

RARE TREMADOCIAN TRILOBITES FROM NORWAY

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Abstract: Six rare trilobites from the Tremadocian Ceratopyge Limestone in Norway are described. The genus *Pagometopus* (close to *Orometopus*) and the species *Pagometopus gibbus* and *Peltocare modestum* are new. The terminology for the exoskeletal plates of the cephalon is revised. A chart shows the stratigraphic occurrence of the Tremadocian trilobites recorded from Norway.

Introduction and Acknowledgements

During the late autumn of 1958 I collected some trilobites from the Ceratopyge Limestone (substage 3ay) of Late Tremadocian age at localities north of Slemmestad, 20 km southwest of Oslo. Some of the trilobites proved to belong to rather rare species, two of which had not been described earlier. At several of the collecting trips I was ably assisted by Mr. Frank Nikolaisen, who has presented some of the specimens dealt with in this paper to the Palaeontological Museum in Oslo. There was additional material of some of these species preserved in this museum, and collected after the time of Prof. W. C. Brøgger, who described and made famous the *Ceratopyge* or *Euloma-Niobe* fauna of the Ceratopyge Limestone (BRØGGER, 1882; 1896). So far, only 1–12 specimens have been collected in Norway of the species described below, although certain layers of the Ceratopyge Limestone are extremely rich in trilobites and have yielded large collections. Three of the species described here are known also from Sweden, where they likewise are rare. I have preferred to describe the species in the present paper rather than to postpone their description to an eventual general revision of the fauna of the Ceratopyge Limestone in Norway.

The very similar fauna of the Ceratopyge Limestone in Sweden has been described *i.a.* by MOBERG & SEGERBERG (1906), and more recently by TJERNVIK (1956) in an important paper, where the generic reference has been changed in many of the species occurring in Norway.

I wish to express my sincere thanks to Miss B. Mauritz for taking the photographs, Miss I. Lowzow for drawing the text figures, and Dr. R. D. Morton for reading the manuscript.

Palaeontological Museum of the University in Oslo, February 1959.

G. HENNINGSMOEN

Terminology

The exoskeleton of the head, or cephalon, consists of ¹—6 free exoskeletal plates (*i.e.* plates separated by sutures), like the rostral plate and the cranium. The cephalon is also divided into a number of other morphological features (areas, furrows, etc.), and for these

¹ If the agnostids had no hypostome, otherwise 2—6.

I follow on the whole the terminology applied in the Treatise on Invertebrate Paleontology, except that I use the term *glabella* in its original sense, *i.e.* to include the occipital ring, and the term *dorsal furrow* instead of axial furrow. Furthermore the symbols *S1*, *S2*, etc., and *L1*, *L2*, etc. are used for the glabellar furrows and lobes, respectively, counted from the rear (cf. JAANUSSON, 1956; HENNINGS-MOEN, 1957). I shall, however, propose a few new terms for exoskeletal plates of the head (text fig. 1).

In opisthoparian, gonatoparian, and proparian trilobites (*i.e.* forms with functional facial sutures) the cephalon consists of the cranidium, librigenae (free cheeks), hypostome², and in many forms also the rostral plate (rostrum), and, rarely, the metastome.

In hypoparian trilobites the cephalon has a dorsal plate, a ventral plate called the doublure or inner lamella, and a hypostome. The dorsal plate is often referred to as the cephalon. To avoid this ambiguity of the term cephalon, I propose to call the dorsal plate (glabella + gena) the *genicranium* (pl. *genicrania*); from Latin *gena* (cheek) and *cranium* (skull). The ventral plate I propose to call the *doublural plate*, which I believe is better than using the more general term doublure, especially in trilobites where this ventral plate carries the genal spines. Thus the doublural plate of *e.g.* *Tretaspis* consists of the doublure and the genal spines. Such forms might be regarded as opisthoparians, the librigenae being united and consisting of the doublure and genal spines only. Even so, the terms genicranium and doublural plates seem better for these forms than cranidium and united librigenae. There is an even morphological transition from trilobites with facial sutures to hypoparian ones with marginal suture, and thus also from a cranidium to a genicranium. I suggest to restrict the use of the term cranidium to trilobites where the sutures cut across the genal fields, *i.e.* inside the border furrow. I would then use the term genicranium also in those conocoryphids where the suture cuts off the genal spines and a slice of the border on each side. At least in some conocoryphids the doublural plate is separated into two doublural plates by the intervening rostral plate.

In olenellid trilobites the cephalon consists of the rostral plate,

¹ There is some inconstancy as to whether the hypostome (and metastome) should be regarded as a part of the cephalon. I see no good reason for not doing so, more so as the hypostome in some trilobites is fused with the rostral plate.

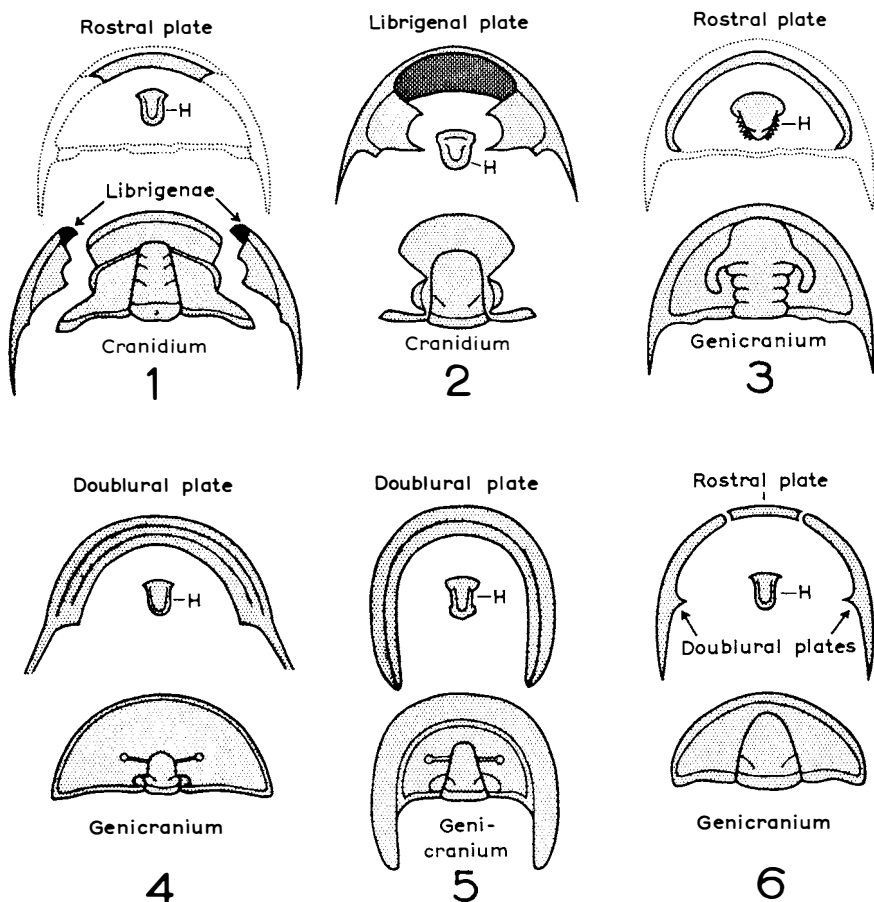


Fig. 1. Examples of cephalic plates in trilobites with facial sutures (1 — *Ptychoparia*, 2 — *Levisella*), in an olenellid (3) and in forms with a wholly or predominantly marginal suture (4 — *Harpides*, 5 — harpid, 6 — *Conocoryphe*). H = hypostome.

the hypostome, and a main plate comprising the dorsal part of the cephalon and a doublural part. Rather than to coin a new term for this main plate, I suggest to use the term genicranium in this case, too. This is consistent with the usage of the term cranium, which may include a part of the doublure (many forms) or may not (e.g. asaphids).

No hypostome has as yet been described in agnostids, and the

cephalon apparently consists of a single plate, which may of course be called the cephalon. However, if agnostids did have hypostome, the main plate should rather be termed the genicranium.

For the fused rostral plate and hypostome I propose the term *rostri-hypostomal plate*, and for the united librigenae the term *librigenal plate*.

FAMILY OLENIDAE BURMEISTER, 1843

Classification: — I have discussed the classification of the olenids in a previous paper (HENNINGSMOEN, 1957), but could not then make use of a paper published in the same year by HARRINGTON and LEANZA, who erected a family Hypermecaspidae. As discussed below (p. 161), I prefer to regard the Hypermecaspidae as a subfamily of the Olenidae.

Origin and relationships: — I have earlier (1957, p. 30, and text fig. 3 on p. 23) suggested that the Olenidae might have developed from the Andrarinidae. At that time I thought that the aphelaspids might be included in the Andrarinidae, but they are now assigned to the family Pterocephaliidae LOCHMAN, 1956, which has been suggested to have developed from the Olenidae (LOCHMAN-BALK & WILSON, 1958, text fig. 10 on p. 330). I agree that the Pterocephaliidae may be rather closely related to the olenids, but believe that they either developed from the same ancestral group (as suggested in 1957, p. 31) or that the olenids developed from the aphelaspids through forms like *Olenus alpha* HENNINGSMOEN, 1957.

It has been suggested that *Parabolinoides* and related genera, now assigned to the Parabolinoididae LOCHMAN, 1956, are derived from the Olenidae (WILSON, 1954, p. 265; WILSON, 1957, p. 331; see also LOCHMAN-BALK & WILSON, 1958, text fig. 10). However, I still do not think this is the case (cf. HENNINGSMOEN, 1957, p. 22). Most probably the Parabolinoididae may be traced back to some earlier North American genera (and be related to e.g. *Elvinia*, cf. HENNINGSMOEN, 1957, p. 28). If so, the fact that the Parabolinoididae are characteristic of the *Conaspis* zone in the so-called cratonic realm, whereas there is little evidence of the *Conaspis* fauna in the miogeosynclinal areas, would no longer be puzzling. As stated by LOCHMAN-BALK & WILSON (1958, p. 338), this would be an enigma if the Parabolinoididae were derived from olenids, characteristic of the so-called extracratonic realm.

It seems probable to me that the Olenidae, Pterocephaliidae, Parabolinoiidae, Idahoiidae, Elviniidae, and genera like *Irvingella*, *Dunderbergia*, and *Conaspis* together with its probable forerunner *Comanchia* are all related and might be grouped in a higher taxonomic unit. This unit could also embrace derived families, like the Ptychaspidae, developed from *Conaspis* through *Eoptychaspis* (cf. NELSON, 1951, p. 777), the Saukiidae, whether they developed from the Ptychaspidae (cf. RAASCH, 1952, p. 149), from *Conaspis* (cf. LOCHMAN, 1956, p. 451), or from some other related group, furthermore the Dikelocephaliidae, whether they developed from a conaspid stock or from the Idahoiidae (cf. LOCHMAN-BALK & WILSON, 1958, p. 335, footnote 2), and probably also the Hungaiidae (cf. below). It is possible that the *Loganellus*-group and the Remopleurididae likewise belong here. This group of families apparently is too large and variegated to be regarded as a superfamily, and I suggest to accomodate them in a suborder Olenina of the order Ptychopariida. A suborder Olenina was recognized by HARRINGTON & LEANZA, 1957, but they attributed it to HUPÉ, 1953, who, however, only erected a superfamily Olenoidæ. The suborder Olenina might be attributed to SWINNERTON, 1915, who proposed a section Olenina of his suborder Conocoryphida. No doubt Middle Cambrian families should be included in the Olenina as well, perhaps e.g. the Andrarinidae and Anomocaridae. The Asaphidae and Ceratopygidae of the suborder Asaphina may be related to the Olenina (cf. HENNINGSMOEN, 1957, p. 28).

The relationships have not been traced for all the families suggested above to belong to the Olenina, but I believe that their possible relationships are worth considering, for which reason the above was written.

SUBFAMILY PELTURINAE HAWLE & CORDA, 1847

Genus *Peltocare* HENNINGSMOEN, 1957

Type species: — *Acerocare norvegicum* MOBERG & MÖLLER, 1898, by original designation.

Peltocare modestum n. sp.

Pl. 1, figs. 9-10.

Name: — From Latin *modestus*, modest.

Holotype: — A cranidium, P.M.O. no. 69565, pl. 1, fig. 9.

Material: — In addition to the holotype, only two more cranida, P.M.O. nos. 69566 and S 1932a.

Occurrence. — Ceratopyge Limestone (3a y), near base of the thick, very fossiliferous bed, Bjørkåsholmen, Asker, Norway.

Diagnosis: — Differs from the type species in having somewhat narrower fixigenae, a more rounded front to the glabella, a more rounded margin to the cranidium between the eyes, and possibly in being a smaller species.

Description: — Cranidium about 1.5 times as wide as long, rather convex. Glabella pelturoid, well rounded in front and with 2 pairs (S1, S2) of faint furrows. Fixigenae pelturoid, only slightly more than half as wide as occipital ring. Eyes small, slightly behind the front of glabella, and rather close to the glabella. Preglabellar field short (sag.). Anterior margin rather convex, subparallel to the front of glabella. Posterior, occipital, and dorsal furrows distinct. Surface smooth. The length of the holotype cranidium is 3.0 mm and of another cranidium 2.7 mm. Other parts unknown.

Affinities: — *Peltocare modestum* n. sp. is no doubt close to the type species, but differs in some characters mentioned in the diagnosis, also when compared with cranidia of *P. norvegicum* of the same size. If the three known cranidia of *P. modestum* belong to adult specimens, *P. modestum* is considerably smaller than *P. norvegicum*, whose cranidium may reach a length of at least 15 mm. The rounded anterior margin of the cranidium of *P. modestum* seems to distinguish it from all other species assigned to *Peltocare*, although *P. olenoides* (SALTER, 1866) from the Upper Tremadoc of Wales is too poorly known to allow a comparison of this character.

FAMILY UNCERTAIN

Genus *Tropidopyge* HARRINGTON & KAY, 1951

Type species: — *Dicellosephalus Bröggeri* MOBERG & SEGERBERG, 1906, by original designation.

Tropidopyge broeggeri (MOBERG & SEGERBERG, 1906)

Pl. 1, figs. 5–7.

- 1906 *Dicellosephalus Bröggeri* n. sp. — MOBERG & SEGERBERG, p. 87, pl. V, figs. 7–8. (Descr., figs. of 2 pygidia.)
- 1951 *Dikelocephalus Bröggeri* MOBERG & SEGERBERG — HARRINGTON & KAY, p. 663. (Selected as type species of *Tropidopyge*.)
- 1957 *Tropidopyge broeggeri* (MOBERG & SEGERBERG) — HARRINGTON & LEANZA, p. 120. (Suggested to belong to the Hypermecaspididae.)

Lectotype: — The pygidium figured by MOBERG & SEGERBERG, 1906, pl. V, fig. 7, from the Ceratopyge Limestone at Ottenby in Öland, Sweden, selected by HARRINGTON & KAY, 1951.

Norwegian material: — Two incomplete pygidia, P.M.O. nos. 756a and 69567, the latter with its counterpiece (no. 69568) preserved.

Occurrence: — Ceratopyge Limestone (3ay), Norway: Stensberggata in Oslo; Sjøstrand in Asker (in a dark limestone nodule from the base of the Ceratopyge Limestone). Ceratopyge Limestone, Sweden.

Description of Norwegian material: — The larger (pl. 1, fig. 7) of the two pygidia is 14 mm long and shows no postaxial ridge. In this and in other features it agrees well with the larger pygidium figured by MOBERG & SEGERBERG (1906, pl. V, fig. 7), which is furthermore of about the same size. The smaller Norwegian pygidium (pl. 1, figs. 5–6) has a postaxial ridge and is very similar, both in morphology and shape, to the smaller pygidium figured by MOBERG & SEGERBERG (1906, pl. V, fig. 8). One might suspect that the smaller and larger pygidia represented two species, but from the original description it appears that intermediate sizes are known. Characteristic of the pygidium of *Tropidopyge broeggeri* are its subelliptical outline, short axis reaching only slightly more than halfway to the posterior border, short pleural furrows, wide doublure, and distinct terrace lines both on its dorsal surface and the doublure.

Affinities: — The only other species referred to *Tropidopyge*, *T. stenorhachis* HARRINGTON & KAY, 1951, from the Tremadocian of Colombia, resembles, but may not necessarily be congeneric with *T. broeggeri*.

The genus *Tropidopyge* was originally assigned to the family Dikelocephalidae by HARRINGTON & KAY (1951, p. 663), but was believed probably to belong to the family Hypermecaspididae HARRINGTON & LEANZA, 1957, by those who established the family. The only other genus included in this family is *Hypermecaspis* itself. As pointed out by HARRINGTON & LEANZA (1957, p. 120), *Hypermecaspis* seems most closely allied to *Parabolinella* BRØGGER, 1882, from which genus I believe it developed. The main reason for separating the Hypermecaspididae from the Olenidae appears to be the trend in *Hypermecaspis* towards an enlarged pygidium, whereas the pygidium is always small in the Olenidae, except for the aberrant pygidium of *Ctenopyge*

pecten. However, the genus *Hypermecaspis* embraces species with a small pygidium (*H. armata*) of the olenid type as well as species with a relatively large pygidium (*H. inermis*), and I prefer to regard the hypermecaspidids as constituting a subfamily of the family Olenidae.

As observed by HARRINGTON & LEANZA (1951), the pygidium of *Tropidopyge* resembles that of *Hypermecaspis*. However, it also resembles the pygidium of several other trilobites, e.g. the pygidium of "*Pterocephalina*" *utahensis* figured by RESSER (1942, pl. 15, figs. 7–11) or, as pointed out by MOBERG & SEGERBERG (1906, p. 88), *Dikelocephalus pepinensis* OWEN (now assigned to *Saukiella*). SDZUY (1955, p. 37) suggested that *Tropidopyge* might belong to the subfamily Paracoosiinae KOBAYASHI, 1950, in which subfamily the genus *Pterocephalina* RESSER was included. MOBERG & SEGERBERG (1906, p. 90) cautioned that we do not know for certain whether the cranium assigned to *Dikelocephalina discraeura* really belongs to this species, and stated that there is a possibility that it belongs to *Tropidopyge broeggeri*. This is not very likely, but all in all, I believe it is best not to assign *Tropidopyge* to any family for the time being.

If *Tropidopyge broeggeri* is related to *Hypermecaspis*, there is a possibility that it is conspecific with *Hypermecaspis* ("*Parabolinella*") *rugosa*, in which case *Hypermecaspis* might be considered as a junior synonym of *Tropidopyge*. KOBAYASHI (1951, p. 13) suggested that *Dikelocephalus broeggeri* might be congeneric with the type species of *Hagiorites* KOBAYASHI, 1951, based on an imperfect pygidium. If so, *Hagiorites* would become a junior synonym of *Tropidopyge*.

While this paper was in print, RASETTI has published an illustration of a pygidium of *Richardsonella subcristata* RASETTI (Jour. Paleont., vol. 33, pl. 55, fig. 18), which is very similar to that of *Tropidopyge broeggeri*.

FAMILY HUNGAIIDAE RAYMOND, 1924

SUBFAMILY DIKELOKEPHALININAE KOBAYASHI, 1936

Remarks: — KOBAYASHI (1936) regarded the Dikelocephalininae as a subfamily of the family Dikelocephalidae MILLER, 1890, and was followed in this *i.a.* by RICHTER & RICHTER (1954). RAW (1949, p. 514) suggested that *Dikelocephalina* might be a near relation of *Hungaiia*, and HUPÉ (1953) considered the Dikelocephalininae as a

subfamily of the Hungaiidae. SDZUY (1955) regarded the Dikelokephalininae as a subfamily of the Anomocaridae POULSEN, 1927, together with the Anomocarinae, Hungaiinae, and Paracoosiinae KOBAYASHI, 1950, whereas HARRINGTON & LEANZA (1957) considered the Dikelokephalinidae as a separate family.

I agree with the later views that the similarities between the dike-lokephalinids and dikelocephalids may be an example of homoeomorphy, rather than indicating close relationships. Thus the glabellar patterns of the two groups are rather different. I believe RAW and HUPÉ are right in assuming relationships between *Hungaia* and the dike-lokephalinids. Although the glabella of *Hungaia* apparently is the more advanced, the cephalo of the two groups have much in common, including the alar-like inflations, and so have their pygidia. The relationships between the Anomocaridae and Hungaiidae are as yet uncertain, and I prefer to follow HUPÉ in regarding the Dikelokephalininae as forming a subfamily of the Hungaiidae.

There can be little doubt that *Dikelokephalina* is closely related to *Asaphopsis* MANSUY, 1920, and KOBAYASHI (1936, p. 175) pointed out that they might be members of a continuous series of gradual transitions. *Asaphopsis intermedia*, described from the Llanvirnian of Argentina by HARRINGTON & LEANZA (1957, p. 191), is interesting in having 2 pairs of pygidial spines, the outer pair being situated as the pair in *Asaphopsis*, the inner pair as the pair in *Dikelokephalina*. *Hungioides* KOBAYASHI, 1936, apparently is related, and these three genera were united in the subfamily Dikelokephalininae by KOBAYASHI (1936), who later added *Dactylocephalus* and *Hagiorites*, both KOBAYASHI, 1951. Another genus, *Asaphopsoides*, was added by HUPÉ, 1953.

An interesting form was redescribed by SDZUY (1955, p. 37) as *Pterocephalina* (*Leimitzia*) *bavarica* (BARRANDE, 1868), and made the type species of the new subgenus *Leimitzia*. The genus *Pterocephalina* RESSER, 1938, has since (PALMER, 1956) been shown to be a junior synonym of *Litocephalus* RESSER, 1937. *Leimitzia* can hardly be regarded as a subgenus of *Litocephalus* as now defined, and I regard *Leimitzia* as a separate genus. *Leimitzia* agrees with the Dikelokephalininae in the general structure of the cranidium, also in having alar-like inflations, and its pygidium resembles those of the Dikelokephalininae, although it apparently does not carry any spines. I prefer to assign *Leimitzia* to the Dikelokephalininae, rather than to the

Pterocephaliidae, to which *i.a.* *Litocephalus* is now referred. It is, however, quite possible that the similarities between these two groups indicate relationships. As mentioned by SDZUY (1955), another probable member of *Leimitzia* is *Dikelocephalus celticus* SALTER, 1866, based on pygidia, with the associated and probably conspecific *D. discoidalis* SALTER, 1866, based on parts of the cephalon. *Leimitzia celtica* is known to occur in the Upper Cambrian zone of *Parabolina spinulosa* (cf. STUBBLEFIELD, 1951, p. 56), and would then be the earliest known member of the Dikelocephalininae, the next earlier being *Leimitzia bavarica* from the Lower Tremadocian. The similarities between *Leimitzia* and the *Pterocephaliidae* thus become especially significant.

Genus *Dikelocephalina* BRÖGGER, 1896

Type species: — *Centroleura? dicraeura* ANGELIN, 1854, designated by VOGDES, 1925.

Dikelocephalina dicraeura (ANGELIN, 1854).

Pl. 1, figs 1–4.

- 1854 *Centroleura? dicraeura*. n. sp. — ANGELIN, p. 88, pl. XLI, fig. 9. (Short diagn., fig. of pygidium).
- 1869 *Dikelocephalus dicraeura* ANG. — LINNARSSON, p. 71 (Recorded.)
- 1882 *Dicelocephalus dicraeura*, ANG. — BRÖGGER, p. 126. (Remarks.)
- 1896 *Dikelocephalina dicraeura*, ANG. — BRÖGGER, pp. 177–179 (reprint, pp. 14–16), text fig. 4. (Compared with similar forms, fig. of pygidium.)
- 1900 *Dicellocephalina dicraeura* ANG. sp. — MOBERG, p. 534, pl. 14, fig. 1 (Descr. and fig. of cranium assigned to this species).
- 1906 *Dicellocephalina dicraeura* ANGELIN sp. — MOBERG & SEGERBERG, p. 90, pl. V, figs. 13–14, 12? (Remarks. Figs. of 2 pygidia, and a cranium assigned to this species.)
- 1919 *Dikelocephalina dicraeura* (ANGELIN) — LAKE, pp. 117–120. (Compared with *D. furca*.)
- 1925 *Dikelocephalina dicraeura* ANGELIN — VOGDES, p. 98. (Listed as genotype of *Dikelocephalina*.)
- 1956 *Dikelocephalina dicraeura* (ANGELIN) — TJERNVIK, p. 278. (Listed).

Type data: — Holotype (by monotypy) is the pygidium figured by ANGELIN (1854, pl. XLI, fig. 9) from Ceratopyge Beds ("Ceratopygarum"), most probably Ceratopyge Limestone, at Gamlebyen ("Opslo") in Oslo, Norway.

Norwegian material. — Four more or less fragmentary pygidia are preserved in Paleontologisk Museum, Oslo, *viz.* nos. 847, S 1175, 69572 (and counterpiece 69573), and 69575 (and counterpiece 69574).

Occurrence: — Ceratopyge Limestone (3ay), Norway: Road cut W. of Slemmestad in Røyken; Bjørkåsholmen in Asker; Bygdøy Sjøbad, Trefoldighetskirken, and Gamlebyen in Oslo. Ceratopyge Limestone, Sweden.

Description: — The outline of the pygidium is not evenly curved. The anterior margins are short and almost straight, the anterolateral corners well rounded, shoulder-like, the lateral margins almost straight, diverging somewhat to the rear, thus forming an obtuse and well rounded angle with the posterior margin, which is evenly convex, except for the two posterior spines and the intervening concave margin. The spines are flat and broad-based, but taper rapidly, and, as seen in plate 1, fig. 2, continue as round and slender spines. The axis has 6 distinct rings and a 7th poorly separated from the endlobe, which merges into a short and triangular postaxial ridge, which does not reach the posterior margin. The pleural furrows are wide and distinct inside the doublure, narrower and less well defined further out, and do not completely cross the brim. The upper surface of the pygidium is ornamented with rather close packed terrace lines, and the wide doublure with less closely spaced ones. The largest pygidium present is 30 mm long, spines not included.

Affinities: — *Dikelocephalina dicraeura* closely resembles *D. furca* (SALTER, 1866) from the Upper Tremadoc of Wales, as observed by LAKE (1919, p. 119), who pointed out that the outline of the pygidium of *D. furca* differed from that of *D. dicraeura*, as known then. It is now known that they agree even in this character. The cranidium assigned to *D. dicraeura* resembles that assigned to *D. furca*, and the difference noted by LAKE may be due to different preservation, as suspected by him. It is thus possible that the two forms are conspecific, but better material is needed to decide this.

FAMILY HARPIDIDAE¹ RAW, 1949

(*nom. transl.* WHITTINGTON, 1950, *ex* Harpidinae RAW, 1949).

Relationships within the family: — *Harpides* apparently is related to the two North American genera *Loganopeltis* RASETTI, 1943, and

¹ The family name based on *Harpides* (*gen. sing.* *Harpidae*, stem *Harpid-*) is Harpididae, not Harpidedidae, as suggested by PRANTL & PŘIBYL (1955).

Loganopeltoides RASETTI, 1945, and it was for these three genera that RAW (1949) suggested the subfamily Harpidinae (of the family Harpididae¹). WHITTINGTON later (1950a, 1950b) suggested to regard this group as a separate family. It seems unnecessary to split it into two families, Loganopeltoidae (*Loganopeltis*, *Loganopeltoides*) and Harpididae (*Harpides*, *Dictyocephalites*), as proposed by HUPÉ (1953), although *Loganopeltoides* is a proparian form (this was doubted by RAW, 1949, who considered it hypoparian), and both it and *Loganopeltis* (hypoparian) differ from *Harpides i.a.* in having a smaller brim. So far it has been possible to compare only the genicrania of these genera, but the great resemblance of these strongly suggest that they should be placed in the same family. It should be pointed out that even *Loganopeltis* shows smooth alar-like areas, so distinct in *Harpides*. Besides similar genae, all three genera have in common the type of glabella, the granulose surface ornamentation, and the radiating ridges.

Relationships to other families: — WHITTINGTON (1950b, p. 302) lists some of the differences between *Harpides* and harpids, viz. that the bilaminar border in *Harpides* was without the prolongations and the characteristic division into the inner, steep cheek roll and outer brim, and that it may have lacked the structure of opposed pits. We still do not know whether *Harpides* had opposed pits in the bilaminar border, but if not, they may easily be imagined to have developed from the pit-like depressions between the finer anostomosing ridges. *Harpides* and harpids have so many features in common that they most probably are closely related. Some of these features are the marginal suture, the bilaminar border, the alae, the pits, and also the preglabellar boss and the radiating ridges, so well developed in *Harpides* and present in many harpids. Furthermore, the glabella in *Selenoharpes* is very similar to that of *Harpides*. All this does not necessarily mean that the harpids developed from *Harpides*, which is perhaps less likely now that the earliest known harpid, *Australoharpes depressus* HARRINGTON & LEANZA, 1957, is reported from the

¹ The genus *Harpes* was erected by GOLDFUSS (1943, p. 584), who explicitly stated that it was named after the cyclops *Harpes*. Being a personal name, *gen. sing.* is *Harpis*, and the stem *Harp-* (3rd. declination). The family name based on *Harpes* thus becomes Harpidae, as pointed out by RICHTER in 1943, and not Harpedidae as maintained by PRANTL & PŘIBYL (1955).

same Lower Tremadocian zone as the earliest known species of *Harpides*, *H. neogaeus*. On the whole, the harpidids and harpids have so much in common, that the harpidids might just as well be regarded as forming a primitive subfamily of the Harpididae.

RAW (1949, p. 514) remarked that the Harpididae seem to be related to the Trinucleidae as well. In spite of similarities in the bilaminar border, there are still important differences, like the shape and furrows of the glabella, and it seems difficult at present to trace any relationships (cf. WHITTINGTON, 1950a, p. 6). The Entomaspidae show resemblances both to the Harpididae and Trinucleidae, as pointed out by RASETTI (1952, p. 801), but as cautioned by him, only the discovery of intermediate forms between the Trinucleidae and Entomaspidae could substantiate the hypothesis of relationship between the two families. In many features (e.g. the glabella) the Entomaspidae resemble much more the Harpididae than the Trinucleidae.

As to the ancestral stock from which the Harpididae developed. *Loganopeltoides* indicates that they had facial sutures. The peculiar type of proparian sutures in this genus probably evolved from more "normal" facial sutures, quite possibly opisthoparian sutures. It is interesting to notice the many similarities in the more central parts of the cephalon in *Harpides* and the cranidium assigned to *Dikelocephalina dicraeura* (as figured by MOBERG & SEGERBERG, 1906, pl. V, fig. 12). Thus the shape of the glabella and glabellar furrows are much the same, both have small eyes and distinct eye ridges, as well as alae. As further more the pygidium of the related genus *Hungaia* has much in common with the pygidium of *Loganopeltoides*, one should consider the possibility that the Harpididae and Hungaiidae developed from the same stock. It is interesting that *Hungaia*, too, has a wide brim with well developed radiating ridges.

Genus *Harpides* BEYRICH, 1846

Type species: — *Harpides hospes* BEYRICH, 1846, by monotypy.

Harpides rugosus (SARS & BOECK, 1838)

Pl. 2, figs. 5–11.

1838 *Trilobites rugosus* Ss. & Bk. Mscr. — BOECK, p. 143. (Short descr.).

1854 *Harpides rugosus* SARS & BOECK — ANGELIN, p. 87, pl. XLI, figs. 7–7a. (Short diagn., fig. of genicranium.)

1869 *Harpides rugosus* SARS & BOECK — LINNARSSON, p. 67. (Recorded.)

- 1882 *Harpides rugosus*, Sars & Boeck — Brøgger, p. 127. (Remarks.)
1906 *Harpides rugosus* Sars & Boeck — Moberg & Segerberg, pl. 85, p. V fig. 1. (Remarks, fig. of fragmentary genicranium).
1906 *Harpides rugosus* Sars & Boeck — von Post, p. 476, pl. 13, figs. 3–5. Listed. Figs. of genicrania, including Angelin's original.)
1940 *Harpides rugosus* (Sars & Boeck Ms) — Størmer, p. 146, pl. 1, figs. 14–15. (Cites Boeck's original descr. Figs. of 2 fragmentary genicrania, one selected as lectotype.)
1949 *Harpides rugosus* (Sars and Boeck) — Raw, p. 511. (Remarks.)
1950 *Harpides rugosus* (Sars and Boeck) — Whittington, 1950b, p. 302. (Remarks.)
1956 *Harpides rugosus* (Sars & Boeck) — Tjernvik, p. 268. (Remarks.)

Lectotype: — A fragmentary genicranium (P.M.O. no. 20053) from the Ceratopyge Limestone, Oslo, Norway, selected by Størmer, 1940.

Norwegian material: — Ten more or less fragmentary genicrania (P.M.O. nos. 846, 1176, S 3037, 20052, 20053, 35935, 60321a, 69581, 69582, 69583) and two fragmentary doublural plates (P.M.O. nos. 1290, 56024a).

Occurrence: — Ceratopyge Limestone (3ay), Norway: Slemmestad and Ramtonholmen in Røyken; Bjørkåsholmen in Asker; Vekkeø and Rikshospitalet in Oslo; Steinsodden in Ringsaker. Ceratopyge Limestone, Sweden.

Description: — Four fragmentary genicrania (pl. 2, figs. 5, 7–9) together show the morphology of practically the whole genicranium. The differences in length-width ratio may be due to distortion.

The glabella is truncated in front and tapers forwards, but not evenly, since L2 is somewhat withdrawn. Occipital furrow with a distinct forward curve in front of the occipital node. S1 distinct, straight, oblique backwards, reaching one-third across glabella. S2 faint, short, transverse. S3 very faint and short, oblique forwards. Gena semicircular with upsloping, narrow border. Eyes small, on line with front of glabella, distance from glabella subequal to width of glabella in front. Eye ridges distinct, directed outwards and slightly forwards from glabella to eyes. Alae small but distinct. An elongate preglabellar boss is distinct but ill defined. Genal corners without spine. The surface of the test, including the ridges, is ornamented with granules of varying size, except for the smooth alae and the posterior and dorsal furrows. The internal mould of the test is likewise

granulose, showing that the granules were hollow, as is also true of the radiating and anastomosing ridges of the gena.

The main radiating ridges are broader and further apart in a wide zone along the anterior border, but the space between them is occupied by a meshwork of very fine ridges. The depressions between them may be regarded as pits. They are arranged in groups (cf. WHITTINGTON, 1950b, p. 302), separated by the main ridges. Close to the up-turned border, the main ridges branch into finer ridges, and no ridges cross the border. WHITTINGTON (1950b, p. 302) reports a faint impressed line along the inner margin of the zone with broad ridges in a specimen examined by him. As seen in a photograph (pl. 2, fig. 9) of part of this specimen, this line appears as a faint convex bend on the outer surface of the gena. Between this line and the border there are two other parallel lines, which appear as very faint concave bends on the gena.

Of special interest are two specimens (pl. 2, figs. 6, 10) which apparently represent parts of the cephalic doublure, until now not known in material assigned to *Harpides rugosus*, but assumed to have been present by RAW (1949) and WHITTINGTON (1950b). The specimens show the same type of ridges and granulation as the genicrania of *H. rugosus*, and no doubt belong to this species rather than to an undescribed trilobite. Although very fragmentary and not too well preserved, the one specimen luckily shows a part of the left genal corner (seen from below). The genal spine deviates slightly outwards from the course of the anterior border, as is the case in *H. grimmi* BARRANDE, 1872, and *H. neogaeus* HARRINGTON & LEANZA, 1957. The surface is traversed by radiating ridges, except for the anterior border, the genal corner, and the genal spine. They are, however, in both specimens intersected by a pair of rail-like ridges, subparallel to the anterior margin, and agreeing in position with two furrows seen on the impression of the doublure of a specimen of *H. grimmi*, figured by BARRANDE (1872, pl. 1, fig. 11) in a drawing reproduced by RAW (1949, pl. 83, fig. 3). The two ridges may be compared with a single ridge, the girder, in harpids and trinucleids. In some trinucleids there may likewise be more than one such concentric ridge, thus *Cryptolithus discors* has three (cf. STORMER, 1930, pl. 6, fig. 2). The two ridges on the doublural plate assigned to *H. rugosus* apparently agree in position with the two faint concave bends on the outer surface

of the gena of this species. It is likely that the 4 concentric depressions in *H. neogaeus* represent as many ridges on the doublure. The position of the inner margin of the doublure may be indicated by a convex bend on the surface of the gena, seen in the photograph of the specimen reproduced by HARRINGTON & LEANZA (1957, text fig. 103,1).

In analogy with the terminology for harpids, the two concentric ridges in *H. rugosus* may well be termed the girders, the doublure may be termed the inner lamella, and the outer zone of the genicranium, with broad ridges, may be termed the outer lamella. The doublural plates assigned to *H. rugosus* show that RAW (1949) and WHITTINGTON (1950b) were right in assuming that this species had a marginal suture and that the inner lamella bore the genal spines.

No hypostome, thorax, or pygidium have been assigned to *H. rugosus*.

Affinities: — The Bohemian species *Harpides grimmi* apparently is closely related to *H. rugosus*, or perhaps even a junior synonym of it, as suggested by RAW (1949, p. 511). The parts of the genicranium and doublural plate which can be compared are very similar, but, strangely enough, the impression of the inner lamella of *H. grimmi* does not seem to show any impressions of granulose or radiating ridges, as I have been able to ascertain also in a plaster cast of the specimen mentioned above. As furthermore the other parts of the exoskeleton can not be compared at present, it may be safest to regard the Bohemian and Scandinavian forms as two different species for the time being.

FAMILY OROMETOPIDAE HUPÉ, 1953.

Genus *Pagometopus* n. gen.

Name: — From Greek *pagos* (hill) and *metopon* (forehead), suggesting likeness to *Orometopus* (Greek *oros* = mountain).

Type species: — *Pagometopus gibbus* n. sp.

Diagnosis: — Cranium resembling that of *Orometopus*, with a steep-sided and well elevated glabella, but with a strongly tapering and protruding frontal area.

Affinities: — Only the cranium of *Pagometopus* is known, but it resembles the cranium of *Orometopus* so much that it can hardly be doubted that the two genera are closely related. For this reason I place *Pagometopus* in the family Orometopidae. The well-developed

preglabellar field of *Pagometopus* suggests relationships with the Hapalopleuridae HARRINGTON & LEANZA, 1957, of which e.g. *Araio-pleura* HARRINGTON & LEANZA, 1957, has a somewhat similar glabella. However, the preocular parts of the facial sutures do not converge forwards in the same manner in the Hapalopleuridae as in *Pagometopus*. It is of interest that the pit at the outer end of the posterior border furrow in *Pagometopus* apparently is duplicated in certain members of the trinucleids, which are generally believed to be related to the orometopids (cf. illustration of *Trinucleus bronni* given by STØRMER, 1930, pl. 2, fig. 3).

Pagometopus gibbus n. gen., n. sp.

Pl. 2, figs. 1—4.

Name: — From Latin *gibbus*, humped, humpbacked.

Holotype: — A cranium, P.M.O. no. 69577, pl. 2, fig. 1.

Material: — In addition to the holotype, only 2 more crania, P.M.O. nos. 69578 and 69579 (with counterpiece no. 69580).

Occurrence: — The thick, very fossiliferous bed of the Ceratopyge Limestone (3ay), Bjørkåsholmen, Asker, Norway.

Diagnosis and description: — Cranium about twice as wide as long, relatively flat, except for prominent glabella. Posterior margin rather straight, except for protruding V-shaped occipital part. Lateral margins tapering strongly forwards, incurved at eyes and more or less conspicuously on line with front of glabella. Anterior margin slightly convex. Glabella pyriform, widest anteriorly, bluntly rounded in front, well raised with steep sides, and with a keel-like bend in the middle of slightly more than the posterior half. S1-S3 represented by three faint pit-like impressions close to the dorsal furrow. Faint alar-like inflations are present. Posterior border furrow distinct, with a characteristic pit at its outer end. Eyes relatively small, distance from glabella about half the width of the postocular parts of the fixigenae, and distance from posterior margin about two fifths of the distance from a transversal line through tip of cranium. Eye ridges distinct, directed outwards and slightly backwards. Preglabellar field about one fifth as long as glabella.

Outer surface of test appears smooth, inner side is granulose, giving the internal impression a pitted appearance. No glabellar or occipital spines (ascertained in a counterpiece).

The description is based on 3 cranidia, from 4.5 to 5.5 mm long. No other parts of the trilobite are known.

Affinities: — *Pagometopus gibbus* n. gen., n. sp. resembles species of *Orometopus*, but differs in the characters mentioned above. Furthermore, *P. gibbus* is larger than any described species of *Orometopus*.

FAMILY ALSATASPIDIDAE TURNER, 1940

Synonym: — Selenecemidae WHITTINGTON, 1952.

Genus *Falanaspis* TJERNVIK, 1956

Type species: — *Falanaspis aliena* TJERNVIK, 1956, by original designation.

Falanaspis aliena TJERNVIK, 1956

Pl. 1, fig. 8.

Type data: — Holotype is a genicranium, Palæontological Institute, Uppsala, no. Vg 389, from the zone of *Plesiomegalaspis armata* (lowermost Arenigian) at Stenbrottet, Västergötland, Sweden.

Norwegian material: — One fragmentary genicranium (P.M.O. no. S 1238) from the Ceratopyge Limestone (3ay) at Vekkerø in Oslo.

Remarks: — The Norwegian genicranium agrees well with the Swedish ones, also in having a glabellar node and faint, roundish S1 and S2. There seems to be no reason to describe it as a new form, although it occurs in the zone below that of the Swedish specimens.

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TREMADOCIAN TRILOBITES FOUND IN NORWAY AND THEIR STRATIGRAPHIC OCCURRENCE	HORIZON ? = uncertain determ.						
	2e				3a		
	<i>a</i>	<i>β</i>	<i>γ</i>	<i>δ</i>	<i>a</i>	<i>β</i>	<i>γ</i>
2e = Dictyonema Shale 3a = Ceratopyge Beds * = not previously recorded from Norway							
AGNOSTIDAE							
* <i>Geragnostus crassus</i> TJERNVIK	+
— <i>sidenbladhi</i> (LINNARSSON)	?	?	+
* <i>Trinodus mobergi</i> TJERNVIK	+
OLENIDAE							
<i>Parabolina acanthura</i> (ANGELIN)	+						
<i>Bienwillia? wimani</i> (WESTERGÅRD)		+					
<i>Bienwillia tetragonalis broeggeri</i> HENNINGSMOEN	+		
<i>Parabolinella limitis</i> BRØGGER	+	
— <i>lata</i> HENNINGSMOEN	+
<i>Triarthrus angelini</i> LINNARSSON	+	+
<i>Hypermecaspis rugosa</i> (BRØGGER)	+
<i>Boeckaspis hirsuta</i> (BRØGGER)	+						
— <i>mobergi</i> (WIMAN)	+					
<i>Jufuyaspis keideli norvegica</i> HENNINGSMOEN	+						
— <i>angusta</i> HENNINGSMOEN	+					
<i>Peltocare norvegicum</i> (MOBERG & MÖLLER)	+		
* — <i>modestum</i> n. sp.	+
<i>Saltaspis</i> sp.	+
* <i>Plicatolina</i> sp.	+	
FAMILY UNCERTAIN							
* <i>Tropidopyge broeggeri</i> (MOBERG & SEGERBERG)	+
HUNGAIIDAE							
<i>Dikelocephalina dicraeura</i> (ANGELIN)	+
REMOPLÉURIDIDAE							
<i>Apatokephalus serratus</i> (BOECK)	+	+	+
CERATOPYGIDAE							
<i>Ceratopyge forficula forficula</i> (SARS)	+	
— <i>acicularis</i> (SARS & BOECK)	+
ASAPHIDAE							
* <i>Promegaspides (Borogothus) intactus</i> (MOB. & SEG.)	+
<i>Platypeltoides incipiens</i> (BRØGGER)	+		
<i>Niobe insignis</i> LINNARSSON	?	.	+
<i>Niobella obsoleta</i> (LINNARSSON)	+
* <i>Varvia longicauda</i> TJERNVIK	+
NILEIDAE							
<i>Nileus limbatus</i> BRØGGER	+
<i>Symphysurus angustatus</i> (SARS & BOECK)	+
SHUMARDIIDAE							
<i>Shumardia pusilla</i> (SARS)	?	+	+
EULOMIDAE							
<i>Euloma ornatum</i> ANGELIN	+	+
PLIOMERIDAE							
<i>Parapilekia speciosa</i> (DALMAN)	+
<i>Pliomeroides primigenus</i> (ANGELIN)	+
OROMETOPIDAE							
<i>Orometopus primigenius</i> STØRMER	+	.	
— <i>elatifrons</i> (ANGELIN)	+
* <i>Pagometopus gibbus</i> n. gen., n. sp.	+
ALSATASPIDIDAE							
* <i>Falanaspis aliena</i> TJERNVIK	+
HARPIDIDAE							
<i>Harpides rugosus</i> (SARS & BOECK)	+

PLATES 1—2.

PLATE 1

The photographs are not retouched, but the specimens were coated with ammonium chloride before photographing. P.M.O. = Palaeontological Museum of the University in Oslo.

Dikelokephalina dicraeura (ANGELIN, 1854) — p. 163.

Fig. 1. $\times 1.45$. Pygidium showing part of the doublure. P.M.O. no. 69572. 3a y, road cut west of Slemmestad, Røyken. Coll.: L. Størmer exc., 1953.

Fig. 2. $\times 1.45$. Counterpiece of specimen in fig. 1, showing left pygidial spine. P.M.O. no. 69573.

Fig. 3. $\times 1.45$. Pygidium. P.M.O. no. 69575. 3ay, Bjørkåsholmen, Asker. Coll.: G. Henningsmoen, 1958.

Fig. 4. $\times 1.45$. Pygidium. P.M.O. no. 847. 3ay, Trefoldighetskirken, Oslo. Coll.: Rekdal, 1922.

Tropidopyge broeggeri (MOBERG & SEGERBERG, 1906) — p. 159.

Fig. 5. $\times 1.45$. Pygidium. P.M.O. no. 69567. 3ay (dark limestone nodule), Sjøstrand, Asker. Coll.: G. Henningsmoen, 1958.

Fig. 6. $\times 1.45$. Counterpiece of the specimen in fig. 5. P.M.O. no. 69568.

Fig. 7. $\times 1.45$. Pygidium. An associated librigena disturbs the appearance of the left side. P.M.O. no. 756a. 3ay, Stensberggata, Oslo. Coll.: J. Kiær.

Falenaspis aliena TJERNVIK, 1956 — p. 171.

Fig. 8. $\times 4.1$. Genicranium. P.M.O. no. S 1238. 3ay, Vekkerø, Oslo. Coll.: L. Størmer, 1919.

Peltocare modestum n. sp. — p. 158.

Fig. 9. $\times 4.5$. Holotype cranidium. P.M.O. no. 69565. 3ay, Bjørkåsholmen, Asker. Coll.: G. Henningsmoen, 1958.

Fig. 10. $\times 4.5$. Cranidium. P.M.O. no. 69566. 3ay, Bjørkåsholmen, Asker. Coll.: G. Henningsmoen, 1958.

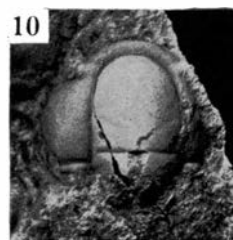
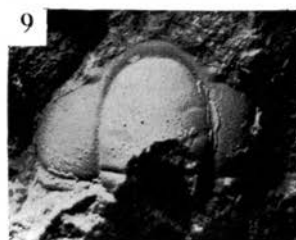
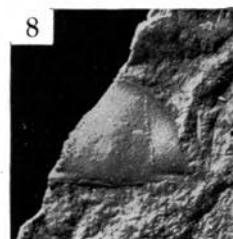
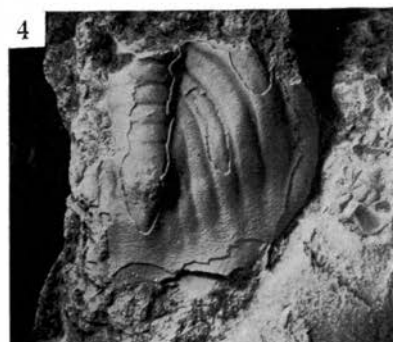
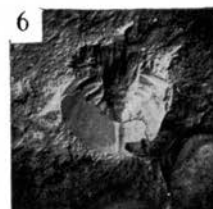
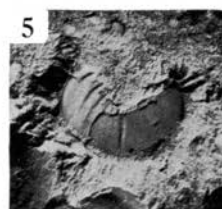
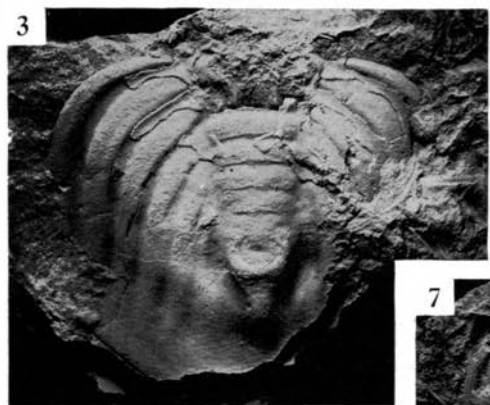
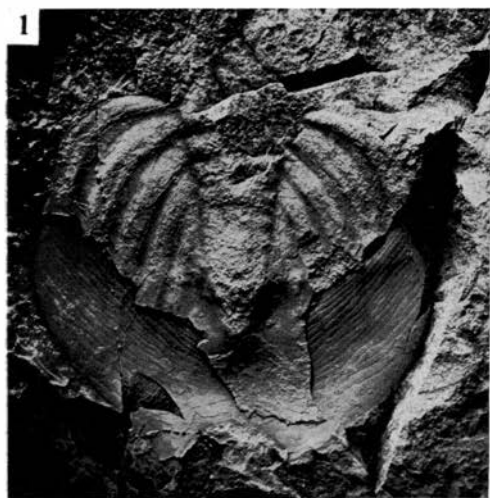


PLATE 2

The photographs are not retouched, but the specimens were coated with ammonium chloride before photographing. P.M.O. = Palaeontological Museum of the University in Oslo.

Pagometopus gibbus n. sp., n. gen. — p. 170.

Fig. 1. $\times 4.5$. Holotype cranidium. P.M.O. no. 69577. 3ay, Bjørkåsholmen, Asker. Coll.: G. Henningsmoen, 1958.

Fig. 2. $\times 4.5$. Cranidium. P.M.O. no. 69578. 3ay, Bjørkåsholmen, Asker. Coll.: G. Henningsmoen, 1958.

Fig. 3. $\times 4.5$. Cranidium. P. M. O. no. 69579. Left side exfoliated, showing the pitted surface of the internal impression. 3ay, Bjørkåsholmen, Asker. Coll.: G. Henningsmoen, 1958.

Fig. 4. $\times 4.5$. Left side view of the specimen in fig. 3.

Harpides rugosus (SARS & BOECK, 1838) — p. 166.

Fig. 5. $\times 1.45$. Genicranium. P.M.O. no. 69581. 3ay, Bjørkåsholmen, Asker. Coll.: F. Nikolaisen, 1958.

Fig. 6. $\times 1.45$. Impression of part of doublural plate. P.M.O. no. 1290. 3ay, Bjørkåsholmen, Asker. Coll.: ? 1915.

Fig. 7. $\times 1.45$. Genicranium showing left genal corner, P.M.O. no. 69582. 3ay, Bjørkåsholmen, Asker. Coll.: G. Henningsmoen, 1958.

Fig. 8. $\times 1.45$. Genicranium. P.M.O. no. 69583. 3ay, Bjørkåsholmen, Asker. Coll.: G. Henningsmoen, 1958.

Fig. 9. $\times 2.2$. Antero-latero-dorsal view of part of left genal area. Plaster mould of P.M.O. no. S 3037. 3ay, Vekkerø, Oslo. Coll.: P. Størmer, 1919.

Fig. 10. $\times 1.45$. Left part of doublural plate, lower surface. P.M.O. no. 56024a. 3ay, Bjørkåsholmen, Asker. Coll. L. Størmer, exc., 1934.

Fig. 11. $\times 2.75$. Detail of the specimen in fig. 8.

