood, Girvan. Orig. Reed, 1904, pl.11, fig.8. Coll. Mrs. Gray.

9. Pygidium, incomplete internal mould, x $3\frac{1}{2}$ (BM In 21947). Dorsal view. Horizon and locality as fig.5. Coll. Mrs. Gray.

10 - 11. LECTOTYPE cranidium, x 4 (BM In 21946). 10: Left lateral view; 11: Dorsal view. Horizon and locality as fig.5. Orig. Reed, 1904, pl.11, fig.7. Coll. Mrs. Gray.

12. Free cheek, internal mould, x $2\frac{2}{3}$ (BM In 21949). For other data see 9.

Decoroproetus sp. M.

13, 14. Free cheek, x $3\frac{1}{2}$. 13: Silicone cast from external mould (OUM 14141b); 14: Internal mould (OUM 14141a). Upper Llandovery, Hughley Shales, Hughley. (SO 56059747). Coll. L.R.M. Cocks.

PLATE 27

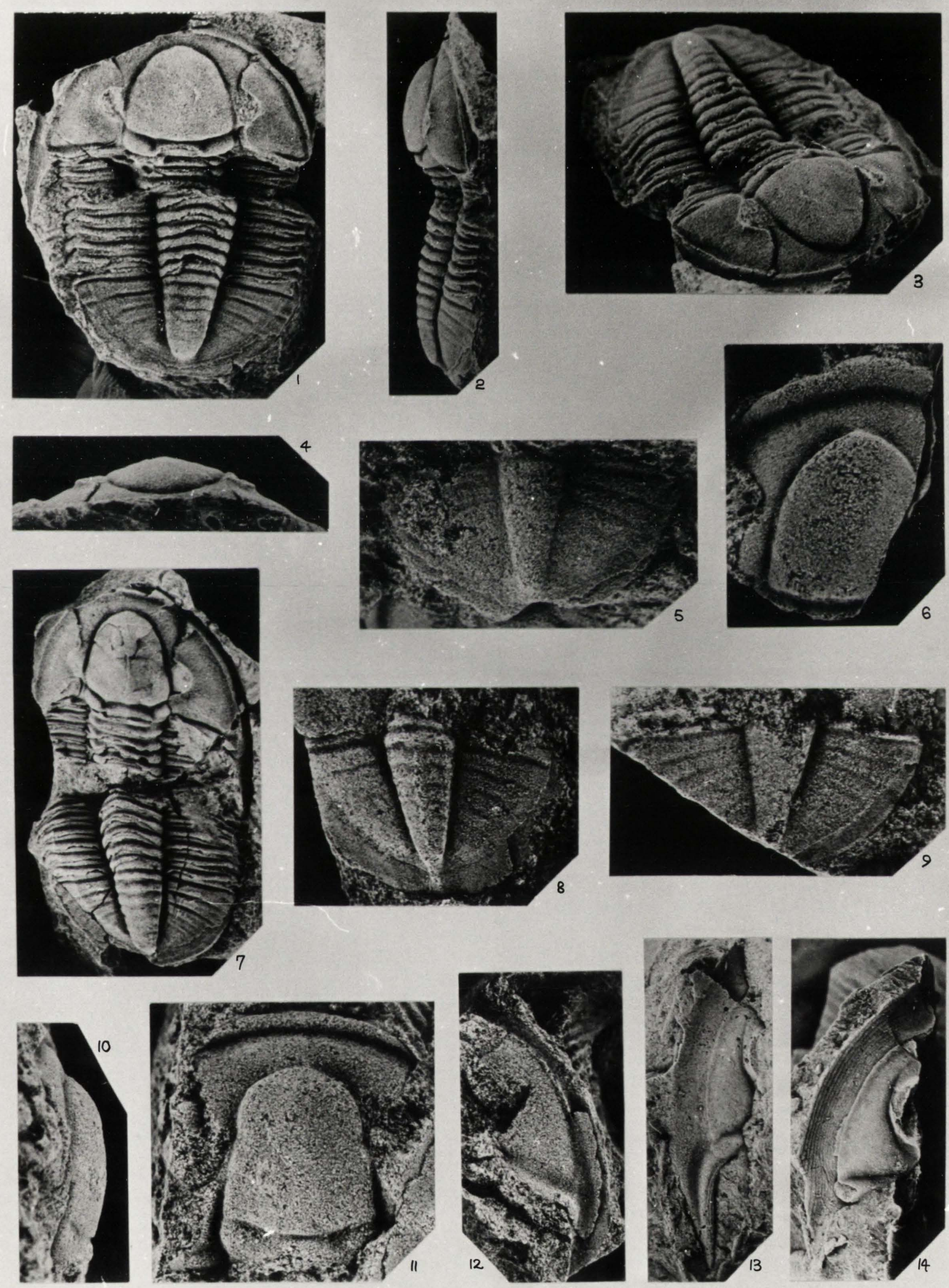

PLATE 28.

Astroproetus subtriangularis (Begg, 1950).

1, 2. HOLOTYPE. Cranidium, internal mould, x 8 (HM A 3822). Middle Llandovery, Saugh Hill Group, Newlands, near Girvan. Orig. Begg, 1950, pl.14, fig.6.

Astroproetus interjectus (Reed, 1935).

3, 4. HOLOTYPE. Cranidium, internal mould, x 19 (HM A 1031). Horizon and locality as 1. Orig. Reed, pl.3, fig.23.

Astroproetus scoticus (Reed, 1941).

5, 6, 9. HOLOTYPE. Cranidium, internal mould, x 4 (HM A 1109). 5: Dorsal view; 6: Left lateral view; 9: Anterior oblique view. Lower Llandovery, Mulloch Hill Group, Craigens, near Girvan. Orig. Reed, 1941, pl.5, fig.3.

Astroproetus cf. interjectus (Reed, 1935).

7. Cranidium, internal mould, x $6\frac{1}{2}$ (BM In 42699). Horizon and locality as 1.

Astroproetus cf. subtriangularis (Begg, 1950).

8. Cranidium, with most of exoskeleton adhering, x 4 (BM In 21959). Dorsal view, Middle Llandovery, Saugh Hill Group, Woodland Point, Girvan. Orig. Reed, 1904, pl.11, fig.12. Coll. Mrs. Gray.

Astroproetus sp. A.

10. Cranidium, silicone cast taken from external mould, x $5\frac{3}{4}$ (P.D. Lane coll). Dorsal view. Upper Llandovery, C_1, Llandovery. Coll. P.D. Lane.

11. Pygidium, internal mould, x 5 (P.D. Lane coll). Dorsal view. For other data see 10.

Warburgella pedina sp. nov.

12a-b, 13, 14a-b. HOLOTYPE. Almost complete, partially enrolled specimen, x 4 (BM I 4520). 12a-b: Dorsal stereograph; 13 Right lateral view; 14a-b: Dorsal stereograph of pygidium and posterior part of thorax. Wenlock Shale, Wenlock Edge. Coll. Rev. C. Croft.

PLATE 28

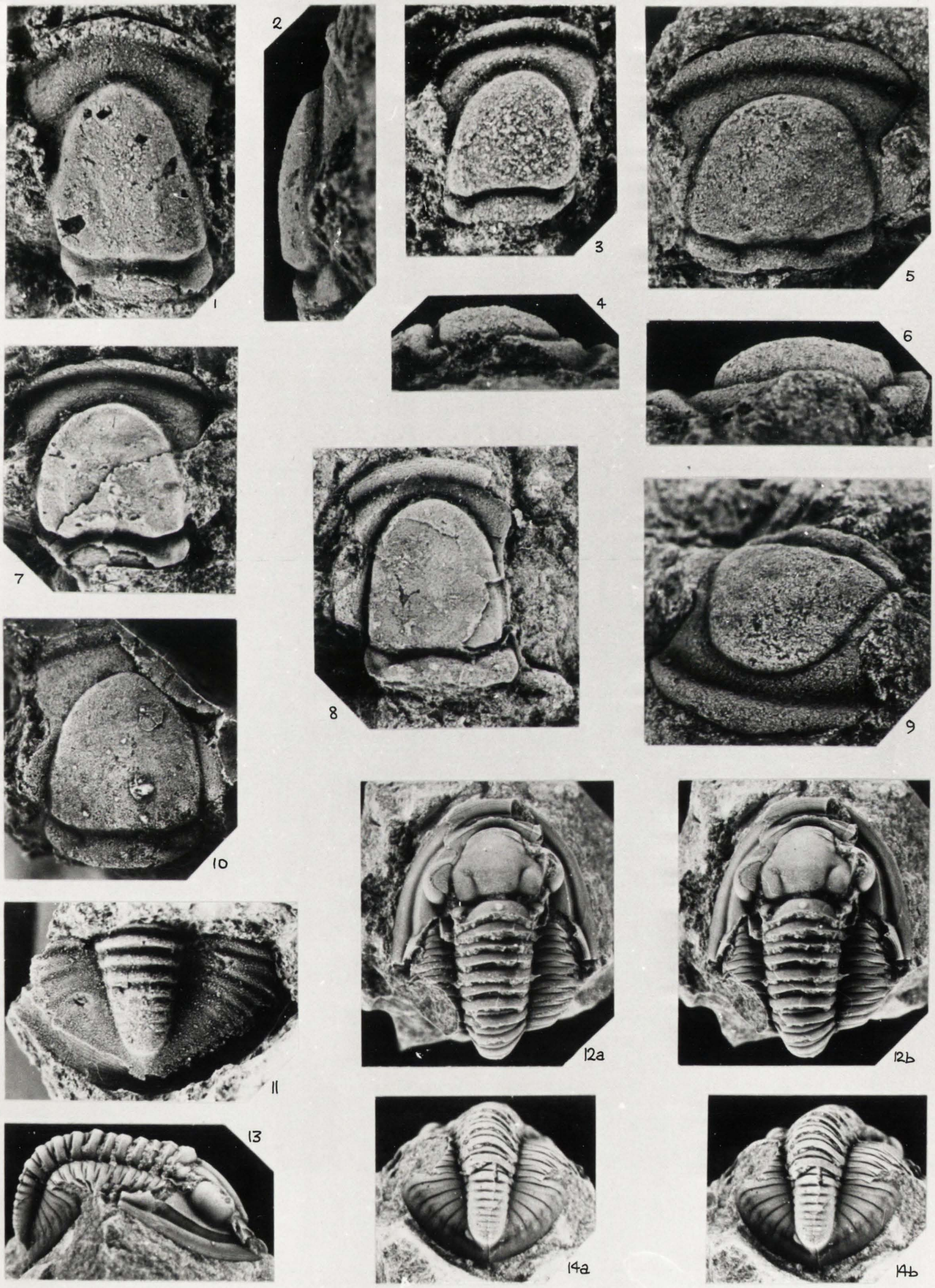

PLATE 29.

Warburgella stokesi (Murchison, 1839).

1 - 2, 4 - 5. NEOTYPE. Complete specimen, lacking right free cheek, x 4 (BU 176). 1-2: Dorsal stereograph; 4: Anterior oblique view; 5: Lateral view. Wenlock limestone, Dudley, Worcestershire. Orig. Whittard, pl.3, fig.1.

3. Complete specimen, x 36 (SMC A 28256). Dorsal view. Wenlock Limestone, Dudley, Fletcher coll.

6. Almost complete specimen, x 3 (SMC A 28255). Dorsal view. Wenlock Limestone, Dudley.

7 - 9. Complete specimen, with pygidium damaged, x 3 (SMC A 28261). 7: Dorsal view. Note irregular striations in glabella and occipital ring. 8: Anterior view; 9: Left lateral view. Wenlock limestone, Dudley.

11. Complete specimen, x $4\frac{3}{4}$ (SMC A 28262). Dorsal view. Wenlock limestone, Dudley.

12. Incomplete cephalon, x $5\frac{1}{2}$ (OUM C 803). ? Wenlock limestone. Locality unknown.

Warburgella sp. A.

10. Badly preserved internal mould of cranidium, x $8\frac{1}{2}$ (OUM C 11328a), dorsal view. Middle Llandovery, Venusbank Formation, Josey's Wood B, Minsterley, Shropshire.

PLATE 29

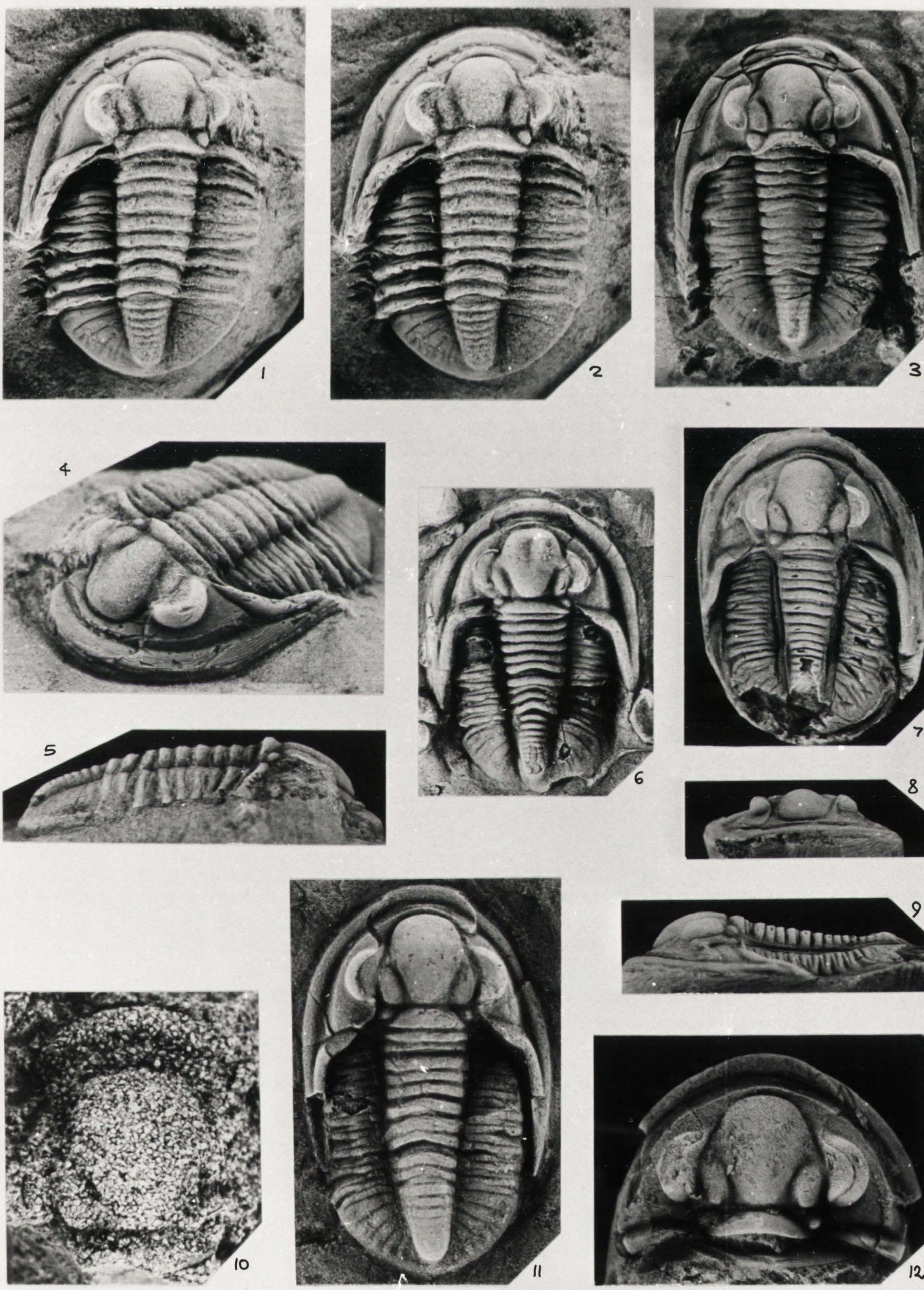

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PLATE 30.

Warburgella bellula (Reed, 1917).

1 - 2. LECTOTYPE cranidium, x 9 (SMC A 16596). 1: Dorsal view; 2: Right lateral view. Wenlock limestone, stream section near quarry, 300 yds. N.E. of Greenpool Farm, Usk. Orig. Reed, pl.8, fig.6.

3. Incomplete cephalon, x 7½ (SMC A 16595). Dorsal view. Horizon and locality as 1. Orig. Reed, pl.8, fig.5.

4 - 5. Hypostome, partially exfoliated, x 9½ (SMC A 16600). 4: Ventral view; 5: Right lateral view. Note prominent maculae. Horizon and locality as 1. Orig. Reed, pl.8, fig.9.

6. Damaged cranidium, x 8 (SMC A 16597). Dorsal view. Horizon and locality as 1. Orig. Reed, pl.8, fig.7.

7 - 8. Pygidium, x 7 (SMC A 16601). 7: Dorsal view; 8: Left lateral view. Horizon and locality as 1. Orig. Reed, pl.8, fig.10.

9. Pygidium, x 6 (LU 53758). Dorsal view. Wenlock limestone, Nodular Beds, Wren's Nest, Dudley, western side, near the old lime kilns. Coll. Miss K. Langley, 1968.

10. Free cheek, x 4 (SMC A 16598). Dorsal view. Horizon and locality as 1. Orig. Reed, pl.8, fig.8.

12, 17. Cranidium, x 7 (LU 53759). 12: Dorsal view. 17: Left lateral view. Note fine pitting on anterior part of glabella. Wenlock limestone, near Clencher's Mill, Eastnor, Herefordshire. Coll. J. Penn and J. Vinnicombe.

13. Free cheek, x 6½ (LU 53760). Dorsal view. For other data see 12.

Cyphoproetus aff. binodosus (Whittard, 1938).

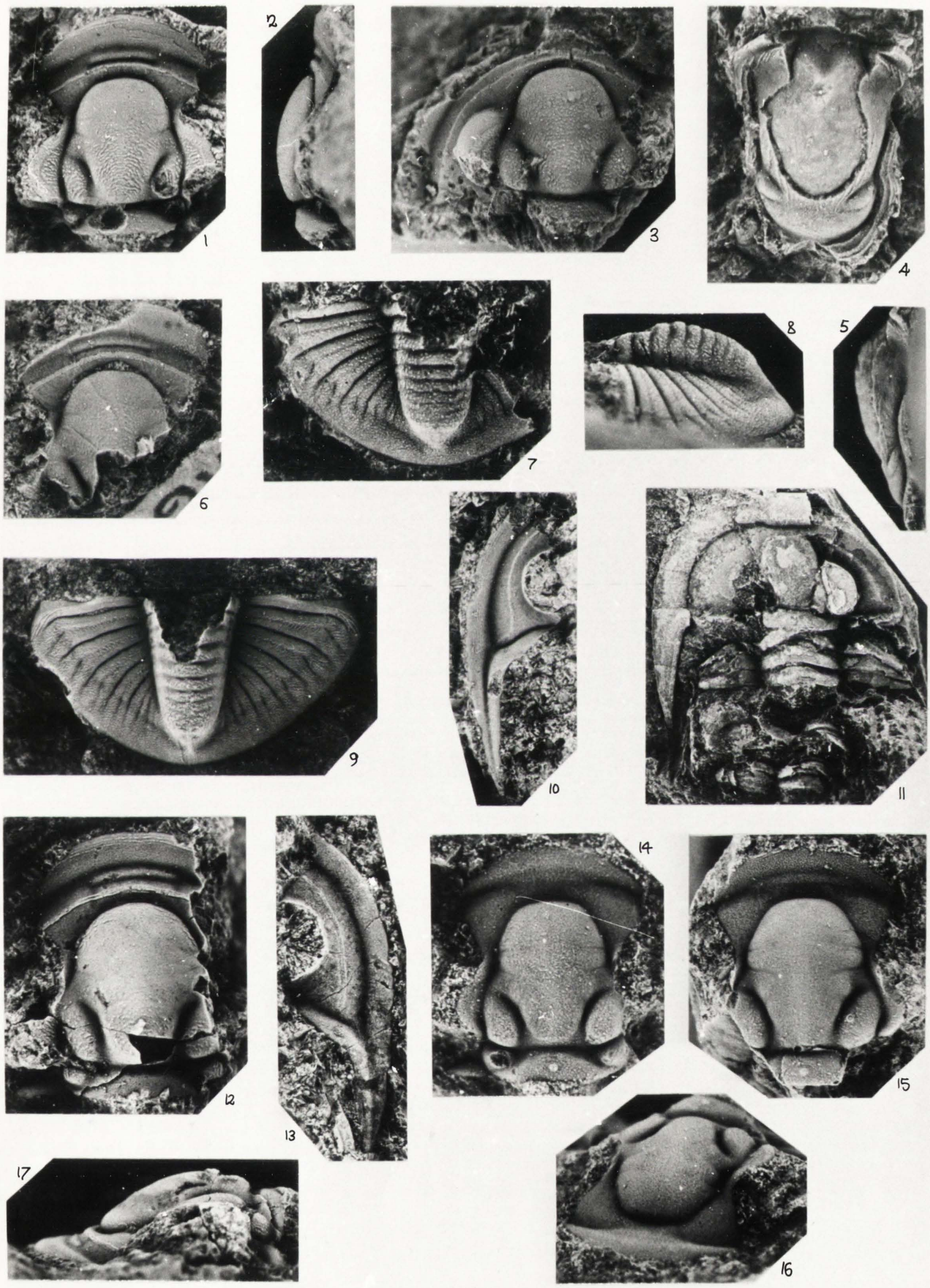
11. Almost complete cephalon with parts of 6 thoracic segments, x 3¼ (GSM BAH 1130). Dorsal view. Upper Llandovery, Hughley Shales, Church Stretton No.2 borehole, 1940 yds. N.N.W. of Methodist Chapel, Asterton, Salop.

Ogmocybe trapeziceps gen. et sp. nov.

14 - 15. HOLOTYPE cranidium, x 12 (BM It 8817). 14: Dorsal view; 15: Anterior oblique view. Upper Leiutwardine Beds, quarry on Diddlebury-Middlehope road, 220 yds. N.E. of Fernhall Mill. Coll. J. Shirley and J. Shergold.

16. Incomplete cranidium, x 7½ (BM It 8818). Dorsal view. Lower Leiutwardine Beds, exposure in track from Whitchurch Farm to Hungerford. Coll. J. Shirley and J. Shergold.

PLATE 30



12. Almost complete internal mould, x $4\frac{1}{2}$ (BM In 21955). Dorsal view. Note mould of slightly displaced rostral plate in front of glabella. Middle Llandovery, Saugh Hill Group, Newlands, Girvan. Orig. Reed, 1904, pl.11, fig.11. Coll. Mrs. Gray.

Cyphoproetus strabismus sp. nov.

15. Partially exfoliated pygidium, x $6\frac{1}{2}$ (TCD 9624). Late Wenlock, *lundgreni* zone, stream section near Court House, Kingswood, Long Mountain. Coll. D. Palmer.

Ogmocybe ? sp. A.

16. Small, incomplete cranidium, x 15 (M. Jones coll). Dorsal view. Higher Lower Leintwardine Beds, channel fill deposits, Leintwardine.

Cyphoproetus nasiger sp. nov.

1. HOLOTYPE, complete internal mould, x 3 (GSM 35999), dorsal view. Upper Llandovery, Purple Shales, Onny River section, near Cheney Longville. Orig. Whittard, 1938, pl.3, fig.3.

Cyphoproetus nasiger sp. nov.

2. Silicone cast taken from external mould, x 4 (GSM 55471), Upper Llandovery, Pentamerus Beds, Harper's Dingle, 1/6 mile N. of Spout Lane, near Little Wenlock. Orig. Whittard, 1938, pl.3, fig.2.

Cyphoproetus ? nasiger sp. nov.

3. Free cheek, silicone cast taken from external mould, x 8 (OUM C 14153). Dorsal view. Upper Llandovery, Hughley Shales, Hughley. Coll. L.R.M. Cocks.

Ogmocybe pharangus gen. et sp. nov.

4. HOLOTYPE. Silicone cast taken from almost complete external mould, x $3\frac{2}{3}$ (GSM 36747). Dorsal view. Probably higher Lower Leintwardine Channel fill deposits, Church Hill, Leintwardine.

6. Almost complete internal mould of small specimen, x $5\frac{2}{3}$ (BM 39407). Dorsal view. Probably higher Lower Leintwardine channel fill deposits, Leintwardine.

7. Almost complete internal mould, x $3\frac{3}{4}$ (YM Coll). Dorsal view. Probably higher Lower Leintwardine channel fill deposits, Ludlow district.

Cyphoproetus binodosus (Whittard 1938).

5. Free cheek, x $6\frac{1}{2}$ (TCD 9608). Dorsal view. Basal Wenlock, Buttington Brick Works. Coll. D. Palmer.

9 - 10. Partially exfoliated cranidium, x 7 (TCD 9609). 9: Dorsal view; 10: Right lateral view. For other data see 5.

13. HOLOTYPE, cranidium, internal mould, x $4\frac{1}{2}$ (GSM 36000). Dorsal view. Upper Llandovery, Purple Shales, Onny River section, near Cheney Longville. Orig. Whittard, 1938, pl.3, fig.4.

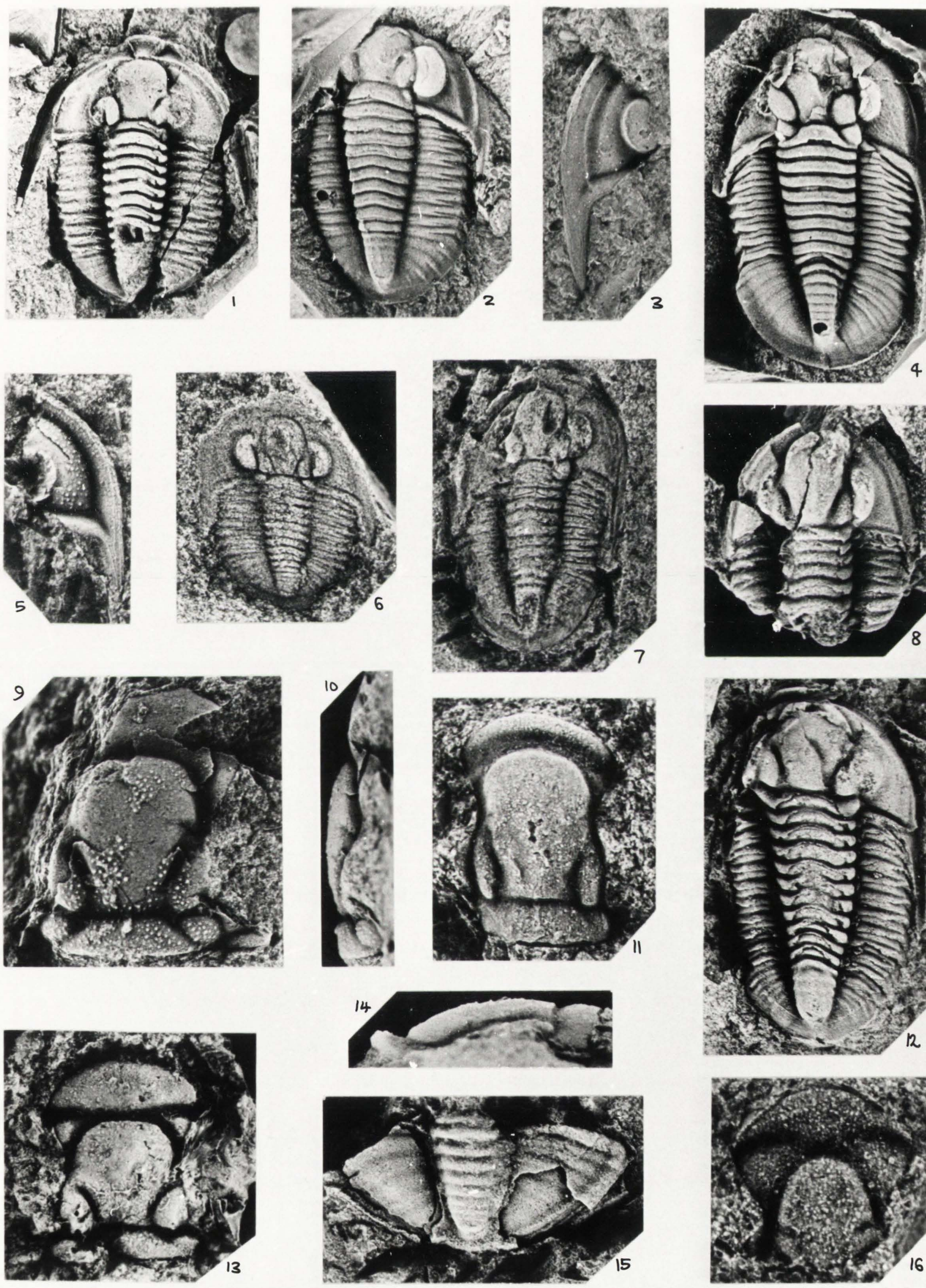
Cyphoproetus externus Reed, 1935.

8. Partially enrolled individual, internal mould, x 5 (BM In 21953). Dorsal view. Lower Llandovery, Mulloch Hill Group, Mulloch Hill, Girvan. Orig. Reed, 1904, pl.11, fig.10. Coll. Mrs. Gray.

11, 14. HOLOTYPE, cranidium, internal mould, x 8 (HM A 1032). 11: Dorsal view; 14: Left lateral view. Middle Llandovery, Saugh Hill Group, Newlands, Girvan. Orig. Reed, 1935, pl.2, fig.15. Coll. J.L. Begg.

Contd......

PLATE 31



4.1

PLATE 32.

Cyphoproetus strabismus sp. nov.

1, 5, 6. Partially exfoliated cephalon, x $3\frac{1}{2}$ (TCD 9619). 1: Dorsal view. Note external mould of trapezoidal rostral plate; 5: Anterior oblique view; 6: Anterior view. For other data see pl.31, fig.15.

2. Pygidium, x $5\frac{1}{2}$ (TCD 9620). Dorsal view. For other data see pl.31, fig.15.

3. Cranidium, x $6\frac{1}{2}$ (TCD 9621). Dorsal view. For other data, see pl.31, fig.15.

4. Cranidium, x 5 (TCD 9622). Dorsal view. For other data see pl.31, fig.15.

7. Incomplete pygidium with parts of 6 attached thoracic segments, x 3 (TCD 9623). Dorsal view. For other data see pl.31, fig.15.

Cyphoproetus depressus (Barrande, 1946).

8. Small, complete specimen, x 5 (OUM C 783). Dorsal view. Wenlock Shale, Malvern Tunnel, Herefordshire. R.B. Grindrod coll.

10, 11. Complete, enrolled specimen, x $5\frac{1}{4}$ (BU Ketley Coll. No. 357). 10: Right lateral view; 11: Dorsal view. Note preannulus. Wenlock Limestone, Dudley.

12. Complete specimen, with eyes damaged, x $3\frac{1}{2}$ (OUM C 784). Dorsal view. For other data see 8.

Rutellum malvernense gen. et sp. nov.

9. Nearly complete exoskeleton, x $2\frac{3}{4}$ (BM 59013). Dorsal view. Wenlock Shale, Malvern.

13. Almost complete, partially exfoliated exoskeleton, x $3\frac{3}{4}$ (OUM C 779). Dorsal view. Note external mould of rostral plate, showing adaxially convex, backwardly diverging convective sutures. Wenlock Shale, Malvern Tunnel. R.B. Grindrod collection.

14. Incomplete, partially exfoliated exoskeleton, x $3\frac{1}{3}$ (BU Ketley coll. No. 373). Upper Llandovery, Woolhope Shale, Malvern.

15. HOLOTYPE, almost complete specimen, x $3\frac{1}{3}$ (GSM 3303). Wenlock Shale, Malvern.

PLATE 32

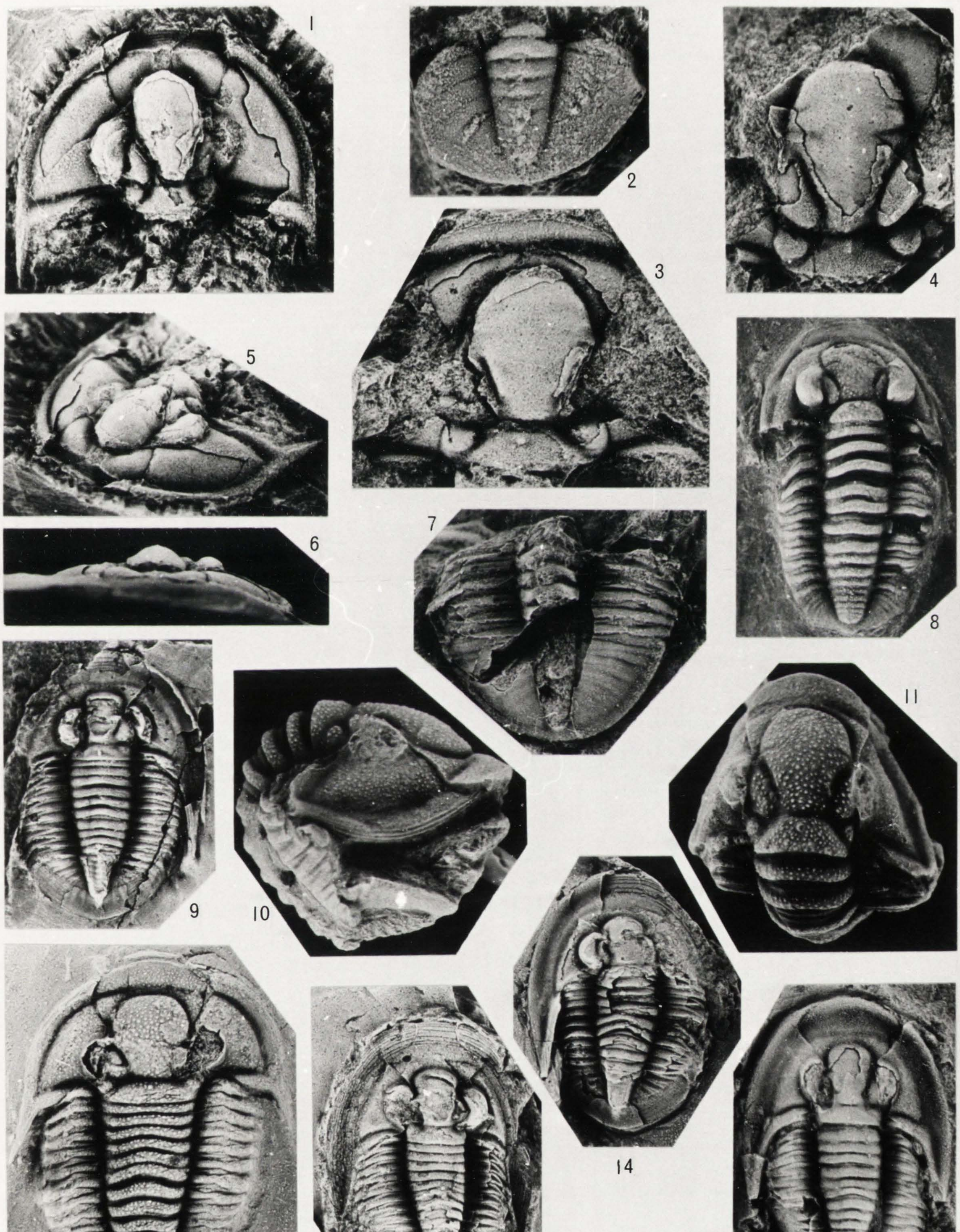


PLATE 33.

Proetus (Proetus) bravonii sp. nov.

1 - 3. HOLOTYPE. Complete internal mould, x $2\frac{1}{4}$ (GSM 36859). 1: Dorsal view. Note mould of triangular rostral plate; 2: Anterior oblique view; 3: Anterior view. Ludlow, probably Upper Leintwardine Beds, Usk, "above the castle". Orig. Salter, 1848, pl.6, figs.1, 1a-c.

4. Cranidium, silicone cast taken from external mould, x $4\frac{1}{2}$ (BM It 589b). Dorsal view. Upper Leintwardine Beds, Goggin Lane section, S.W. of Ludlow. Coll. S.F. Morris.

5. Free cheek, silicone cast taken from external mould, x $3\frac{1}{2}$ (LU 53761), dorsal view. Top of Lower Leintwardine Beds, Edwards Farm, near Leintwardine. Coll. J.H. McD. Whitaker.

6. Cephalon with two attached thoracic segments, internal mould, x 3 (SMC A 16602). Ludlovian, probably Upper Leintwardine Beds, near Hilla Farm, 1 mile N.E. of Bettws-Newydd, Gardiner coll.

7. Incomplete internal mould, x $4\frac{1}{2}$ (BM It 591a), dorsal view. For other data see 4.

8. Pygidium, with sagittal part of axis damaged, x $4\frac{1}{2}$ (BM It 8821), dorsal view. Lower Leintwardine Beds, Quarry at S. end of Slang Coppice, N.W. of Holloway Farm, Wenlock Edge. Coll. J. Shirley and J. Shergold.

9 - 11. HYPOSTOME. Silicone cast taken from external mould, x $7\frac{1}{2}$ (GSM GSB 4061). 9: Dorsal view; 10: Anterior oblique view; 11: Right lateral view. Ludlovian "Lower Ludlow Rock" (probably Lower Underbarrow Flags), Underbarrow.

12. Pygidium, internal mould, x 5 (BM It 8822). Dorsal view. Top of Lower Leintwardine Beds, Goggin Lane section, S.W. of Ludlow. Coll. R.M. Owens, 1969.

13. Almost complete internal mould, x $2\frac{1}{3}$ (GSM Gsb 4065). Dorsal view. Ludlovian "Lower Ludlow Rock" (probably Lower Underbarrow Flags), Underbarrow.

14. Five articulated thoracic segments, internal mould, x 4 (BM It 8823). Dorsal view. For other data see 12.

15 - 16. Cranidium, showing dorsal surface of exoskeleton, x 3 (BM It 8820). 15: Right lateral view; 16 Dorsal view. Lower Leintwardine Beds, quarry at S.E. end of Bache Plantation, Siefton Batch. Coll. J. Shirley and J. Shergold.

PLATE 33

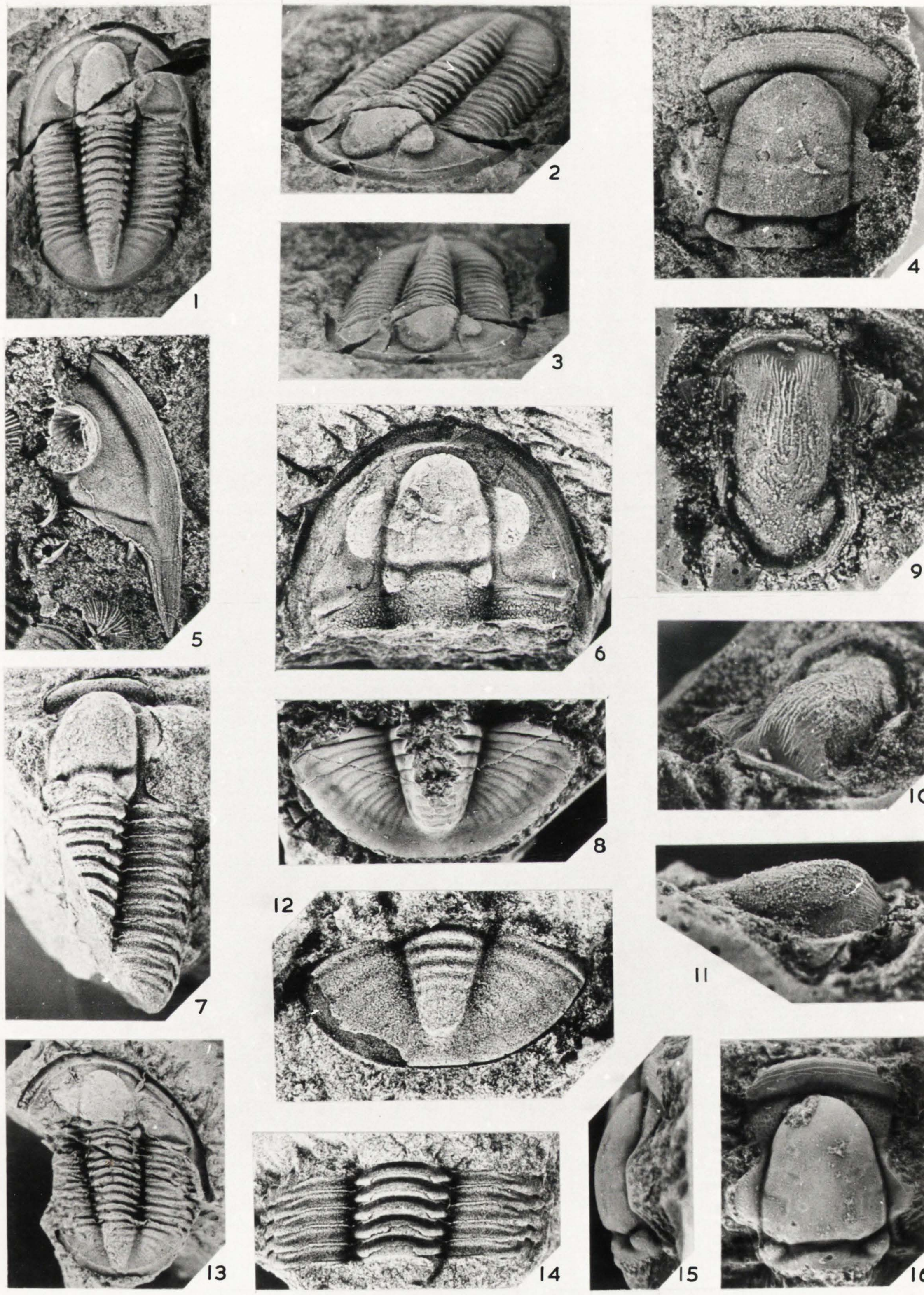


PLATE 34.

Proetus (*Proetus*) *concinuus* (Dalman, 1828).

1a-b, 2a-b, 3. Complete enrolled specimen, x 5 (BM I 1513). 1a-b: Dorsal stereograph of cephalon and anterior part of thorax; 2a-b: Dorsal stereograph of pygidium and posterior part of thorax; 3: Left lateral view. Wenlock Limestone, Dudley.

4. Complete specimen, disarticulated between fourth and fifth thoracic segments, x $3\frac{2}{3}$ (SMC A 28269), dorsal view. Note pitting on inner part of free cheek, and incurved marginal terrace lines on the pygidium. Wenlock Limestone, Dudley.

5 - 7. HOLOTYPE, complete partially enrolled specimen, x 3 (UM G 733). 5: Dorsal view of cephalon; 6: Dorsal view of thorax and pygidium; 7: Left lateral view. Wenlock, Mulde Marl, Djupvik, Gotland. Orig. Dalman, 1828, pl.1, figs.5a-c.

8. Ventral surface of almost complete specimen, x $4\frac{1}{2}$ (SMC A 28263). Note trapezoidal rostral plate, panderian opening at base of genal spine and displaced hypostome. Wenlock Limestone, Dudley.

9 - 10. Cephalon with parts of 5 thoracic segments, x 3 (BU Ketley coll. No. 334). 9: Dorsal view; 10: Anterior oblique view. The left hand genal spine has been damaged, resulting in a rounded genal angle (cf. right hand genal spine of same specimen). Wenlock Limestone, Dudley.

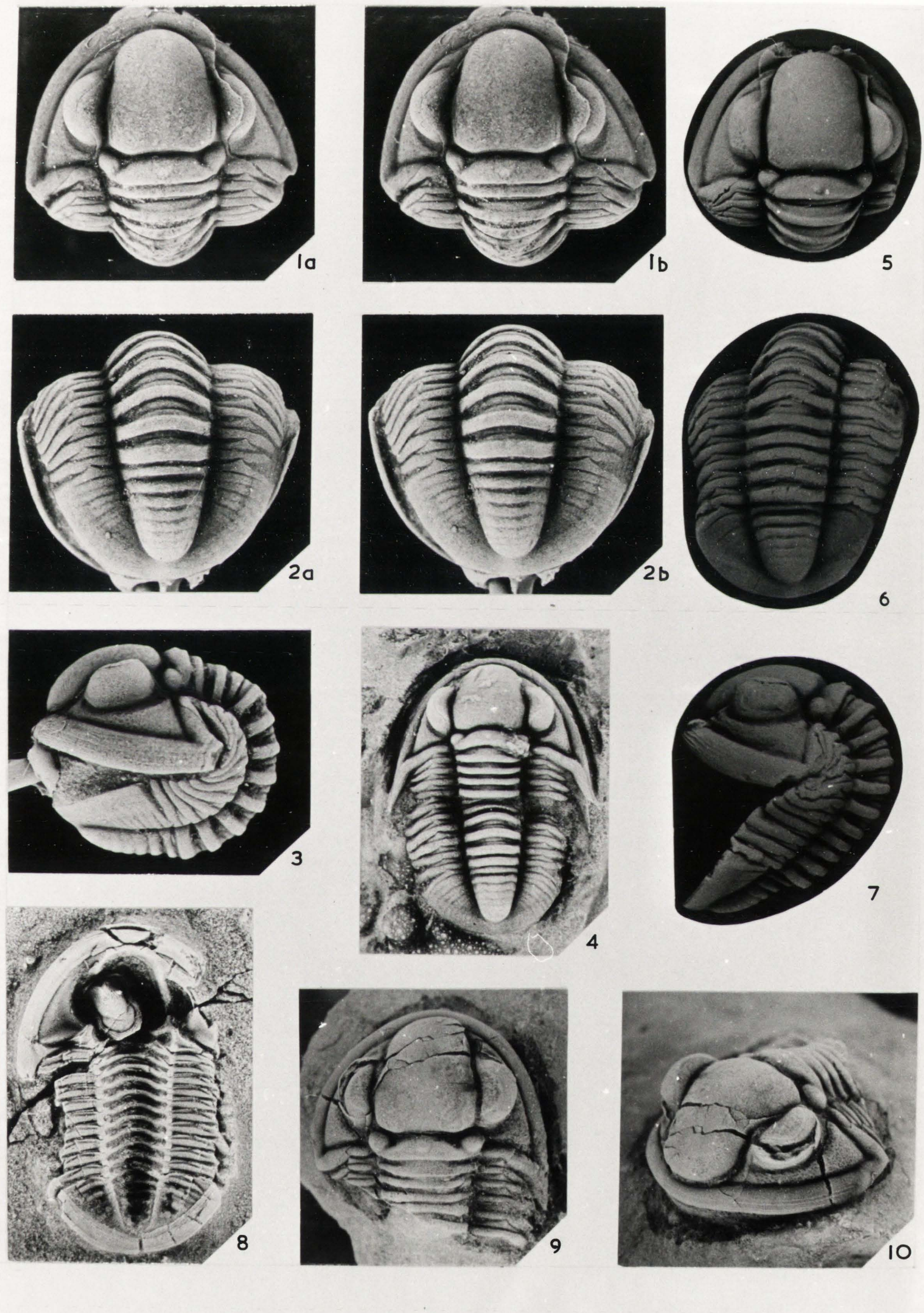

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PLATE 35.

Proetus (Proetus) concinnus (Dalman, 1828).

1. Pygidium with six attached thoracic segments, x $3\frac{3}{4}$ (GSM 36749), dorsal view. Lower Ludlow, Cut Throat Lane, near Ledbury.

2. Pygidium, x $4\frac{1}{2}$ (GSM 36393). Dorsal view. Wenlock Limestone, probably Rock Farm, May Hill. Orig. Salter, 1848, pl.6, fig.3.

3. Distorted cephalon with parts of five attached thoracic segments, x $3\frac{1}{2}$ (OUM C 800). Wenlock Shale, Malvern Tunnel. Coll. R.B. Grindrod.

4 - 7. Partially enrolled specimen, lacking pygidium, x 4 (GSM 36748). 4: Dorsal view; 5:Anterior view; 6: Left lateral view; 7: Anterior oblique view. For other data see 1.

10. Incomplete pygidium, x 5 (GSM GSb 4049). Dorsal view. Wenlock Limestone, "Ledbury Hills". Orig. Murchison, 1839, pl.14, fig.5.

11. Cephalon with three attached thoracic segments, x 4 (GSM 33124). Dorsal view. Wenlock Limestone, Rock Farm, May Hill. Orig. Salter, 1848, pl.6, figs.2a-c.

Proetus (Proetus) dudleyensis sp. nov.

8. Complete specimen, x 2 (OUM C 686). Dorsal view. Wenlock Shale, Malvern Tunnel. R.B. Grindrod coll.

9. Ventral surface of almost complete specimen, x 4 (BU Holcroft coll. No. 443). Note panderian openings at base of genal spine and on doublure of thoracic segments. Wenlock Limestone, Dudley.

12a-b. HOLOTYPE, complete specimen, x $4\frac{1}{4}$ (BU Holcroft coll. No.21). Dorsal stereograph. Wenlock Limestone, Dudley.

PLATE 35

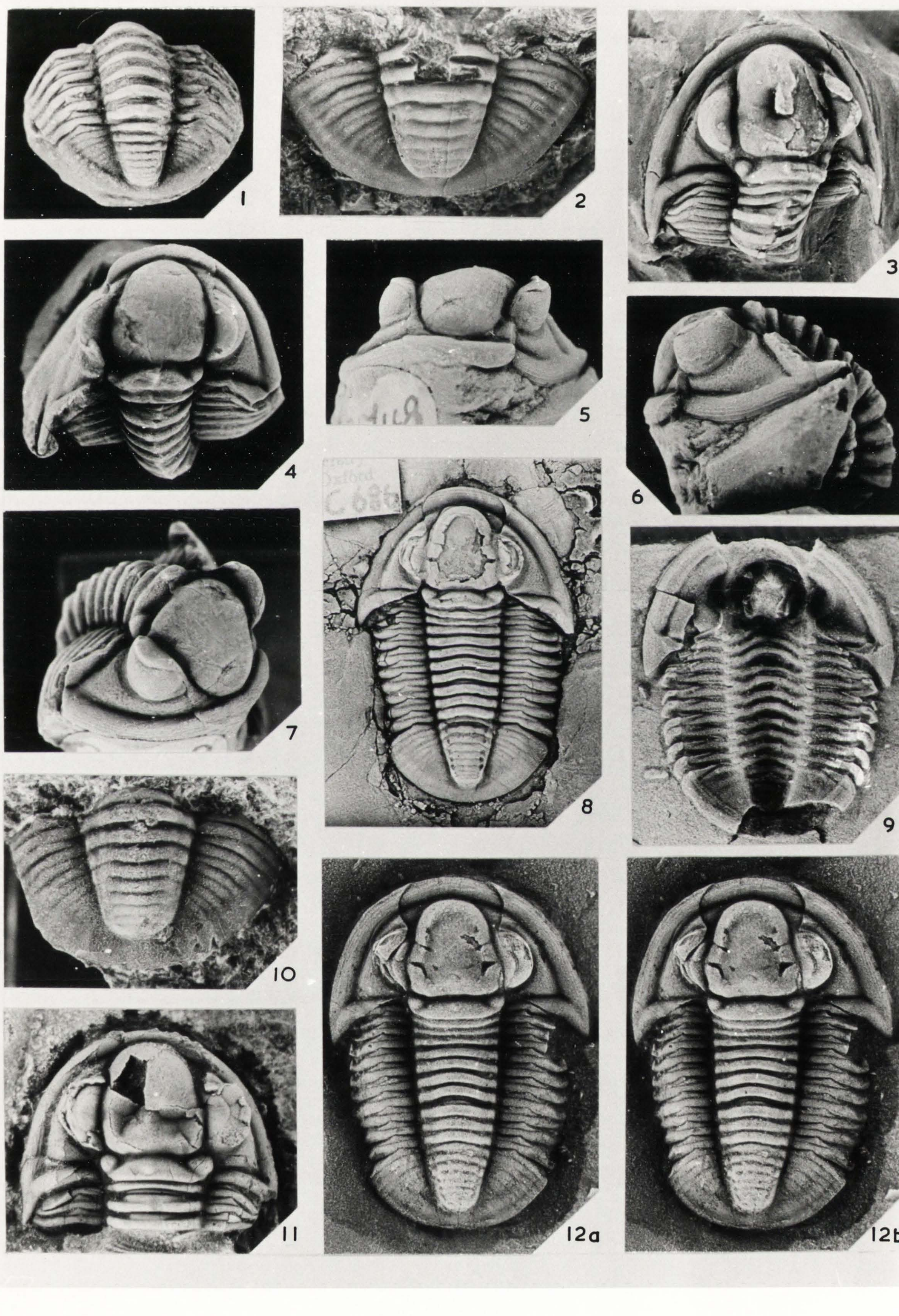

PLATE 36.

Proetus (Proetus) fletcheri Salter, 1873.

1a-b, 2. HOLOTYPE. Almost complete exoskeleton, x $2\frac{1}{4}$ (SMC A 10248). 1a-b: Dorsal stereograph; 2: Lateral oblique view. Wenlock Limestone, Dudley. Orig. Salter, 1873, p.134 and Reed, 1901, pl.1, figs.5-6.

9. Complete specimen, x 4 (BU Holcroft Coll. No.22). Dorsal view. Wenlock Limestone, Dudley.

10. Complete, slightly crushed exoskeleton, x $2\frac{1}{3}$ (SMC A 28253). Dorsal view. Wenlock Limestone, Dudley. Fletcher coll.

Proetus (Proetus) confossus sp. nov.

3 - 5. HOLOTYPE, almost complete cranidium, x 6 (BM It 8845). 3: Dorsal view; 4: Left lateral view; 5: Anterior view. Wenlock Limestone, Nodular Beds, Wren's Nest (western side), Dudley. Coll. R.M. Owens, 1968.

11. Cranidium, x 6 (BM It 8846). Dorsal view. Other data as 3.

Proetus (Proetus) obconicus Lindström, 1885.

6 - 8. LECTOTYPE, complete exoskeleton, enrolled, lacking cephalic border and genal spines, x 4 (RM Ar 29035). 6: Dorsal view of cephalon; 7: Lateral oblique view of cephalon. Note eye socle and distinct pitting on cheeks. 8: Anterior view. Ludlow, Eke Beds (= Leintwardinian). Lau backar, Gotland. Orig. Lindström, pl.15, fig.24.

12. Pygidium, x $4\frac{1}{2}$ (RM Ar 29034). Dorsal view. Horizon and locality as fig.6. Orig. Lindström, pl.15, fig.23.

13 - 14. Cranidium, x $4\frac{1}{4}$ (RM Ar 29033). 13: Dorsal view; 14: Right lateral view. Horizon and locality as fig.6. Orig. Lindström, 1885, pl.15, fig.22.

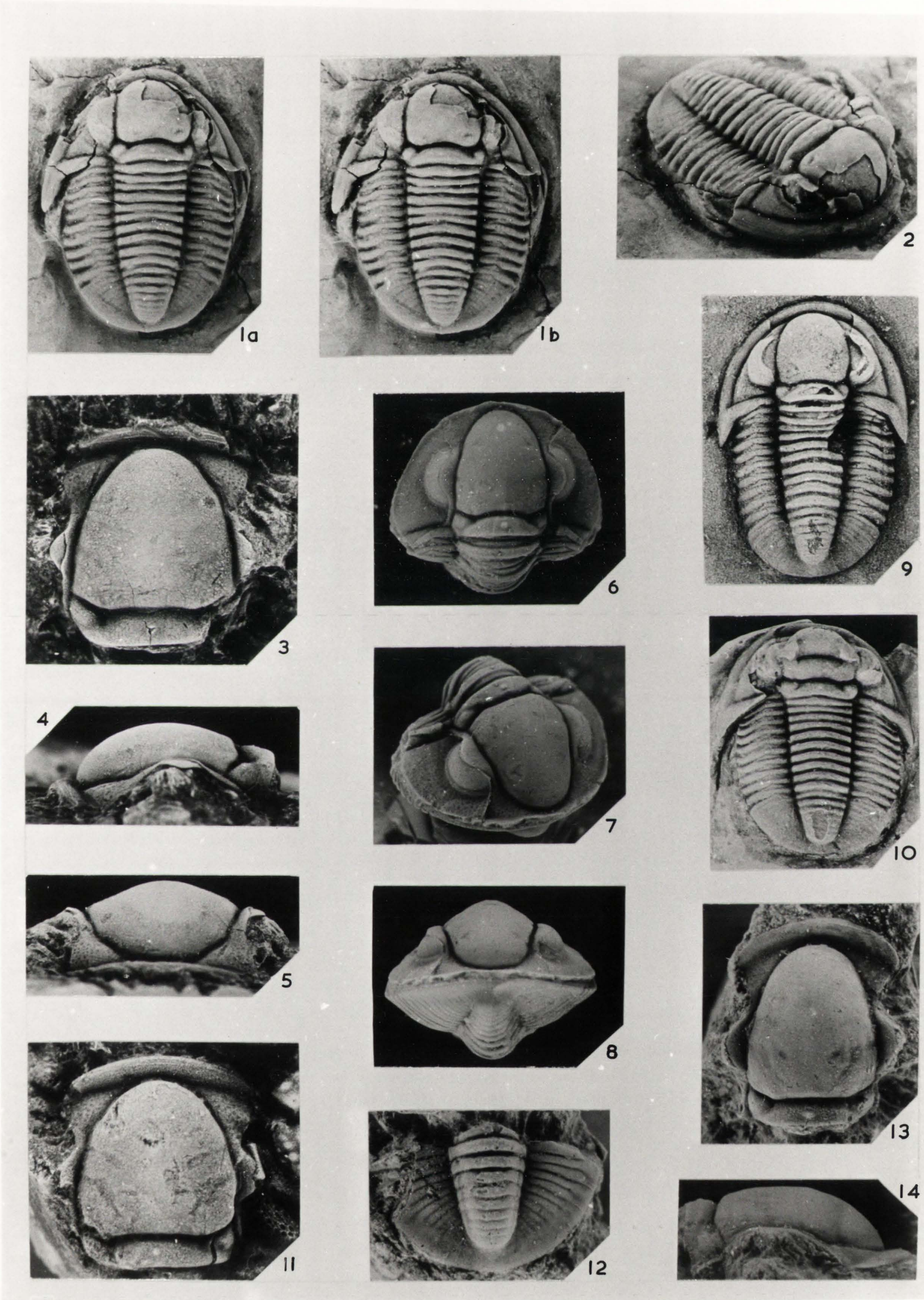
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PLATE 37.

Proetus (Proetus) confossus sp. nov.

1. Free cheek, ventral surface, x 11 (BM It 8847). Note wide panderian opening on doublure at base of genal spine. For other data see pl.35, fig.3.

4. Cranidium, x 5½ (BM It 8869). Dorsal view. Note granular surface sculpture. For other data see pl.36, fig.3.

5. Pygidium, x 5 (BM It 8848). Dorsal view. For other data see pl.36, fig.3.

Proetus (Proetus) cf. obconicus Lindström, 1885.

2, 3. Enrolled specimen, lacking cephalic border and genal spines, x 4 (Y.M.,Reed Coll). 2: Cephalon and anterior part of thorax, dorsal view; 3: Pygidium and posterior part of thorax, dorsal view. Wenlock Limestone, Dudley.

Proetus astringens sp. nov.

6, 9. Incomplete enrolled exoskeleton, internal mould, x 4½ (BM It 8850). 6: Cephalon, dorsal view. Note mould of triangular rostral plate; 9: Anterior section of thorax, dorsal view. Upper Elton Beds, exposure in stream 625 yds. S.E. of Upper Millichope, Shropshire. Coll. J. Shirley and J. Shergold.

8. Complete, partially exfoliated specimen, x 3⅔ (M. Breeze Coll. 69/19). Dorsal view. Lower Bringewood Beds, Woodbury Quarry, Abberley Hills, Worcestershire. Coll. Miss M. Breeze, 1969.

12a-b. HOLOTYPE, internal mould with pygidium disarticulated, x 3½ (BM It 8849). Dorsal stereograph. Upper Elton Beds (Hill Hope Beds), Storridge, Herefordshire. Coll. J. Penn and J. Vinnicombe.

Proetus cf. bravonii sp. nov.

7. Cephalon, internal mould, lacking left free cheek, x 8 (BM It 8825). Dorsal view. Lower Bringewood Beds, well section near quarry at N. edge of Big Wood, 300 yds. S. of Whiteloach Farm, Wenlock Edge. Coll. J. Shirley and J. Shergold.

Proetus latifrons (M'Coy, 1846).

10. Incomplete thorax and pygidium, silicone cast taken from external mould, x 3 (NMI.G9: 1970). ? Upper Llandovery, Egool, Ballaghaderreen, Co. Roscommon, Eire.

11. Free cheek, internal mould, x 7½ (BM It 8866). Dorsal view. Wenlock Shale, section in old rail cut S.E. of Moon's Hill Quarry, near Stoke St. Michael, Mendip Hills. Coll. R.M. Owens, 1967.

PLATE 37

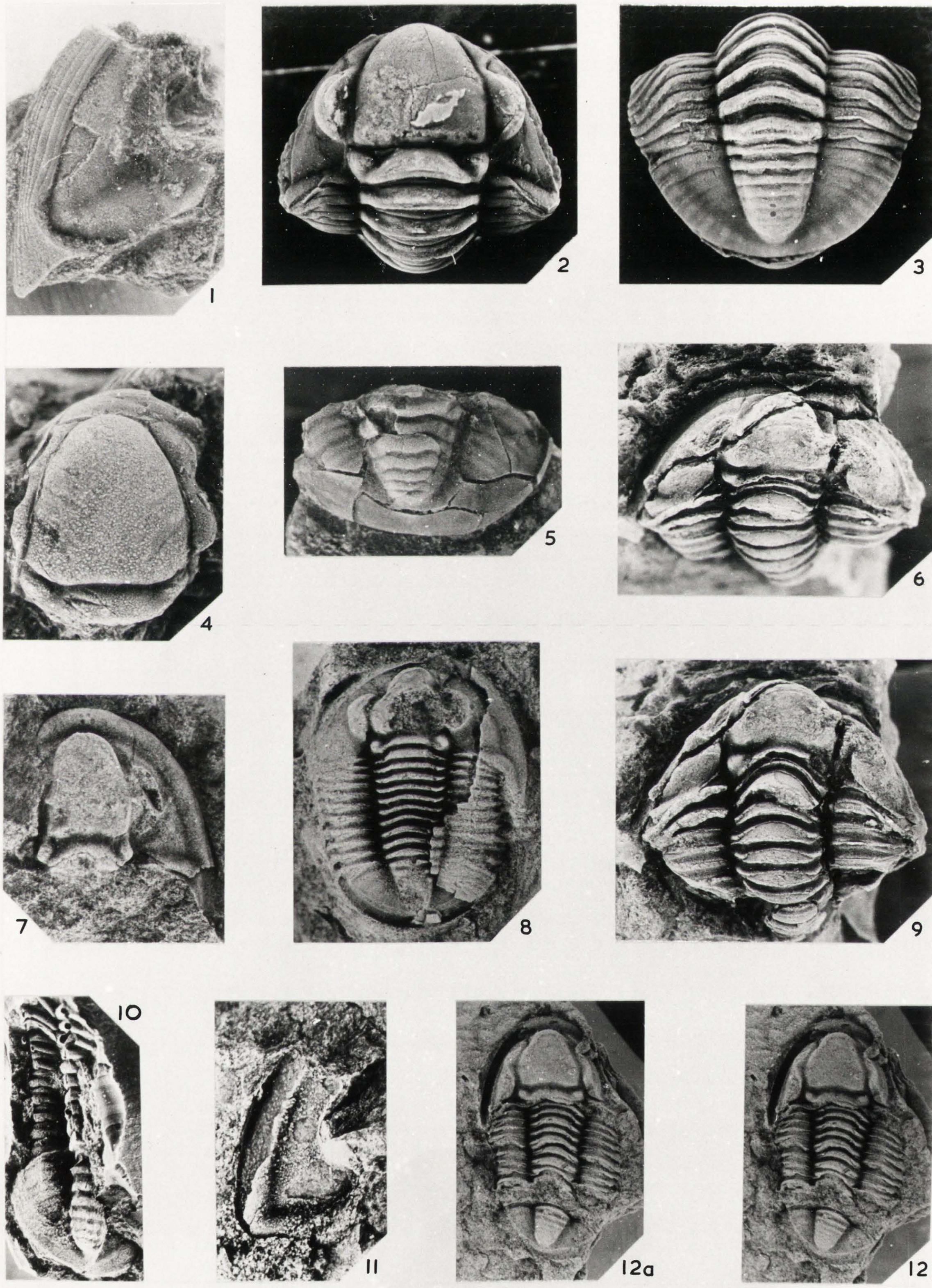


PLATE 38.

Proetus latifrons (M'Coy, 1846).

1a-b, 2, 4. HOLOTYPE. Complete, slightly damaged, internal mould, x 2½ (NMI.G8: 1970). 1a-b: Dorsal stereograph; 2: Lateral oblique view; 4: Anterior view. ? Upper Llandovery, Egool, Ballaghaderreen, Co. Roscommon, Eire. Orig. M'Coy, 1846, pl.4, fig.11.

3a-b. Cranidium, internal mould, x 4¾ (BM It 8867). Dorsal stereograph. Note weak lateral glabellar furrows. For other data see pl.37, fig.11.

7. Partially enrolled specimen, incomplete internal mould, x 5½ (BM It 8868). Dorsal view. For other data see pl.37, fig.11.

Proetus granulatus Lindström, 1885.

5. HOLOTYPE cephalon, x 4 (RM Ar 29374). Dorsal view. Wenlock series, Kyrkberget, Visby, Gotland. Orig. Lindström, 1885, pl.14, fig.13.

Proetus falcatus sp. nov.

6. Almost complete specimen, x 3½ (OUM C 775). Dorsal view. Wenlock Shale, Malvern Tunnel. R.B. Grindrod Coll.

8a-b, 9, 10. HOLOTYPE. Almost complete exoskeleton, x 4 (BM 59022). 8a-b: Dorsal stereograph; 9: Anterior view; 10: Lateral oblique view. Lower Ludlow, Dudley. Allport Coll.

PLATE 38

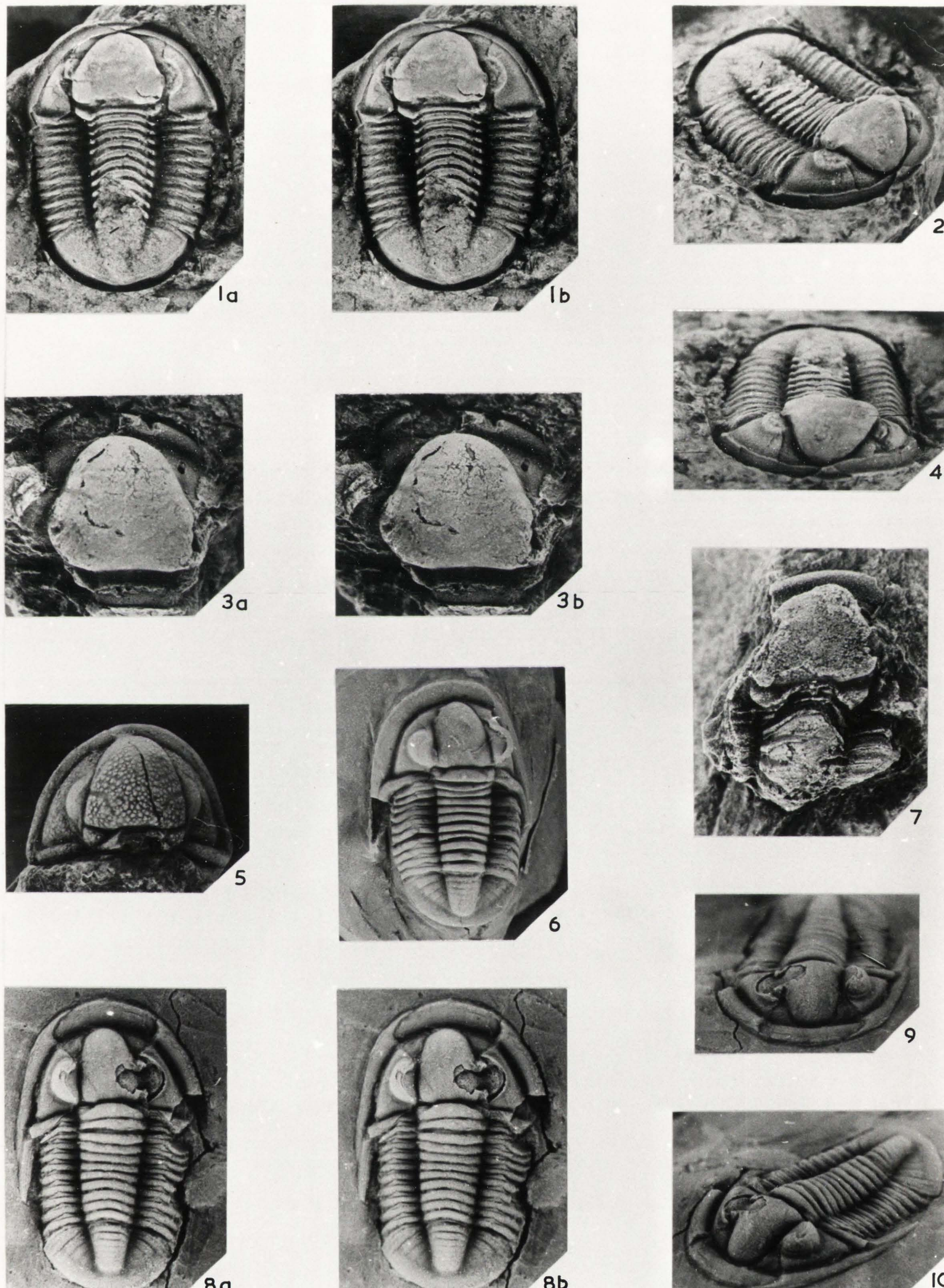


PLATE 39.

Proetus cf. latifrons (M'Coy, 1846).

1. Almost complete specimen, x $3\frac{3}{4}$ (SMC A 39560). Dorsal view. Upper Llandovery, Coralliferous series, 80' above base, Marloes Bay, Pembrokeshire. Coll. D. Gibby.

Proetus haverfordensis sp. nov.

2 - 3. HOLOTYPE, complete specimen, x $2\frac{1}{2}$ (SMC A 32743a-b (part and counterpart)). 2: Internal mould; 3: Silicone cast taken from external mould. Note incurved marginal terrace lines on pygidium. Upper Llandovery, near Uzmaston Farm, the Frolic, Haverfordwest. Turnbull Coll.

7. Pygidium, x 3 (GSM TJ 779). Dorsal view. Upper Llandovery, Canaston Beds, Cleddau Bank, near Blackpool, Pembrokeshire.

11. Incomplete cephalon with parts of 5 attached thoracic segments, x $3\frac{3}{4}$ (GSM TJ 655). Dorsal view. Upper Llandovery, Canaston Beds, near Narberth, Pembrokeshire.

Crassiproetus? curtisi nom. nov.

4. HOLOTYPE, x 1.1 (GSM GSb 4687). Upper Llandovery, base of Tortworth Beds, Cullimore's Trap Quarry, Charfield, Gloucestershire. Orig. Proetus asaphoides Curtis, 1958, pl.29, fig.2. Coll. T. Weaver.

Proetus sp. A.

5, 9. Cranidium (M. Jones Coll). 5: Silicone cast taken from external mould, x 6; 9: Internal mould, x $5\frac{1}{2}$. Higher Lower Leintwardine Beds, Channel fill deposits, Church Hill, Leintwardine. Coll. M. Jones, 1967.

Proetus sp. C.

6. Cranidium, internal mould, x 6 (OUM C 16117a). Dorsal view. Upper Llandovery Rentamerus Beds, Marshbrook. Coll. L.R.M. Cocks.

Proetus sp. B.

8. Pygidium, internal mould, x $6\frac{1}{2}$ (GSM 90031). Dorsal view. Upper Llandovery, Damery Beds, Damery Bridge, near Tortworth. Orig. Curtis, 1958, pl.29, fig.3.

10. Pygidium, with fragments of dorsal surface remaining, x $4\frac{1}{2}$ (GSM 35997). Dorsal view. For other data see 8.

Proetus sp. C.

12. Cranidium, internal mould, x $5\frac{1}{2}$ (OUM C 1926b). Dorsal view. Upper Llandovery, Huntley Hill Beds, trackside exposures immediately west of old quarry on east side of Nottswood Hill, 760 yds. W.S.W. of Hinders Farm, May Hill. A.M. Ziegler Coll.

Proetus sp. D.

13 - 14. Cranidium, x 5 (BM). 13: Silicone cast taken from incomplete external mould; 14: Internal mould. Middle Llandovery Saugh Hill Group, Newlands, near Girvan. Orig. Reed, 1904, pl.11, figs.4,4a. Gray Coll.

Proetus cf. latifrons (M'Coy, 1846).

15. Incomplete internal mould, x 2 (GSM Pr. 2571). Dorsal view. Upper Llandovery, Canaston Beds, small quarry by roadside at Valley gate, $\frac{3}{4}$ mile W. of Narberth Bridge, Pembrokeshire.

PLATE 39

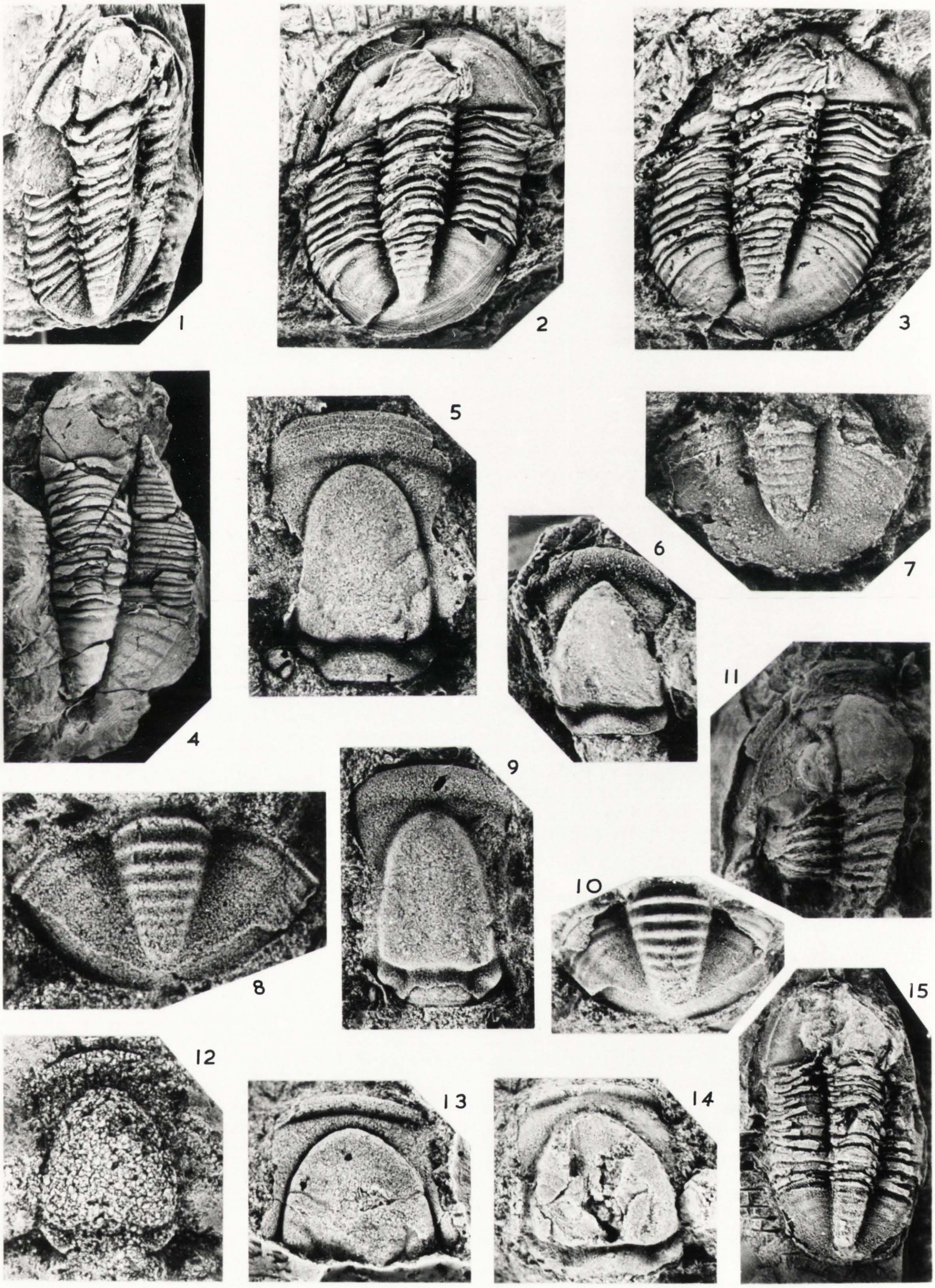


PLATE 40.

Schizoproetus tiro sp. nov.

1 - 2, 5, 7. HOLOTYPE cranidium, x $4\frac{1}{4}$ (SGU Coll). 1-2: Dorsal stereograph; 5: Right lateral view. 7: Anterior view. Wenlock, Halla Beds "Proetus-kalk", canal section, Hörsne, Gotland. Coll. G. Liljevall, 1940.

3. Incomplete cephalon, x $2\frac{1}{2}$ (SGU Coll). Dorsal view. Other data as 1.

4. Cranidium, x 8 (SGU Coll). Dorsal view. Other data as 1.

6. Thoracic segment, x 4 (SGU Coll). Dorsal view. Note preannulus. Other data as 1.

8. Hypostome, x $5\frac{1}{2}$ (SGU Coll). Dorsal view. Other data as 1.

9, 12. Hypostome, x 8 (SGU Coll). 9: Dorsal view; 12: Left lateral view. Other data as 1.

10. Free cheek, x $5\frac{1}{2}$ (SGU Coll). Dorsal view. Other data as 1.

11, 14. Free cheek (SGU Coll). 11: Enlargement of border region, showing two orders of pits and raised striae near margin, x 15; 14: General dorsal view, x $4\frac{1}{4}$. Other data as 1.

13. Small cranidium, x 9 (SGU Coll). Dorsal view. Note granular surface sculpture and isolated lateral occipital lobes. Other data as 1.

PLATE 40

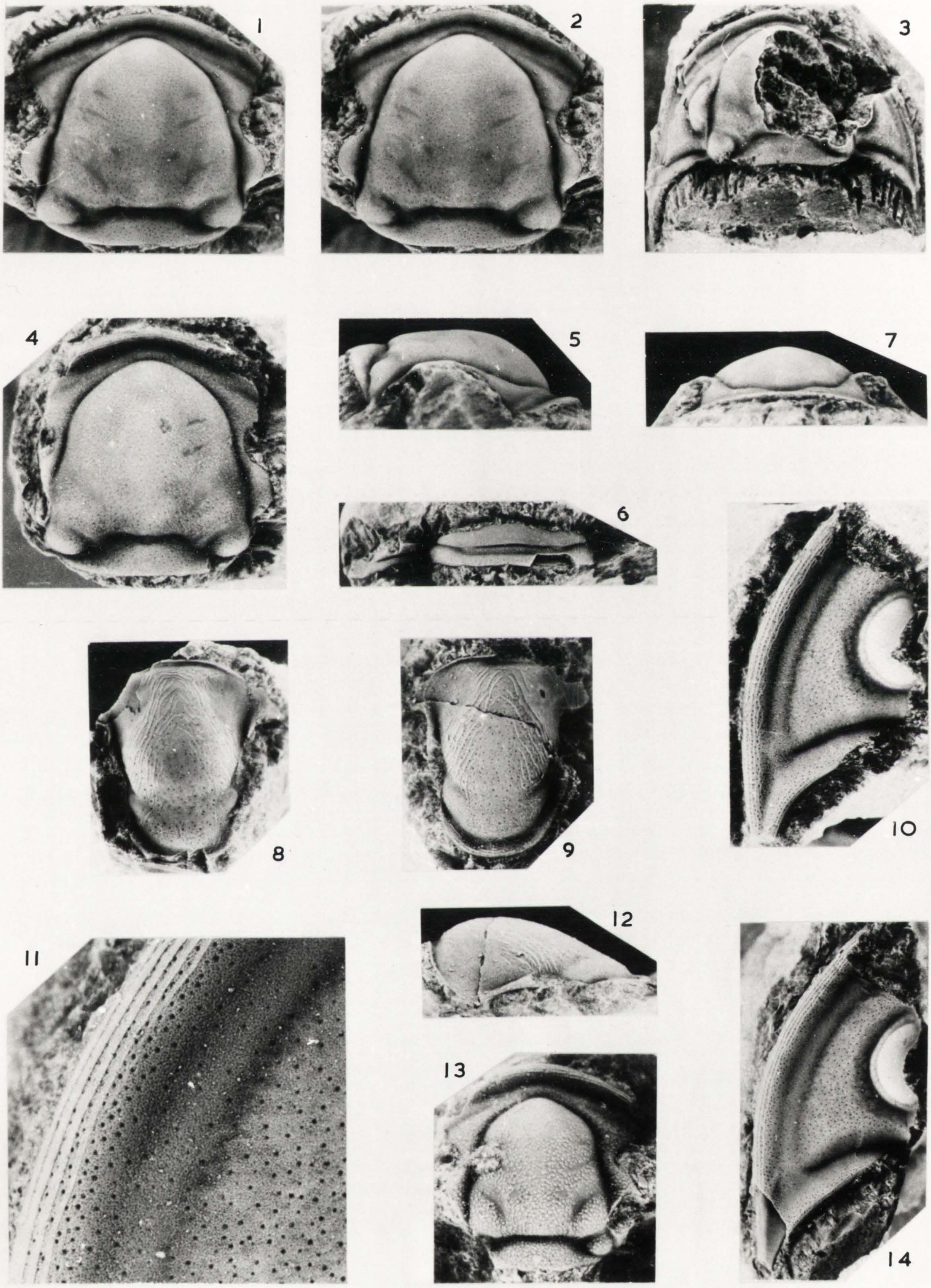


PLATE 41.

Schizoproetus tiro sp. nov.

1, 2, 14. Large pygidium (SGU Coll). 1,2: Dorsal stereograph, x $2\frac{3}{4}$; 14: Enlargement of axis, showing fine pits, x 8. Other data as pl.40, fig.1.

4, 5, 8, 12. Pygidium (SGU Coll). 4-5: Dorsal stereograph, x $4\frac{1}{2}$; 8: Detail of anterolateral part of margin, showing incurving marginal terrace lines, x $10\frac{1}{2}$; Enlargement of axis, showing coarse pits, x $13\frac{1}{2}$. For other data, see pl.40, fig.1.

6, 9, 13. Pygidium, x 4 (SGU Coll). 6: Left lateral view; 9: Dorsal view; 13: Posterior view. Other data as pl.40, fig.1.

7. Small pygidium, x 11 (SGU Coll). Dorsal view. Note fine granular sculpture. Other data as pl.40, fig.1.

10. Small pygidium, x $7\frac{1}{2}$ (SGU Coll). Dorsal view. Note very fine granular sculpture (cf. figs.7 and 11). Other data as pl.40, fig.1.

11. Smallest pygidium, x 14 (SGU Coll). Dorsal view. Note granular sculpture. Other data as pl.40, fig.1.

Schizoproetus tiro sp. nov.?

3. Small, worn pygidium, x $3\frac{1}{4}$ (GSM 33122). Dorsal view. Wenlock Limestone, Dudley.

PLATE 41

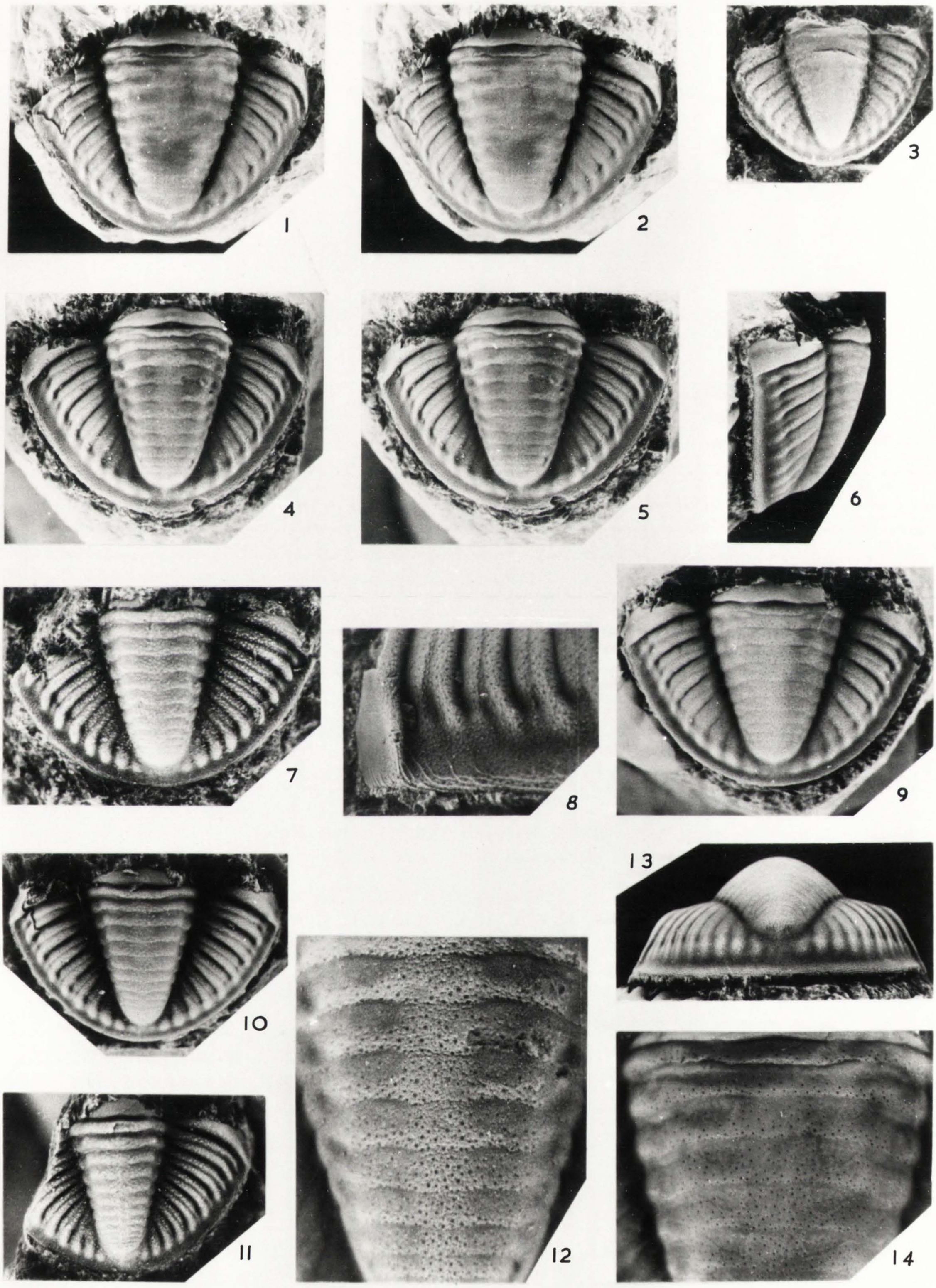


PLATE 42.

Proetus ryckholti Barrande, 1846.

1. Silicone cast of holotype, almost complete specimen, x $3\frac{1}{2}$ (NMP Br. 174). Dorsal view. Budnanian, Kopanina Beds, Dlouhá Hora, Bohemia. Orig. Barrande, 1852, pl.15, figs.15-17.

2 - 3. Plaster cast of damaged specimen, showing hypostome and cephalic doublure, x $4\frac{3}{4}$ (NMP Br. 175). Dorsal stereograph. Horizon and locality as 1. Orig. Barrande 1852, pl.15, figs.18-19 (hypostome).

Proetus (Coniproetus) condensus Přibyl, 1965.

4. Silicone cast of holotype cranidium, x 3 (NMP). Dorsal view. Lower Devonian, Upper Koněprusy Limestone, Plesivec, near Menany, Bohemia. Orig. Přibyl, 1965, pl.1, fig.1.

Proetus (Proetus) morinensis Přibyl, 1946.

5, 6. Two silicone casts of a single enrolled specimen, x 6 (NMP). 5: Dorsal view of cephalon; 6: Dorsal view of pygidium and posterior part of thorax. Budnanian, Kopanina Beds, "Amerika" quarry, Moriny, Bohemia. Orig. Přibyl, 1960, pl.2, fig.4.

Proetus (Coniproetus) nasutus sp. nov.

7 - 9, 11. Plaster cast of holotype cranidium, x $3\frac{1}{2}$ (NMP 218/67). 7: Dorsal view; 8: Anterior oblique view; 9: Anterior view; 11: Left lateral view. Budnanian, Kopanina Beds, Slivenec, Prague. Orig. Přibyl, 1960, pl.1, figs.17-18.

10, 12, 13. Pygidium, silicone cast, x 5 (NMP CE 274). 10: Posterior view; 12: Left lateral view; 13: Dorsal view. Budnanian, Kopanina Beds, Svatý Janpod Skalou. Orig. Přibyl, 1960, pl.1, figs.21-22.

PLATE 42

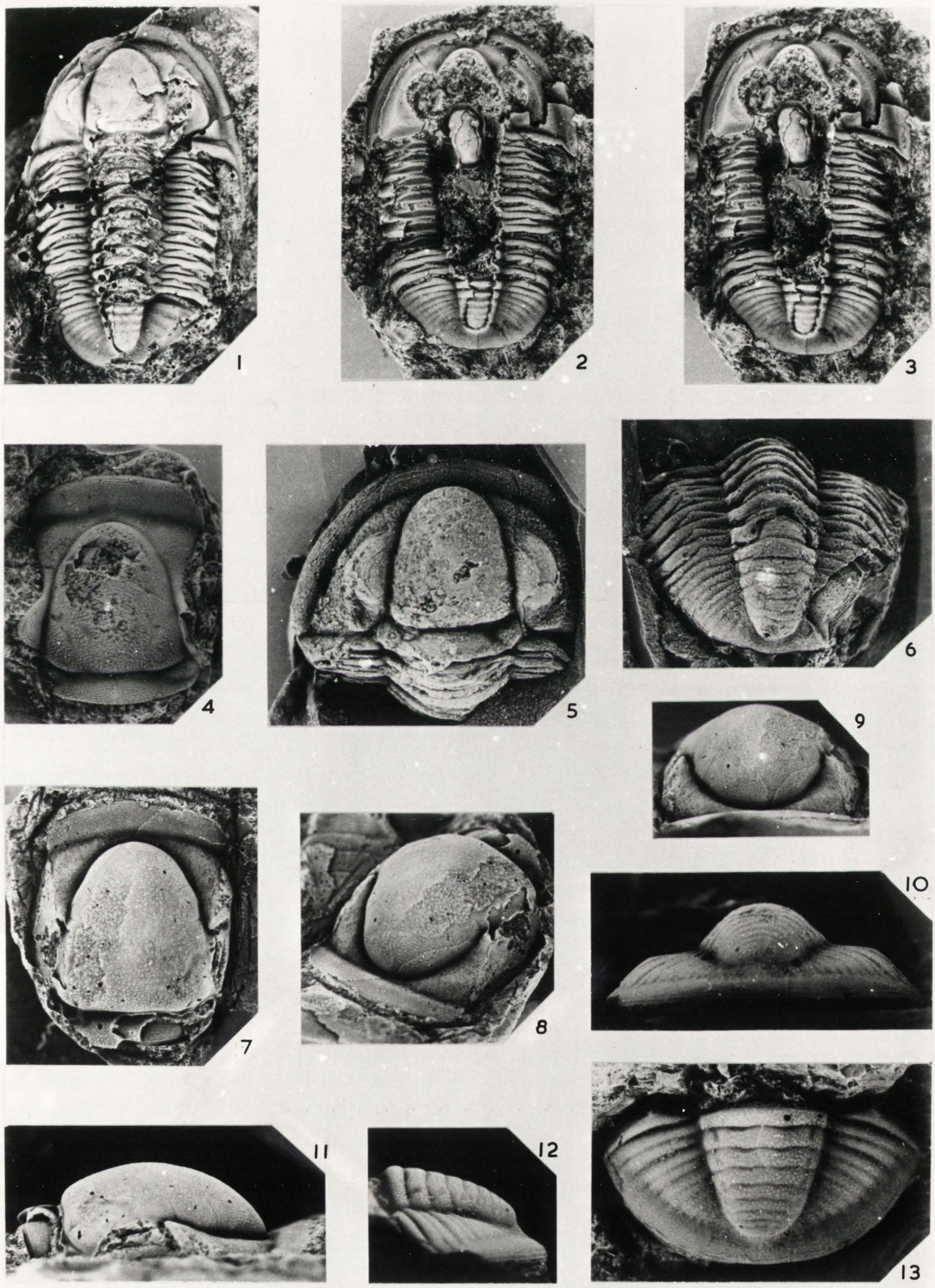


PLATE 43.

"Proetus" (= Cornuproetus?) ramisulcatus Nieszkowski, 1857?

1. Cranidium, x 4 (RM Ar 34412). Dorsal view. Upper Ordovician, Porkuni Stage, Nõmküla, at the railway, Estonia. Coll. G. Holm, 1883.

4. Free cheek, x 4 (RM Ar 34410). Dorsal view. Other data as 1.

8, 9. Pygidium, x 8 (RM Ar 34422). 8: Left lateral view; 9: Dorsal view. Other data as 1.

Cornuproetus (Cornuproetus) intermedius (Barrande, 1846).

2. Cranidium, with most of the anterior border exfoliated, x 4 (BM 42398). Dorsal view. Budnanian, Kopanina Beds, Tobolka. Barrande Coll.

10. Pygidium, x 4 (BM 42398). Dorsal view. Budnanian, Kopanina Beds, Tobolka. Barrande Coll.

11. Free cheek, x 5½ (BM 42398). Dorsal view. Budnanian, Kopanina Beds, Tobolka. Barrande Coll. (N.B. This and the above two specimens all bear the same BM catalogue number).

12, 13. HOLOTYPE, plaster cast, x 2½ (NMP Br 216). Dorsal stereograph. Budnanian, Kopanina Beds, Dlouhá Hora. Orig. Barrande, 1852, pl.16, figs.31-33.

Cornuproetus (Cornuproetus) peraticus sp. nov.

3, 5 - 7. HOLOTYPE cranidium, x 6½ (GSM Coll). 3: Anterior oblique view; 5: Dorsal view; 6: Left lateral view; 7: Anterior view. Woolhope Limestone, Old Radnor.

PLATE 43

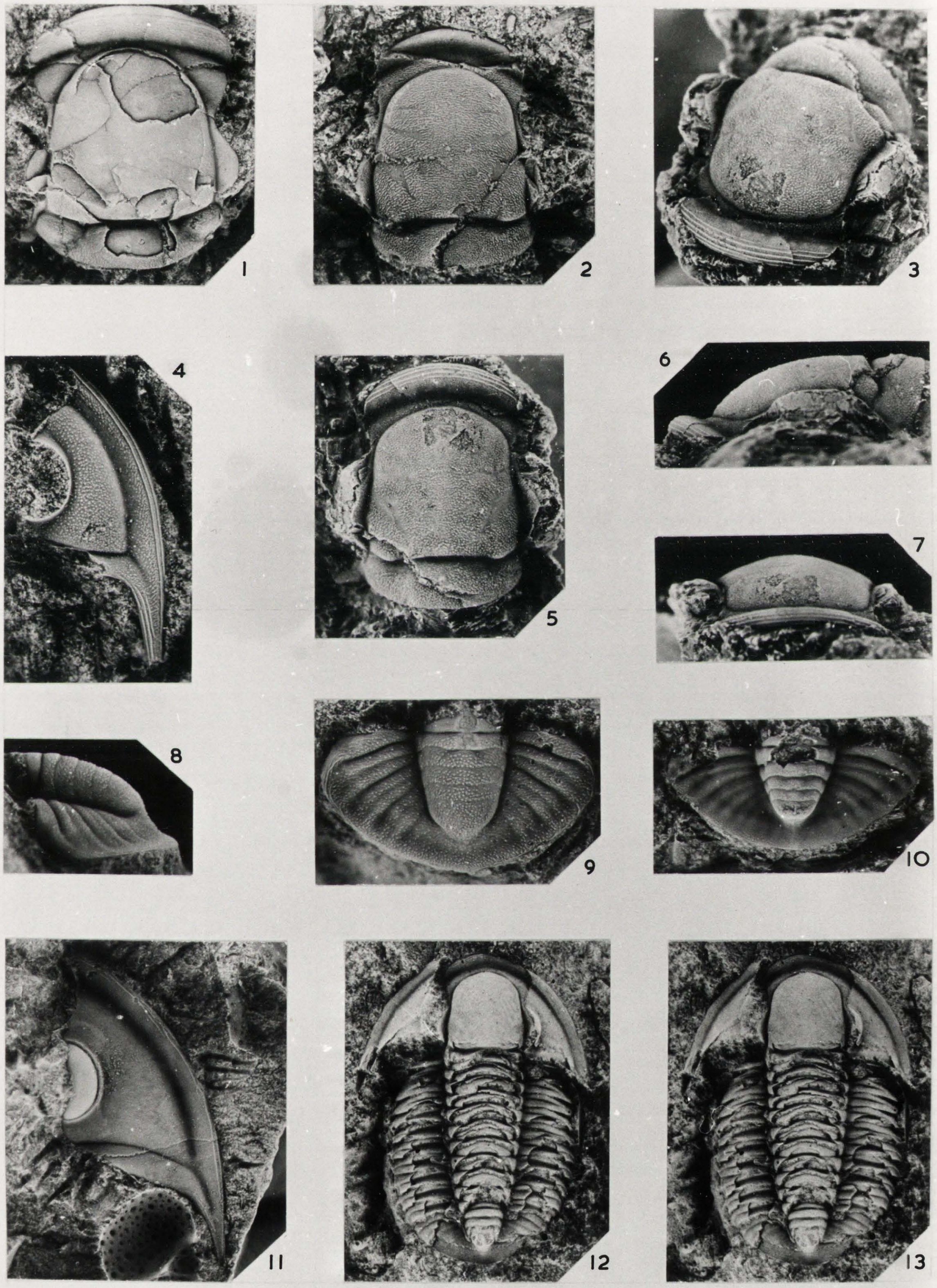


PLATE 44.

Cornuproetus (Cornuproetus) consobrinus Přibyl, 1965.

1 - 3. HOLOTYPE, incomplete cephalon, plaster cast, x $2\frac{3}{4}$ (NMP 720/66). 1: Dorsal view; 2: Anterior view; 3: Right lateral view. Lower Budnanian, Listice, near Beroun, Bohemia. Orig. Pribyl, 1965, pl.2, fig.5.

Cornuproetus (Cornuproetus) venustus (Barrande, 1846).

4. Almost complete specimen, x $4\frac{1}{2}$ (BM I 3605). Dorsal view. Kopanina Beds, Dlouhá Hora, Bohemia. Barrande Coll.

5 - 7, 9, 10. Silicone cast of HOLOTYPE, x 4 (NMP Br 227). 5 - 6: Dorsal stereograph; 7: Lateral oblique view; 9: Anterior view; 10: Left lateral view. Horizon and locality as 4. Orig. Barrande 1852, pl.17, figs.1-3.

Cornuproetus (Cornuproetus) vertumnus Prantl and Vaněk, 1958.

8. Pygidium, plaster cast, x 7 (NMP L 3662). Dorsal view. Litenian, Motol Beds, flexilis zone, Lodenice. Orig. Prantl and Vaněk, pl.2, fig.3.

12. Later case of HOLOTYPE cranidium, x $6\frac{1}{2}$ (NMP L 3661). Dorsal view. Horizon and locality as 12. Orig. Prantl and Vaněk, pl.2, fig.2.

Cornuproetus (Cornuproetus) reussi (Hawle and Corda, 1847).

11. LECTOTYPE cranidium, plaster cast, x 4 (NMP L 3652). Dorsal view. Litenian, upper layers of Motol Beds, Listice, near Beroun. Orig. Prantl and Vaněk, pl.1, fig.5.

13. Cranidium, plaster cast, x 4 (NMP L 3653). Dorsal view. Horizon and locality as 11. Orig. Prantl and Vaněk, pl.1, fig.6.

Cornuproetus (Lodenicia) dentatulus (Novák, 1890).

14. HOLOTYPE pygidium, plaster cast, x 7 (NMP CE 275). Dorsal view. Litenian, Motol Beds, testis zone, Cernidla, near Lodenice. Orig. Přibyl, 1965, pl.2, fig.2.

Cornuproetus (Lepidoproetus) limatulus Přibyl, 1966.

15 - 16. HOLOTYPE cranidium, latex cast, x 7 (NMP SMP 6802). Dorsal stereograph. Budnanian, Kopanina Beds, Kosov, near Beroun, Bohemia. Orig. Přibyl, 1966, pl.1, fig.3.

PLATE 44

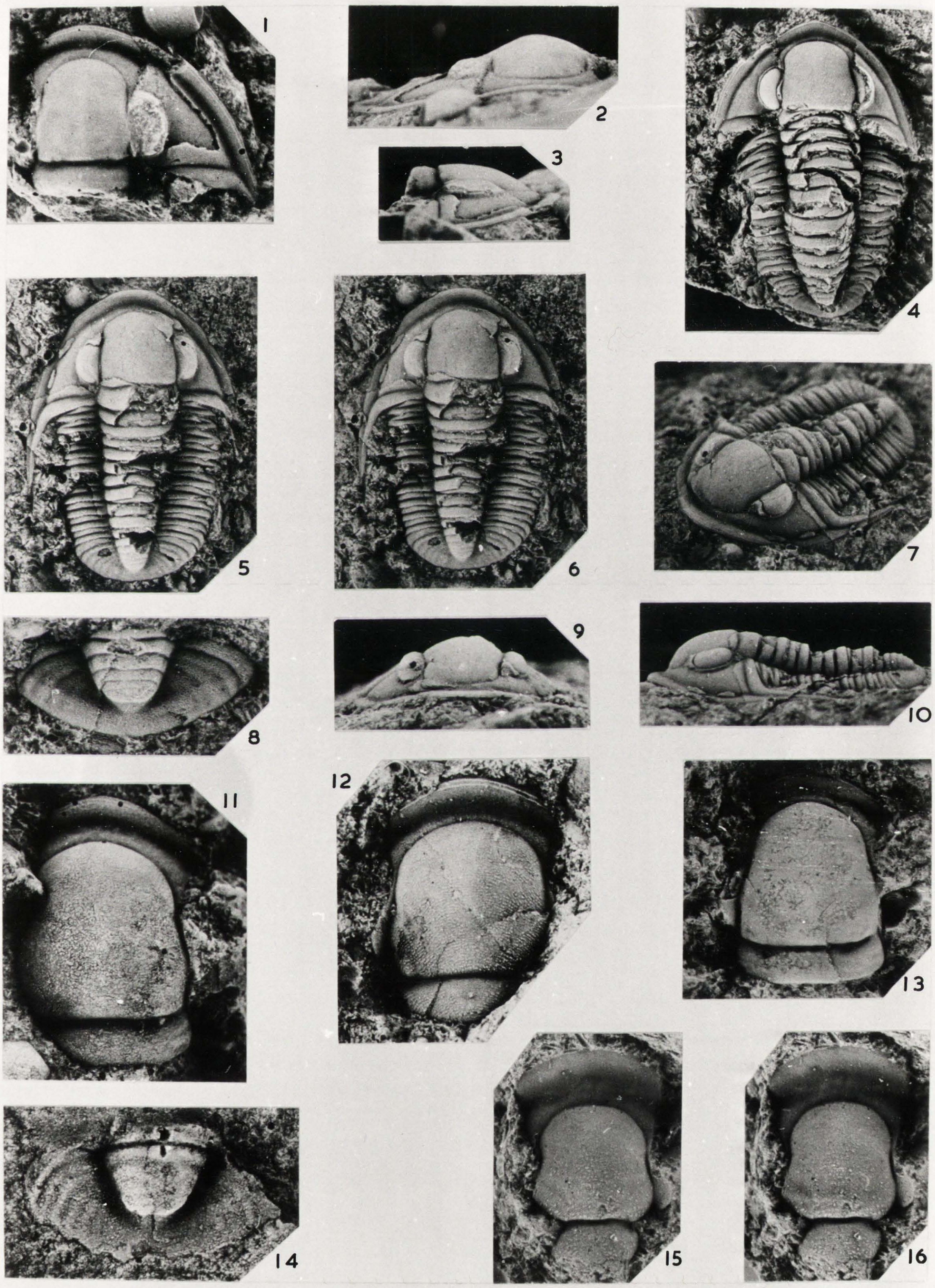


PLATE 45.

Eremiproetus senex Alberti, 1967.

1 - 2, 4 - 6. Complete specimen, plaster cast, x 4 (NMP Br 229). 1-2: Dorsal stereograph; 4: Anterior oblique view; 5: Anterior view; 6: Left lateral view. Budnanian, Kopanina Beds, Dlouhá Hora, Bohemia. Orig. Barrande, 1852, pl.17, figs.1-6 (= Proetus venustus Barr pars).

3. Almost complete specimen, plaster cast, x 3 (NMP Br 228). Dorsal view. Horizon and locality as 1.

Tropidocoryphe heothina sp. nov.

7. HOLOTYPE, pygidium x $4\frac{1}{2}$ (BM 42384). Dorsal view. Litenian, Motol Beds, Svatý Jan pod Skalou, Bohemia. Barrande Coll.

8. Pygidium, x 3 (BM 42384). Dorsal view. Note broad doublure where pygidium has been damaged on left hand side. Other data as 7.

Decoroproetus decorus decorus (Barrande, 1846).

9. Complete specimen, x $1\frac{3}{4}$ (NMP Br 241). Dorsal view. Litenian, Motol Beds, Lodenice. Orig. Prantl and Vaněk, 1958, pl.2, fig.1.

10 - 11. Small complete specimen, latex cast, x $3\frac{1}{2}$ (NMP Br 240). Dorsal stereograph. Litenian, Motol Beds, flexilis zone, Lodenice. Orig. Barrande, 1852, pl.17, fig.21.

12. LECTOTYPE, poorly preserved complete specimen, plaster cast, x 2 (NMP Br 233). Dorsal view. Litenian, Motol Beds, flexilis zone, Lodenice-Černidla. Ad. Orig. Barr 1852, pl.17, figs.13-15.

13. Pygidium, plaster cast, x 3 (NMP Br 234). Dorsal view. Horizon and locality as 10. Ad. orig. Barr 1852, pl.17, fig.13.

PLATE 45

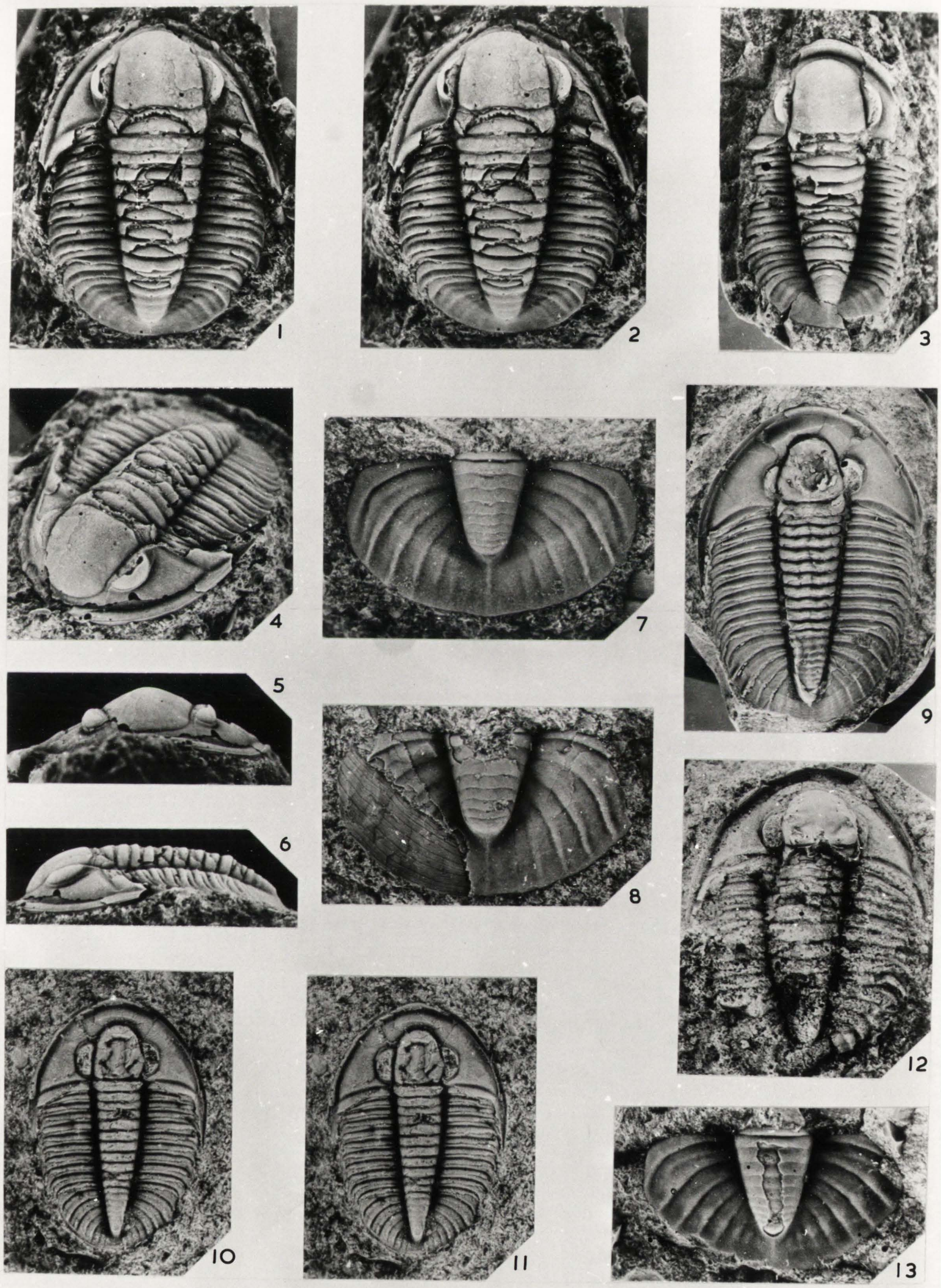


PLATE 46.

Decoroproetus decorus (Barrande, 1846) quirinus Prantl and Vaněk, 1958.

1. HOLOTYPE cranidium, plaster cast, x 4½ (NMP Br 287). Dorsal view. Budnanian, Kopanina Beds, Old quarry near church at Jinonice, near Prague. Orig. Prantl and Vanek, pl.1, fig.2.

2. Pygidium, plaster cast, x 4½ (NMP Br 274). Dorsal view. Budnanian, Kopanina Beds, Old quarry near the church at Jinonice, near Prague. Orig. Prantl and Vaněk, 1958, pl.1, fig.3.

Decoroproetus decorus decorus (Barrande, 1846).

3. Cranidium, plaster cast, x 4½ (NMP Br 282). Dorsal view. Litenian, Listice, near Beroun. Orig. Prantl and Vanek, 1958, pl.1, fig.1.

Prantlia longifrons (Lindström, 1885).

4 - 7. HOLOTYPE cephalon, x 4½ (RM Ar 2183). 4: Dorsal view; 5: Anterior oblique view; 6: Anterior view. 7: Lateral view. Ludlow, Hemse Beds (nilssoni-scanicus zone), Lindeklint, Gotland. Orig. Lindström, 1885, pl.16, fig.14.

Prantlia longula (Hawle and Corda, 1847).

8 - 10, 12. HOLOTYPE. Complete, ill preserved specimen, plaster cast, x 3 (NMP Coll). 8: Left lateral view; 9: Dorsal view; 10: Lateral oblique view; 12: Anterior view; Budnanian, Kopanina Beds, Dlouhá hora, Bohemia. Orig. Pribyl, 1946a, pl.1, fig.12.

11. Pygidium, x 3 (HK Erben Coll, Bonn). Dorsal view. Budnanian, Kopanina Beds. Dlouhá hora, Bohemia.

Decoroproetus octonus sp. nov.

13. HOLOTYPE, complete specimen, x 3⅔ (NMP Br 238). Dorsal view. Litenian, Motol Beds, flexilis zone, Lodenice. Orig. Barr, 1852, pl.17, fig.19 (= Proetus decorus Barr. pars).

Cyphoproetus strabismus sp. nov.

14. Cephalon, x 5 (BM 42362). Dorsal view. Litenian, Motol Beds, Lodenice. Barrande Coll.

16. HOLOTYPE, almost complete specimen, x 4 (BM 42362). Dorsal view. Litenian, Motol Beds, Lodenice. Barrande Coll.

Cyphoproetus depressus (Barrande, 1846).

15, 18, 19. HOLOTYPE. Incomplete exoskeleton, latex cast, x 6 (NMP Br 221). 15: Anterior oblique view; 18: Right lateral view; 19: Dorsal view. Litenian, Motol Beds, Lodenice. Ad orig. Barrande 1852, pl.16, figs.38-40.

PLATE 46

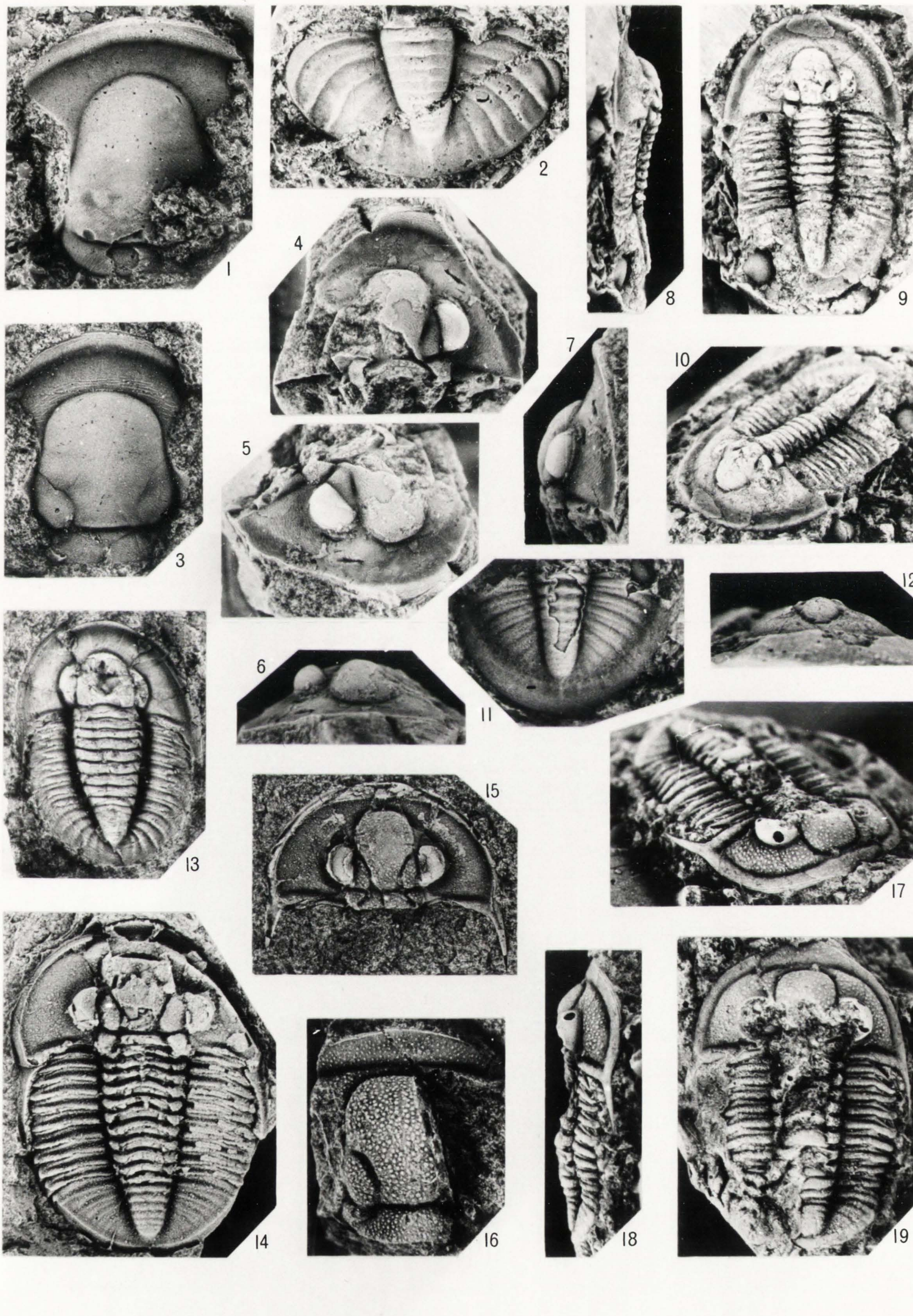


PLATE 47.

Scharyia micropyga (Hawle and Corda, 1847) *wenlockiana* Přibyl, 1967.

1. Degree 5 meraspis, latex cast, x 9 (NMP Br 235). Dorsal view. Litenian, Motol Beds, *flexilis* zone, Lodenice. Orig. Barrande, 1852, pl.17, fig.16 (= *Proetus decorus* Barr. *pars*).

5. Cranidium, internal mould, x 9 (NMP Akz Kat 2929 1893). Horizon and locality as 1. Orig. Přibyl, 1967, pl.1, fig.2.

6. Complete exoskeleton, internal mould, x 11 (BM 42384). Horizon and locality as 1. Barrande Coll.

Scharyia sp. A.

2. Incomplete cranidium, silicone cast, x 17 (Australian Museum). Dorsal view. Upper Ludlow, Bowning Series, Lower Trilobite Bed, Bowning Creek, New South Wales, Australia.

3. Complete specimen, silicone cast, x 9 (Australian Museum). Dorsal view. Horizon and locality as 2. Orig. Etheridge and Mitchell 1892, pl.25, fig.2d.

4. Pygidium, silicone cast, x 18 (Australian Museum). Dorsal view. Horizon and locality as 2.

Panarchaegonus whittardi (Begg, 1939).

7. HOLOTYPE, complete internal mould, x $8\frac{1}{2}$ (HM A 1083). Dorsal view. Ashgill, late Rawtheyan, Upper Drummuck Group, Lady Burn, Girvan. Orig. Begg, 1939, pl.6, fig.3.

Scharyia angusta Pribyl, 1966.

8. Cranidium, plaster cast, x 13 (NMP Br 185). Dorsal view. Lower Devonian, Lochkovian, Lochkov, Bohemia. Orig. Barrande, 1852, pl.15, figs.37-38, Pribyl 1967, pl.2, fig.1.

9. HOLOTYPE pygidium, plaster cast, x 13 (NMP Br 187). Dorsal view. Lower Devonian, Lochkovian, Lochkov, Bohemia. Orig. Barrande, 1852, pl.15, figs.39-40. Pribyl, 1967, pl.2, fig.2.

PLATE 47

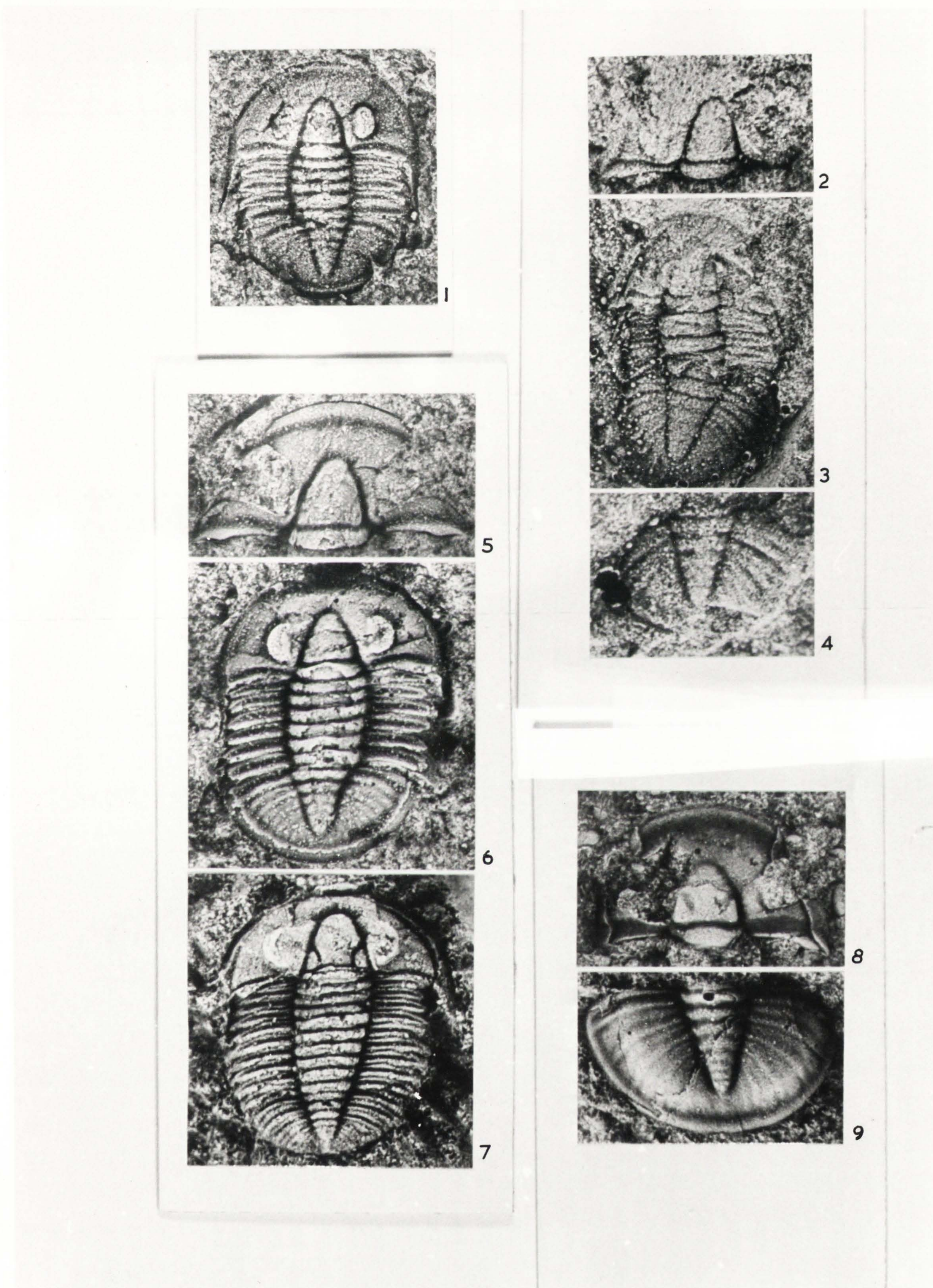


PLATE 48.

Scharyia britannica sp. nov.

1. HOLOTYPE, cranidium, silicone cast taken from external mould, x 15 (BM It 8838). Dorsal view. Ludlow Lower Elton Beds, Oldcastle Farm, near Colwall Green, Herefordshire. Coll. J. Penn and J. Vinnicombe.

2. Thoracic segment, internal mould, x 15 (BM It 8839). Dorsal view. Other data as 1.

3, 4. Pygidium, x 15 (BM It 8840a-b). 3: Internal mould; 4: Silicone cast taken from counterpart external mould. Dorsal view. Other data as 1.

5, 6. Free cheek, x 15 (BM It 8841a-b). 5: External mould (note course of facial suture); 6: Counterpart internal mould. Other data as 1.

7. Late protaspis, x 36 (BM It 8842). Dorsal view. Other data as 1.

8. Small cranidium, x 19 (BM It 8826). Dorsal view. Other data as 1.

9. Transitory pygidium, x 22 (BM It 8824). Dorsal view. Other data as 1.

10. Late protaspis, x 44 (BM It 8819). Dorsal view. Other data as 1.

11. Small pygidium, x 16 (BM It 8840 - on same slab as fig.3. Dorsal view. Other data as 1.

PLATE 48

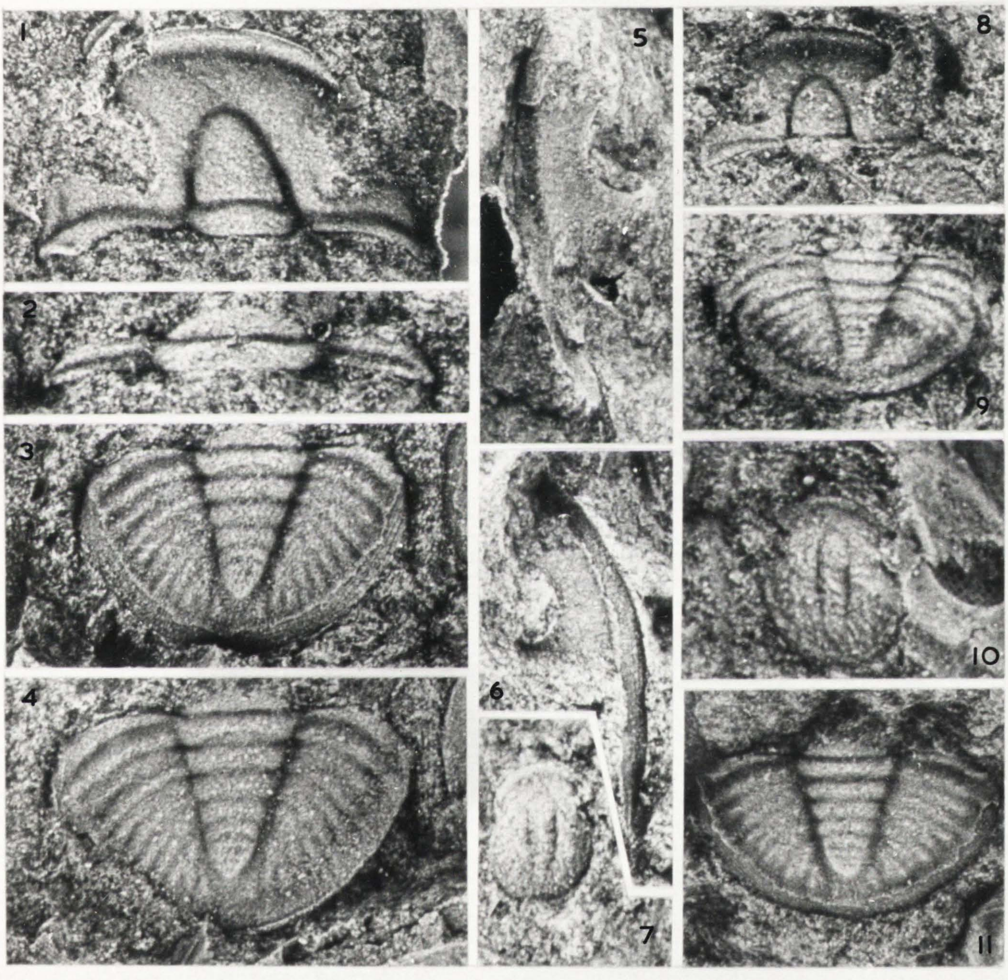


PLATE 49.

Scharyia siljanensis sp. nov.

1 - 2. Pygidium, x 15 (RM Ar 47555). 1: Dorsal view; 2: Left lateral view. Harjuan, Boda Limestone, Kalloln, Lake Siljan district, Sweden. Coll. R.M. Owens, 1969.

3. Pygidium, x 10 (RM Ar 47496). Dorsal view. Harjuan, Boda Limestone, Kallholn, Lake Siljan district, Sweden.

4. Pygidium, x 15 (RM Ar 10805). Dorsal view, Harjuan, Boda Limestone, Gryssen, Ostbjörka, Lake Siljan district, Sweden. Coll. G. Holm, 1880.

5. Pygidium, x 9 (UM D 77). Dorsal view. Harjuan, Boda Limestone, Boda, Lake Siljan district, Sweden. Orig. Warburg, pl.5, fig.61 (= "*Cyphaspis* sp. ind. 'b'").

6 - 7. HOLOTYPE, cranidium, x 22 (RM Ar 47554). 6: Dorsal view; 7: Right lateral view. Other data as 1.

Scharyia sp. B.

8. Incomplete cranidium, x 12 (UM D 76). Dorsal view. Horizon and locality as 1. Orig. Warburg 1925, pl.5, fig.60. (= "*Cyphaspis* sp. ind. 'a'").

9. Incomplete cranidium, x 12 (UM D 75). Dorsal view. Horizon and locality as 1. Orig. Warburg 1925, pl.5, fig.59. (= "*Cyphaspis* sp. ind. 'a'").

Scharyia sp. C.

10. Pygidium, x $9\frac{1}{2}$ (UM D 78). Dorsal view. Horizon and locality as 5. Orig. Warburg 1925, pl.5, fig.62. (= "*Cyphaspis*? sp. ind. 'd'").

PLATE 49

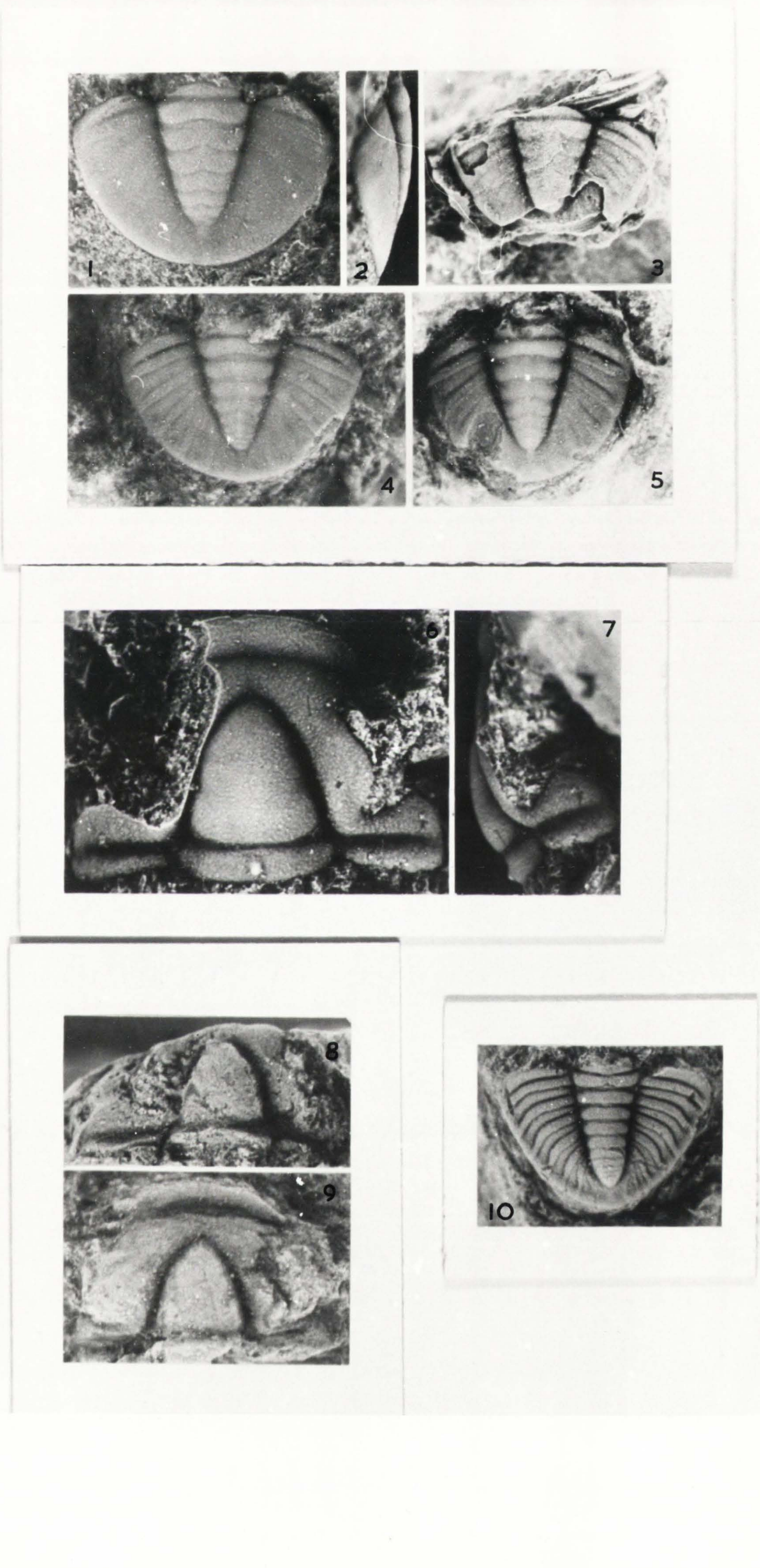


PLATE 50.

Stereoscan photographs of the dorsal surface of the cranidium of Stenoblepharum strasburgense (Cooper, 1953), from the Edinburg Formation of Virginia, U.S.A. All specimens from BM collections.

1. Right hand anterolateral part of the cranidium, 47.25x. (1141/30,32). *

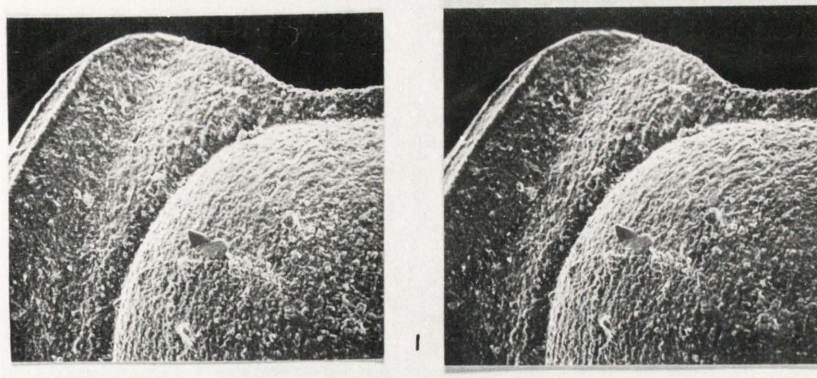
2. Right hand posterolateral part of the cranidium, 47.25x. (1141/29,28). Note the lp muscle area.

3. Left lateral view of posterolateral part of cranidium, 80x. (1140/8,5). Note structure of surface sculpture, a series of overlapping ridges.

4. Area of occipital tubercle, 209x. (1140/4,12).

* These numbers, found on Plates 50-52 refer to film and frame numbers in the collection of stereoscan negatives at the Geology Department, University of Leicester.

PLATE 50



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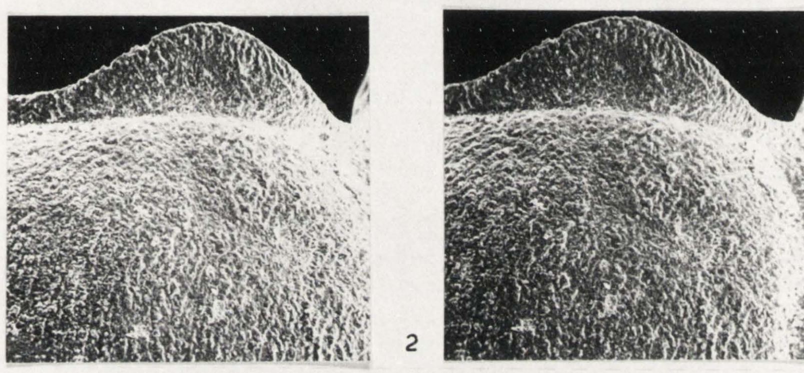

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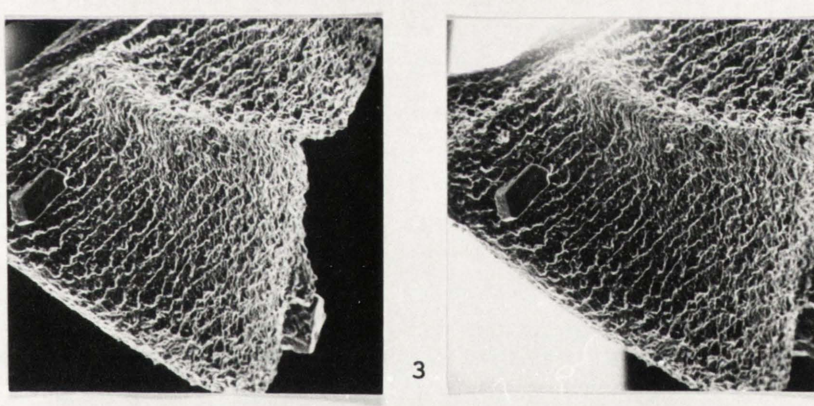

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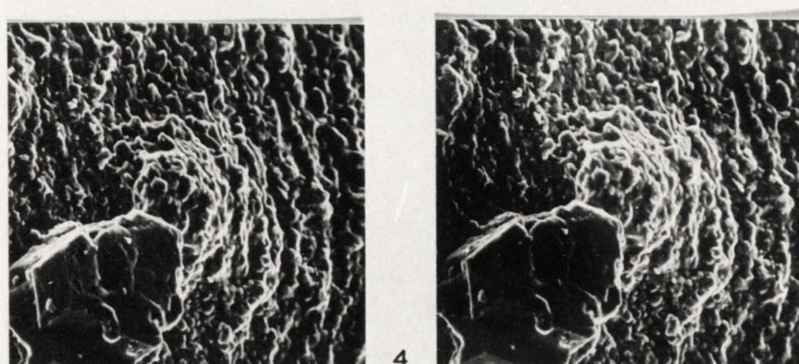


4

<u>PLATE 51.</u>

Stereoscan photographs of the ventral surface of the pygidium of <u>Stenoblepharum</u> <u>strasburgense</u>. Horizon and locality as Pl.50.

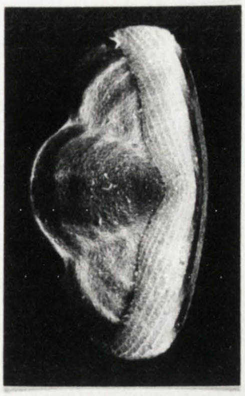
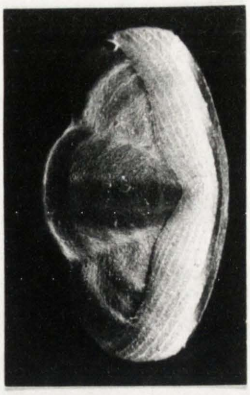
<u>1</u>. General ventral view of entire pygidium. 17.25x. (1139/24,19).

<u>2</u>. Area behind the axis. 53x. Note construction of the doublure behind the axis, where the series of dip and scarp slopes are deflected.

<u>3</u>. Same area as fig.2, enlarged. 106x. (1139/21,16).

<u>4</u>. Left lateral end of the doublure. 55x. (1139/26,25).

PLATE 51

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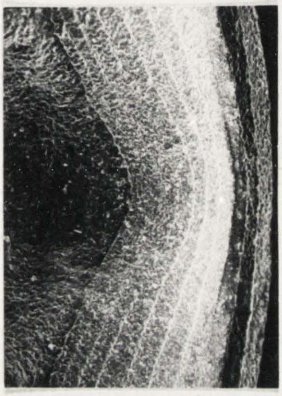
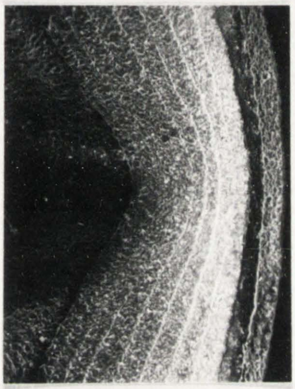

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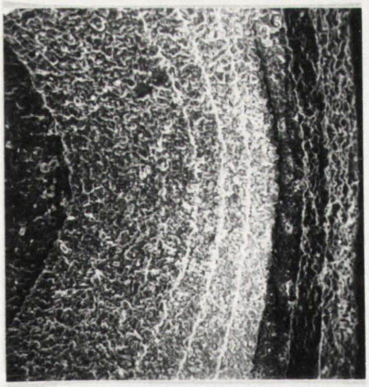
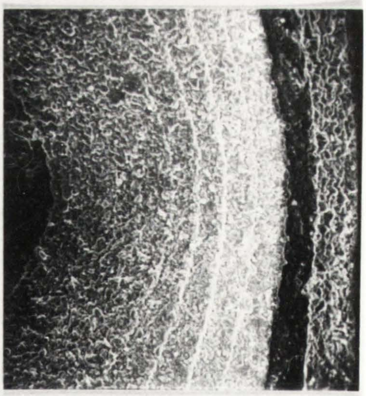

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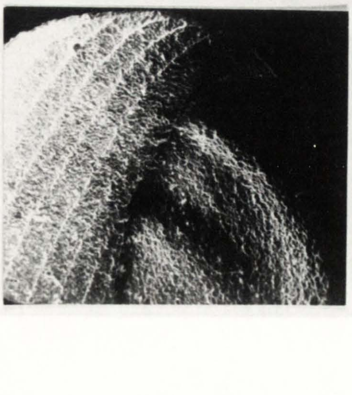
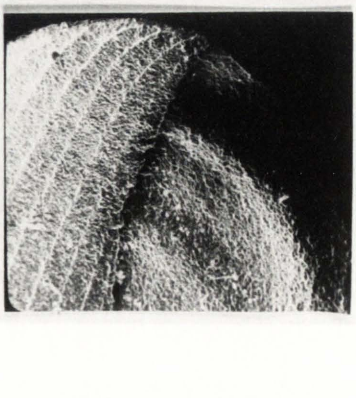

4

PLATE 52.

Stereoscan photographs of free cheeks of Decoroproetus pristinus from the Llandeilo of Dynevor Park, Llandeilo. (BM In 56706 A (figs.1-3)), In 56706 B (fig.4)).

1. Ventral oblique view of free cheek. 21x. (1139/4,3). Note structure of doublure and the series of terrace lines as parallel crest-like ridges.

2. Ventral oblique view of free cheek. 61.6x. (1139/6,8). Shows vertical section through the doublure. Note the crest-like terrace lines in section.

3. Lateral view of margin of free cheek. 123.2x. (1139/0,38). Note the marginal terrace lines, cf. those on the pygidial doublure of S. strasburgense (pl.51, figs.2-3).

4. View of vertical section of the doublure. Note the apparent bilamellar structure of the doublure and dorsal exoskeleton.

PLATE 52