

**GEOLOGICAL
SURVEY
OF
CANADA**

**DEPARTMENT OF ENERGY,
MINES AND RESOURCES**

PAPER 73-24

**MEDIAL LOWER CAMBRIAN TRILOBITES
FROM THE MACKENZIE MOUNTAINS
NORTHWESTERN CANADA**

W.H. Fritz

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ABSTRACT

Seventeen species of trilobites are described from the Mackenzie Mountains. They belong to nine new species, one established species, and seven unnamed species. One new genus, *Ekwipagetia*, is described. All of the trilobites are from strata that correlate with the *Nevadella* Zone and are from the Sekwi Formation.

At least part of the fossils are from the outer detrital belt, a belt of strata ringing the craton and lying seawards of a middle carbonate and an inner detrital belt. Few of the trilobites are similar to those described by Fritz (1972) from the nearby middle carbonate belt, trilobites that were used to establish a Lower Cambrian zonation for the North American Faunal Province. Since this zonation seems to work well in the middle and inner detrital belts, a major alteration of the zonation to include the present fossils is not recommended. Instead, it seems that a new zonation for the Lower Cambrian fossils in the outer detrital belt might be more useful, but the description of more fossils is necessary before this idea can be either confirmed or rejected.

RÉSUMÉ

L'auteur décrit dix-sept espèces de trilobites des monts Mackenzie. Neuf de ces trilobites appartiennent à de nouvelles espèces, un à une espèce déjà connue et sept à des espèces qui n'ont pas encore de nom. L'auteur décrit un nouveau genre, *Ekwipagetia*. Tous les trilobites proviennent des strates qui correspondent à la zone à *Nevadella* et appartiennent à la formation de Sekwi.

Au moins une partie des fossiles proviennent de la zone détritique extérieure, faite de strates entourant le craton et située du côté de la mer par rapport à une zone de roches carbonatées précédant une zone détritique intérieure. Une faible partie des trilobites sont semblables à ceux décrits par Fritz (1972), trouvés aux environs de la zone de roches carbonatées intermédiaire, trilobites qui ont servi à établir une zonation du Cambrien inférieur pour la province faunique d'Amérique du Nord. Puisque cette zonation semble être utile dans les zones détritiques intermédiaire et inférieure, un changement important de la zonation pour inclure ces fossiles n'est pas recommandée. Il semble plutôt qu'une nouvelle zonation des fossiles du Cambrien inférieur dans la zone détritique extérieure soit plus utile, mais il est nécessaire de décrire encore d'avantage de fossiles avant que cette hypothèse soit confirmée ou rejetée.

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INTRODUCTION

Location and Acknowledgments

The trilobites discussed in this paper were collected in the Mackenzie Mountains, Northwest Territories (Fig. 1) in 1970. The collecting localities are approximately 140 miles northeast of the town of Ross River, Yukon Territory. From Ross River, the localities can be approached by driving on the Canol Road to a short aeroplane landing strip located five and one-half miles southwest of the Yukon-Northwest Territories border. A helicopter temporarily based at the landing strip was used to travel the remaining 32 miles northeast to the main collecting section and to various other outcrops. A vehicle could have been driven to the Yukon-Northwest Territories border, but from that point the final 26 miles of road to the main section was in poor repair, and further vehicle travel would have been difficult or impossible.

All of the collecting sites were recommended by S.L. Blusson (1971, 1973), who did the geological mapping of the Sekwi Mountain sheet. Blusson also assisted by lending field support. Additional support was received from R.G. Garrett, who was conducting a geochemical sampling program in the general region. Garrett arranged helicopter flights, radio communications, and the use of his student assistant, L.G. Annand. Constructive criticisms on the manuscript were received from W.T. Dean, A.R. Palmer, and Franco Rasetti.

Geological Setting and Past Research

The Lower Cambrian Sekwi Formation undergoes a rapid lateral facies change within the area covered by the Sekwi Mountain map-sheet. In the northeastern part of the area, the formation is characterized by limestone and dolomite belonging to the middle carbonate belt as described by Palmer (1960, 1969) and Robison (1960). The type locality of the Sekwi Formation lies within this belt and has been described by Hanfield (1968). Trilobites from the type section were collected by the writer in 1965 and described by him in 1972.

While studying the trilobites it was noted that some differed from the trilobites one expects to find in the North American Faunal Province. The contrast between the two kinds of trilobites is of a magnitude great enough to suggest the influence of a nearby, abrupt change in the paleoenvironment. After considering the "unusual" trilobites and the nearby rock types, it was guessed that the siltstone and thin-bedded limestone of the Sekwi Formation in the southwestern half of the Sekwi Mountain map-sheet belonged to the outer detrital belt, and that more of the "unusual" trilobites could be found in that area. Support for this guess came in 1970 when trilobites that did indeed differ from the "normal" trilobites of the North American Faunal Province were discovered 22 miles west of the type Sekwi in outer detrital strata. These trilobites are described in the present paper.

Additional sections were measured in the Sekwi Mountain area in 1972. The results (Fritz, 1973) have not been studied in detail, but it is already clear that the depositional boundary between the outer detrital and middle carbonate belt migrated laterally during Lower Cambrian time. Because of this migration, some stratigraphic sections contain rocks belonging to more than one depositional belt.

Lithostratigraphy

In the main stratigraphic section measured for this study (Fig. 2, pocket), the 429- to 1,935-foot interval is assigned to the outer detrital belt, and the 1,935- to 3,200-foot interval to the middle carbonate belt. The basal Sekwi unit, the 0- to 429-foot interval in the main section, the 0- to

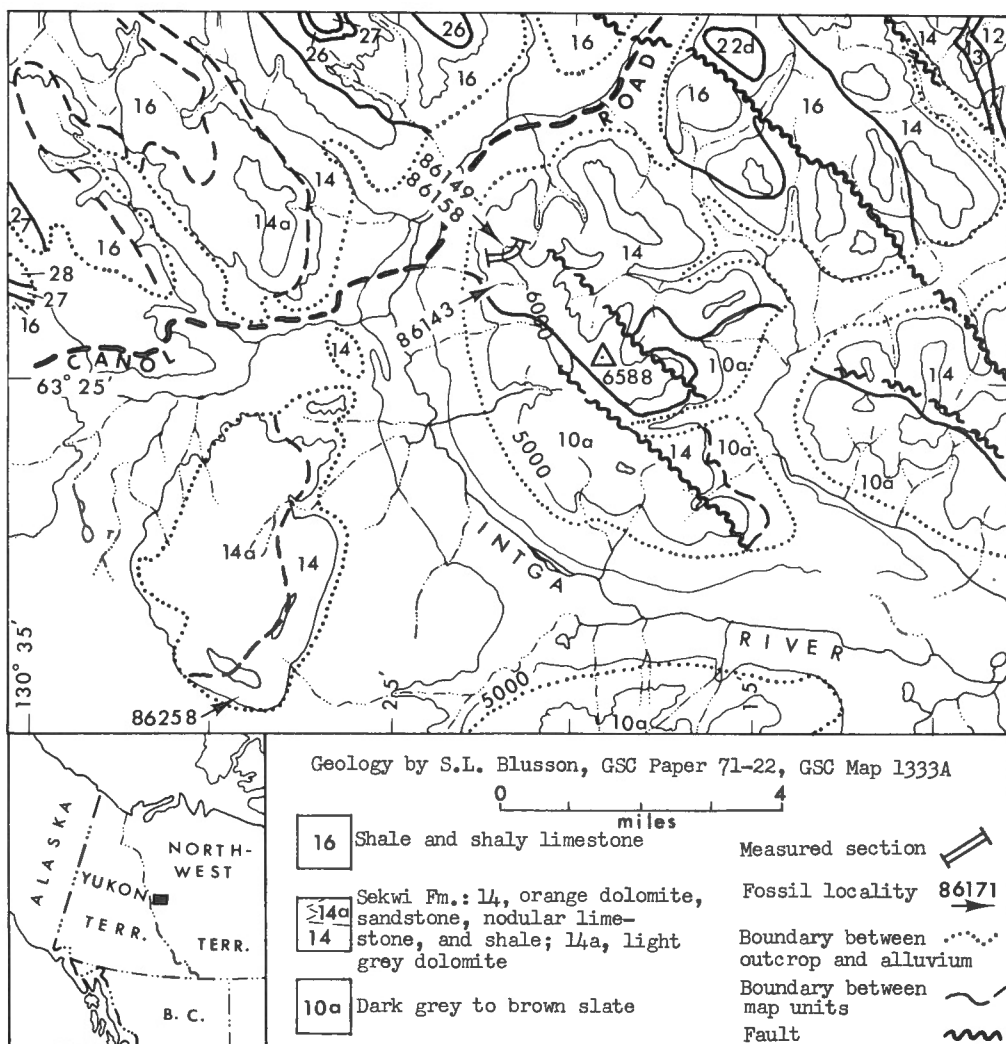


Figure 1. Map showing the location of the fossil collecting sites.

230-foot interval in the short section a half mile south of the main section, and the strata sampled at GSC locality 86258 represent a lithologic unit informally referred to as the "Swiss Cheese" unit by field geologists. The history of this unit is presently too uncertain for it to be assigned to one of the depositional belts.

Outcrops of the strata in both intervals 0 to 429 feet and 429 to 1,935 feet have been mapped at nearby outcrops by Blusson (Fig. 1) as Sekwi map-unit 14, and interval 1,935 to 3,200 feet has been mapped by him as Sekwi map-unit 14a. Although the two units were combined as unit 14 at the site of the main stratigraphic section, it is believed that unit 14a could have been separated there if more time had been available during Blusson's reconnaissance mapping program.

The "Swiss Cheese" unit (0-429 feet) consists of limy siltstone that weathers light brownish orange to orangish brown. Sparse nodules of light grey weathering limestone or limy siltstone mottle the weathered surface. On deeply weathered surfaces the more soluble nodules recede leaving round or oval cavities. Fresh siltstone surfaces are light brown to medium grey and the nodules fracture medium grey.

In the short section located one half mile south of the main section (Figs. 1, 2) limestone in thin, wavy beds is present in the interval 47 to 102 feet above the base of the "Swiss Cheese" unit. This limestone subunit is probably the same as that exposed immediately below the 279-foot horizon in the main section and the limestone present at locality 86258. At all three localities the limestone weathers light blue-grey, fractures medium to dark grey, is finely crystalline, and contains *Serrodiscus mackenziensis* sp. nov.

There is a discrepancy in thickness when the "Swiss Cheese" unit at the site of the main section is compared (Fig. 2) with the same unit at the short section one half mile to the south. Since the "Swiss Cheese" interval is mostly covered at the main section, a fault, misplaced basal contact, or a true deposition change might account for the discrepancy.

Outer detrital strata in the interval 429 to 1,935 feet consist mostly of light brown weathering siltstone that is slightly limy and is medium dark grey on fresh surfaces. The siltstone weathers to chips one-quarter inch thick and one or two inches in average diameter. Folds attributed to penecontemporaneous slumping are present in intervals 523 to 685 feet and 797 to 845 feet above the base of the formation.

In the interval 429 to 782 feet are numerous thin beds of dark grey to black weathering and fracturing limestone. Depositional breccia and folding are common, and some of the thin beds have been redeposited to form light grey weathering, thick beds of limestone breccia. Penecontemporaneous folds in the interval 474 to 493 feet indicate slump movement in the direction of N65°W, N50°W, N63°W, and N40°W. At 510 feet a fold axis in the limestone indicates a slumping direction that was either S80°W or N80°E. Slump directions based on folds in the interval 746 to 782 feet are 0°W, N35°W, and N73°W.

Massive archaeocyathid bioherms in the intervals 845 to 878 feet and 996 to 1,090 feet constitute the most unusual lithology in the 429- to 1,935-foot interval of outer detrital belt strata. The bioherms are orange weathering and fracture medium dark grey. Footages cited above are maximum thicknesses seen on the main section where the bioherms noticeably pinch and swell over a short lateral distance. Most of the archaeocyathids are somewhat recrystallized, as is the coral-like fossil *Tabulaconus* sp. that is common in the higher of the two bioherm intervals.

In the uppermost 442 feet of the strata assigned to the other detrital belt, thin and medium interbeds of brown to orange weathering, fine grained quartzite are present. Also present, between the 1,565- and 1,717-foot levels, is a medium bedded, dark grey weathering and fracturing limestone subunit. This subunit is oolitic throughout. Pisolites are common at 1,625 feet and *Girvanella?* sp. is present at 1,645 and 1,671.

Strata in interval 1,935 to 3,200⁺ feet (Sekwi map-unit 14a) are assigned to the middle carbonate belt, as they are mostly dolomite. In the lower 710 feet of the interval, light grey weathering dolomite in thick, blocky beds predominates. In the next 360 feet only orange and light grey weathering, thin bedded dolomite was seen in float and at sparsely scattered outcrops. At the top of the interval are several hundred feet (unmeasured) of medium bedded dolomite that weathers dark brown and light grey.

Biostratigraphy

Palmer (1971, p. 58) is probably correct in stating, "Failure to recognize that faunal sequences in the inner and outer detrital belts, particularly, can be quite different may have contributed to some biostratigraphical problems in the Cordilleran region which are only now becoming apparent." With this in mind, no attempt is made to force the present outer detrital belt fossils into the Lower Cambrian zonation currently in use (Fritz, 1972), as this zonation may be limited in the future to the inner detrital and middle carbonate belts. However, an attempt is made to relate the present fossils to the existing zonation, as the relative age of the fossils will be of interest regardless of future zonation schemes.

It has been mentioned that strata containing the three oldest localities, GSC locs. 86149, 86143, and 86258, are considered to be of the same age because of the similarity of the rock and the common occurrence of *Serrodiscus mackenziensis* sp. nov. Correlation of the main stratigraphic section with sections elsewhere (Fritz, 1973, Fig. 1) indicates that the localities are equivalent to either the early *Nevadella* Zone or late *Fallotaspis* Zone. The presence of *Yukonites lacrinus*? Fritz at GSC loc. 86149 suggests a correlation with the *Nevadella* Zone strata at the type locality of the Sekwi Formation (Fritz, 1972, Fig. 3). The absence of either *Fallotaspis* sp. or *Parafallotaspis* sp. might be taken as negative evidence that the localities do not belong to the *Fallotaspis* Zone.

The next youngest locality (GSC loc. 86150) contains *Judomia*? *absita* sp. nov., *Nevadia*? sp., and *Pagetides latisulcus* sp. nov. The questionable presence of *Judomia* suggest correlation with the *Nevadella* Zone in the North American Faunal Province and with the upper Attaban Horizon of the Aldan Stage on the Siberian Platform (Fritz, 1972b, p. 6). *Nevadia* sp. is known to occur low in the *Nevadella* Zone in the White-Inyo Mountains of California (Nelson and Durham, 1966, Fig. 1), and has been found by the writer at various localities in strata of the same age in the Mackenzie Mountains.

The three youngest collections to be described in this paper are thought to have come from a narrow stratigraphic interval. Two of the collections, GSC locs. 86151 and 86152, are from float located upslope from GSC loc. 86150, and are therefore definitely younger than the latter collection. The fossil content (faunal list on Fig. 2) and lithology of the float collections are similar, suggesting their derivation from the same stratigraphic horizon. The lithology matches that seen in the limestone interval 685 to 782 feet above the base of the formation. The third collection, GSC loc. 86153, was made within the 685-782 foot limestone interval, and contains the following trilobites in common with the float collections: *Judomia*? *absita* sp. nov., *Ekwapagetia plicofimbria* sp. nov. and *Pagetides abyssistriatus* sp. nov. None of the strata above the 685-782 interval are similar to the limestone contained within it, nor were similar fossils found at the higher levels.

For the purpose of correlation, the three youngest collections are considered as samples from one faunule. Two genera, *Sekwiaspis* sp. and *Bradyfallotaspis* are known from the type section of the Sekwi Formation where they occur in the *Nevadella* Zone (Fritz, 1972, Fig. 3). As mentioned above, *Judomia*? sp. is considered evidence for correlation with the *Nevadella* Zone. On the Siberian Platform, *Edelsteinapsis*, *Dinesus* (Erbia), and *Labradoria* are known from the Botoma-Lena Stages or equivalent strata (Khomontovskiy and Repina, 1965, Tables 1, 5, and 9). In North America, *Labradoria* is known from one species in the *Bonnia-Olenellus* Zone of Labrador (p. 17). In summation, it seems likely that the faunule in the three collections correlates with the *Nevadella* Zone as defined at the type section for the Sekwi Formation. The fact that the faunule has *Judomia*? *absita* in common with the next underlying locality (GSC loc. 86150) adds weight to the correlation. The presence of *Edelsteinapsis*?, *Dinesus*, and *Labradoria* in the collections is attributed to a local occurrence of older species in genera that may prove to range through a considerable amount of time.

Directly overlying the 685- to 782-foot limestone interval is 15 feet of fine grained quartzite. The position of the quartzite unit is considered important, as the boundary between the *Nevadella* and *Bonnia-Olenellus* Zones falls near or within a similar quartzite at nearby sections (Fritz, 1973, Fig. 1). In the present section, the minimum age of the quartzite could not be determined, as the closest overlying locality (86154) contained only archaeocyathids and *Tabulaconus* sp. for which there are no reliable range data available. Only archaeocyathids were found at locality 86155. Localities 86156 and 86157 contain several species of *Olenellus* and therefore these horizons can be definitely assigned to the *Bonnia-Olenellus* Zone. Strata in the highest locality (86158) cannot be dated by the questionable organic markings present, but lithologic correlations strongly suggest that they belong to the *Bonnia-Olenellus* Zone.

SYSTEMATIC DESCRIPTIONS

Numbers on the plate descriptions immediately preceded by "GSC No." refer to specimens in the type collections of the Geological Survey of Canada. Numbers preceded by "GSC loc." refer to the fossil collecting sites. These numbers are in the text, plate description, and on Figures 1 and 2. The fossil descriptions and specimen counts were done following the method described in a previous paper (Fritz, 1972, p. 8).

Family Eodiscidae Raymond

Genus *Serrodiscus* R. and E. Richter

Eodiscus (*Serrodiscus*) R. and E. Richter, 1941, p. 23; Shaw, 1950, p. 582.

Paradiscus Kobayashi, 1943a, p. 38; 1943b, p. 44; 1944, p. 50.

Eodiscus (*Paradiscus*) Shaw, 1950, p. 582.

Serrodiscus Rasetti, 1952, p. 444; Hupé, 1952, p. 109; 1953, p. 116; Howell, 1959, p. 188; Pokrovskaya, 1959, p. 170; 1960, p. 55; Egorova et al., 1960, p. 152; Poletaeva, 1960, p. 54; Rushton, 1966, p. 11, Palmer, 1968, p. 33.

Type species. *Eodiscus* (*Serrodiscus*) *serratus* R. and E. Richter, 1941.

Discussion. The diagnosis and remarks by Rushton are followed in assigning the species below to the genus *Serrodiscus*.

Serrodiscus mackenziensis sp. nov.

Plate 1, figure a; Plate 3, figures 1-17

Material. Thirty-seven cephalia 1.8 to 5.6 mm long and seventeen pygidia 1.6 to 5.6 mm long.

Description. Cephalon of medium height, length-width ratio 7:8. Axis converges moderately forward along posterior three-tenths; remaining portion converges gradually forward to strongly rounded front, terminating short distance from border furrow. Axis slopes upward in side profile from rear to three-tenths mark, then uniformly and moderately downward over most of remaining length before curving abruptly downward at front. Three pairs of broad, shallow glabellar furrows present, none join across axial midline; anterior pair

slightly less than half way forward on anterior half of axis; medial pair located at midlength on axis; posterior pair midway on posterior half, branching with one limb inclined forward and other inclined back. Axial furrow of medium width and depth. Gena as wide (tr.) as glabella at level of medial pair of axial furrows, convex, slope is horizontal to slightly inward near axial furrow, steeply outward near outer margin. Border furrow wide and moderately deep throughout; border narrow (tr.) near posterolateral position, width increases in forward direction, marked by five pairs of low nodes and two additional, faint nodes farther forward that are not visible on most cephalons. Occipital furrow very broad and shallow, not crossing axial midline. Posterior border of medium width (exsag.) and horizontal along proximal half, then abruptly inclined downward and forward along distal half, small spine present near proximal end of distal half. Spine or node absent on occipital ring, but small node present at high point on glabella located three-tenths axial length forward from rear margin of axis.

Pygidial length approximately equals width. Axis has greater relative height than on cephalon, converging rearward at uniform rate, terminating near border furrow, composed of 10 rings and terminal piece. Axial rings bear nodes that are relatively large on small pygidia and small on large pygidia. Axial nodes on large pygidia are more prominent on posterior rings than anterior rings. Furrows on axis of medium depth and width. Pleural field approximately as wide as adjacent axis, convex, horizontal or slightly insloping axial furrow steeply outslowing near outer margin. Border furrow of medium depth. Border narrow and bearing seven pairs of vertically directed spines. Surface of pygidium and cephalon marked by densely spaced polygonal(?) network of raised lines.

Discussion. *Serrodiscus bellimarginatus* (Shaler and Foerste, 1888) has both a cephalon and pygidium that closely resemble those of *Serrodiscus mackenziensis* sp. nov. Cephalons of *S. bellimarginatus* differ from those of the present species in having axes with parallel sides and a node or small spine on the rear axial margin. Material from Spain described by R. and E. Richter in 1941 as *Eodiscus* (*Serrodiscus*) *serratus* and *Eodiscus* (*Serrodiscus*) *silesius* is close in appearance to the present species, but is too poorly preserved for a full comparison.

Occurrence. GSC locs. 86143, 86149, and 86258.

Family Pagetiidae Kobayashi

Genus *Pagetides* Rasetti

Pagetides Rasetti, 1945, p. 311; 1966, p. 503; 1967, p. 63; Hupé, 1953, p. 115; Howell, 1959, p. 190; Lazarenko, 1959, p. 5; Pokrovskaya, 1960, p. 55; Chernysheva, 1961, p. 42; Palmer, 1968, p. 36; Fritz, 1972, p. 8.

Type species. *Pagetides elegans* Rasetti, 1945.

Discussion. Rasetti's original description and supplementary remarks (1966, 1967) adequately describe this genus.

Pagetides asperlimbus sp. nov.

Plate 1, figure d; Plate 3, figures 18-30

Material. Six tentatively assigned cranidia 0.8 to 1.4 mm long and four pygidia 1.0 to 1.6 mm long.

Description. Cranidial length-width ratio of medium sized cranidium 7:9, front margin very broadly curved as compared with other species in genus. Glabella nearly parallel sided, front margin evenly rounded. Two pairs of glabellar furrows consisting of lateral indentations one-third and two-thirds distance from front, indentations joined across axis by broad furrows of medium depth. Axial furrows wide and deep; preglabular furrow is of medium depth and width. Preglabellar field short (sag.), but clearly defined from adjacent furrows. Anterior border and anterior border furrow of equal width, furrow of medium depth. Palpebral areas slope inward along proximal one-third to one-half, remaining portions consist of prominent longitudinally ovate elevation. Eye ridges very faint; palpebral furrows narrow but distinct. Occipital spine raised slightly above projection of axial crestline, tapering moderately back from broad base, length estimated to equal glabella plus occipital ring.

Pygidial length-width ratio approximately 3:5. Axis tapers gradually back, terminating before reaching border furrow, consisting of five rings and terminal piece, large nodes may be present (broken) on anterior three axial rings. Pleural field convex, very faintly marked by narrow ridges in interpleural furrow position. Border slightly convex, outslowing, of uniform width except for irregular lateral margin that bears two pairs of faint spines. Border furrow narrow and shallow.

Discussion. Both *Pagetides asperlimbus* sp. nov. and *Pagetides ornatus* sp. nov. are based upon pygidia to which cranidia have been tentatively assigned. Since the material is from one locality and the total quantity is small, the assignment of cranidia must be questioned. Pygidia of *P. asperlimbus* resemble those of *Pagetides spinulus* Fritz, 1972. Both have similar proportions and have small spines on the border. *P. asperlimbus* differs from *P. spinulus* in having one less axial ring, and a border that is convex and outslowing rather than flat and horizontal. Spines of *P. asperlimbus* are mere swellings separated by wider interpinal distances; spines of *P. spinulus* are truncated near the average marginal outline and are separated by narrow, slit-like openings.

Occurrence. GSC loc. 86258.

Pagetides abyssistriatus sp. nov.

Plate 1, figure f; Plate 5, figures 1-19

Material. Seventy-eight cranidia 0.5 to 2.2 mm long and seventy-four pygidia 0.6 to 1.6 mm long.

Description. Cranidial relief medium, length-width ratio 4:5. Glabella parallel-sided, front bluntly pointed, terminating at posterior margin of anterior border furrow; glabellae of small cranidia are preceded by short (sag.) furrow. Two pairs of glabellar furrows, slit-like, longitudinally aligned on glabella-axial furrow contact to produce only slight lateral displacement of either structure, anterior pair of furrows shorter than second pair. Axial furrows deep and wide. Anterior border slightly narrower (exsag.) than anterior border furrow, of uniform width (exsag.), marked by faint furrow running close and parallel to posterior margin and faint radial ridges rather than furrows. Anterior border furrow sharply defined at anterior margin; posterior margin in gradational contact with preglabellar field and adjacent fixigenae. Palpebral area broadly convex (tr.), average slope is horizontal. Eye ridges distinct but narrow and low, proximal third transverse, distal two-thirds curve back. Palpebral lobes one-third as long as glabella, centred opposite anterior ends of posterior pair of glabella furrows, bordered by narrow, deep palpebral furrows. Occipital spine small at base, short.

Pygidial length-width ratio slightly less than 2:3. Axis tapers gradually back, consisting of anterior four rings of average size and of three or four very short (sag.), poorly defined rings and small terminal piece. Anterior three rings clearly defined behind by furrows that are deep at distal ends and elsewhere broad and shallow, fourth ring defined behind by abrupt drop in relief; position of three or four remaining rings poorly defined by very faint furrows and by one pair of small nodes or granules transversely arranged on each ring. Pleural field broadly curved (tr.) and outslipping except near flanks and back where curvature increases and remaining field is steeply inclined for considerable distance to border; field marked by three faint pairs of interpleural furrows. Border furrow broad and deep; border very narrow to wire-like. Cranidial and pygidial surface rough on some areas and elsewhere covered by closely spaced, fine granules; both surfaces also marked by faint, sparse granules of medium size.

Discussion. The species that most clearly resembles this one is *Pagetides latisulcus* sp. nov. (see discussion below).

Occurrence. GSC locs. 86151, 86152, and 86153.

Pagetides latisulcus sp. nov.

Plate 1, figure g; Plate 4, figures 1-15

Material. Fifteen cranidia 0.8 to 1.4 mm long and four pygidia 0.7 to 1.0 mm long.

Description. Cranidial length-width ratio approximately 9:10. Glabella sides slightly convex, converging moderately forward, terminating in point just before reaching anterior border furrow. Glabellar furrows consisting of two pairs of slight indentations into glabella sides. Axial furrow of medium width and shallow. Anterior border uniformly narrow; border furrow very wide (sag.) and of medium depth. Eye ridges narrow and transversely directed. Palpebral area nearly flat and horizontal. Palpebral lobes slightly longer than half glabellar length; palpebral furrows narrow and deep. Occipital spine thin throughout, directed straight back, half as long as glabella, bearing small node near base.

Pygidial length-width ratio approximately 7:10. Axis converging uniformly back and terminating near border furrow, consisting of four averaged sized rings and terminal piece. Existence of additional, short (sag.) rings between fourth ring and terminal piece is open to question. Furrows on axis consist of four pairs of posteriorly diminishing indentations into sides of outslipping, uniformly curved, marked by two faint pairs of interpleural furrows. Border furrow of medium width and depth; border very narrow. Surface of cranidium and pygidium covered with fine granules.

Discussion. Three cranidia in the above collection exhibit a weak ridge closely paralleling the rear margin of the anterior border. Cranidia of *Pagetides latisulcus* sp. nov. differ from those of *Pagetides abyssistriatus* sp. nov. in having a greater relative length, shallower axial furrows, and a longer occipital spine. Pygidia differ from those of *P. abyssistriatus* in having a wider, more rapidly tapering axis, less relief near the outer margin of the pleural field, and a narrower border furrow.

Occurrence. GSC loc. 86150.

Pagetides ornatus sp. nov.

Plate 1, figure c; Plate 2, figures 13-22

Material. Four tentatively assigned cranidia 1.6 to 2.2 mm long and two pygidia 1.4 and 1.6 mm long.

Description. Tentatively assigned cranidium has length-width ratio of approximately 4:5, relief medium for genus, front margin broadly and uniformly curved. Glabella tapers slightly forward, front truncated to bluntly pointed. Glabellar furrows consist of short marginal indentations one-third and two-thirds distance from glabellar front, indentations transversely joined across glabella by very faint furrows. Eye ridges originate at anterolateral margin of glabella, curve slightly forward and then slightly back so that average outward direction is slightly forward. Axial furrow wide and deep. Preglabellar field short (sag.) and low. Anterior border and adjacent furrow of approximately equal width (exsag.), border has very faint radial markings. Palpebral areas convex in cross-section (tr.), greatest height two-thirds distance from axial furrows, then curve steeply downward to narrow but distinct palpebral furrows. Posterior border straight, transverse, terminating behind or slightly outward from palpebral lobe. Occipital spine directed up and back at same angle as glabellar crestline, rapidly narrowing from base, then thin for length that is probably equal to glabella and occipital ring combined.

Pygidial length-width ratio approximately 5:7. Axis narrow, tapering back uniformly to terminate short distance from border furrow, consisting of eight rings and terminal piece, each ring bearing single large node. Pleural field rather low, uniformly curved in cross section (tr.), ornamented by very shallow pleural furrows and rows of sparse granules aligned on anterior edge of second (from front) through fifth pair of fused pleurae. Border furrow of medium width and shallow; border much narrower and marked by granules similar to those on pleural field.

Discussion. The pygidium of *Pagetides granulosus* Palmer, 1968 resembles that of *Pagetides ornatus* sp. nov. in having a slender axis with medial nodes, and in having coarse granules on the pleural field. *P. granulosus* differs from the present pygidium in having seven rather than eight axial rings, and deep pleural furrows. The cranidium of *P. granulosus* is vastly different from the cranidium tentatively assigned to *P. ornatus*.

Occurrence. GSC loc. 86258.

Genus *Ekwipagetia* gen. nov.

Type species. *Ekwipagetia plicofimbria* sp. nov.

Diagnosis. Pagetiid of greater than average size, and of medium to high relief. Cranidium like that of *Pagetides*, but anterior border contains shallow furrow paralleling border margin; border lacks radial markings.

Pygidium similar to that of *Pagetides*, having approximately four to six axial rings and terminal piece. Spine present on posterior ring or terminal piece. Pygidial border very narrow, bearing spines on lateral margin.

Discussion. *Hebediscus marginatus* Rasetti, 1967 probably belongs to this genus. The species is known from a single cranidium collected in the Taconic sequence, New York where it occurs in the *Elliotocephala asaphoides* fauna. Other species are known from undescribed material from GSC locs. 86159-86161 located 55 miles northwest of the present section. All of the above material is equivalent in age to the *Bonnia-Olenellus* Zone and is therefore younger than *Ekwipagetia plicofimbria* sp. nov.

Siberian species that are close to, but fall outside *Ekwipagettia*, are "*Hebediscus*" *attleborensis*? (Shaler and Foerste, 1888), "*Hebediscus*" *ponderosus* Lermontova, 1951, "*Hebediscus*" *granulosus* Lazarenko, 1962 and "*Hebediscus*" *longus* Lazarenko, 1962. The Siberian species are placed by Demokidov and Lazarenko (1964, Table 33) in the *Hebediscus-Judomia* Zone of the Upper Aldan Stage. All four Siberian species differ from *Hebediscus* in having an anterior border and border furrow that are better defined, a smaller cranial axis that bears an occipital spine, and small spines on the pygidial border.

The present genus differs from other Pagetiidae in possessing the combined characteristics of being somewhat larger, as well as having a prominent furrow within the anterior border, a large spine on the pygidial axis, and a pygidial border with spines. Species placed in *Pagetides* resemble those in the present genus, especially *Pagetides amplifrons* Rasetti, 1945, *Pagetides pustulosus* Rasetti, 1945, and *Pagetides rupestris* Rasetti, 1948. The pygidium of *P. pustulosus* is unknown, but pygidia of the remaining two species have the general configuration of *Ekwipagettia plicofimbria*, including the tin border, but lack axial or border spines. *Pagetides* cranidia of the above species are likewise similar, but lack a furrow inside the border and all have prominent radial markings.

Ekwipagettia plicofimbria gen. and sp. nov.

Plate 1, figure b; Plate 6, figures 1-24

Material. Fifty-one cranidia 1.4 to 3.8 mm long and sixty pygidia 0.5 to 3.2 mm long.

Description. Cranidial relief high, length-width ratio slightly greater than 3:4. Glabella in plan view has shape of elongate egg, very high, front reaching short distance into anterior border furrow. Glabellar furrows weak, not visible on most specimens, not joined across axial midline, anterior pair just posterior to level of eye ridges and transverse, second pair directed slightly forward, posterior pair angles slightly back. Axial furrows broad and deep. Anterior border contains shallow furrow paralleling margins and separating it into two parts, anterior part three-fifths as wide (exsag.) as posterior part, separating furrow is nearly extinct near axial midline on large cranidia. Anterior border furrow very broad in front of glabella and eye ridges, of medium width and shallow distally, deep medially in area fringing front margin of glabella. Eye ridges low, of medium width, transverse except for slight rearward curvature distally. Palpebral area convex in cross section (tr.), average slope is inward. Palpebral lobes centred opposite point on glabella two-thirds distance back from glabellar front. Palpebral furrows narrow and deep. Posterior border horizontal and transverse from axial furrow to point directly behind palpebral lobe, then abruptly expanded (exsag.) and angling downward and forward. Occipital spine directed upward and back, broadly arched, cross section ovate with longest dimension in vertical plane, length probably at least equal to that of glabella.

Pygidial length-width ratio 3:4. Axis consists of four rings and elongate terminal piece. Large axial spine originates just posterior to fourth ring and is directed steeply upward, length (broken) at least as long as axis. Furrows on axis consist of four pairs of posteriorly decreasing lateral indentations into axis, furrows not joined across axial midline. Pleural field marked by four pairs of very faint interpleural furrows. Border furrow deep and or medium width; border narrow. Four pairs of short border spines present; in side view spines appear as vertical creases or folds on border.

Discussion. See discussion above following generic diagnosis.

Occurrence. GSC locs. 86151, 86152, and 86153.

Genus *Yukonides* Fritz

Yukonides Fritz, 1972, p. 10.

Type species. *Yukonides lacrinus* Fritz, 1972.

Discussion. At present this genus is known only from the type species and the material below that has questionably been assigned to that species.

Yukonides lacrinus? Fritz

Plate 3, figures 31-34

Yukonides lacrinus Fritz, 1972, p. 10, Pl. 8, figs. 1-12.

Material. Three cranidia 1.4 to 2.0 mm long and two pygidia 0.9 to 1.8 mm long.

Discussion. The above material matches the holotype and paratypes in most respects, but the preservation is poor and slight differences were noted. On the present cranidia, no pits are present near the posterior edge of the anterior border, and the eye tubercles are somewhat smaller. The pygidial axis is preserved only on the smaller (0.9) of the two pygidia. It differs from larger axes on paratype pygidia in having high nodes rather than spines on the axial rings.

Occurrence. GSC loc. 86149.

Family Olenellidae Vogdes

Genus *Bradyfallotaspis* Fritz

Bradyfallotaspis Fritz, 1972, p. 19.

Type species. *Bradyfallotaspis fusa* Fritz

Discussion. No features were seen on the present material that necessitate changes or additions to the diagnosis given by Fritz, 1972.

Bradyfallotaspis sp. 3

Plate 6, figures 25-27

Material. Five cephalic fragments; estimated lengths of restored cephalon 3.0 to 6.4 mm long.

Description. Cephalon length half width or less. Glabella extending nearly to anterior border furrow, anterior lobe long, remaining three lobes short and of approximately equal size. Three pairs of glabellar furrows, anterior pair short, shallow and transverse; medial pair of medium depth and inclined slightly back; posterior pair of medium depth and inclined strongly back. Extraocular area slopes uniformly away from outer margin of visual surface. Anterior and lateral border wide, inner two-thirds nearly flat and sloping

moderately inward, outer third curved and sloping outward. Posterior border transverse, proximal half narrow and expanding outward, distal half of medium width (exsag.). Genal spines inclined slightly outward, at least as long (broken) as half glabellar length. Ornamentation consists of sparse granules and of venation on gena that abruptly terminates after crossing sparse anterior and lateral border furrow. Single row of pits on anterior and lateral border consists of interareas between venation at border crossings.

Discussion. *Bradyfallotaspis* sp. 3 has a wide cephalon, as does three of the four presently known species described by Fritz (1972). The three wide species, *B. petula*, *B. sp. 1*, and *B. sp. 2*, all differ from *B. sp. 3*. in having a much narrower anterior and lateral border. The fourth (narrow) species, *B. fusa* has a border width approaching that of *B. sp. 3*, but the inner two-thirds slopes outward rather than inward.

Occurrence. GSC loc. 86151(?) and 86152.

Genus *Holmia* Matthew

Holmia Matthew, 1890, p. 160; 1899b, p. 59; Marcou, 1890, p. 365; Cole, 1892, fig. 3, p. 343; Peach and Horne (in part), 1892, p. 236; Beecher, 1897, p. 191; Moberg (in part), 1899, p. 318; Weller, 1900, p. 50-51; Pompeckj, 1901, p. 14-17; Lindström, 1901, p. 24; Walcott, 1910, p. 286; Grabau and Shimer, 1910, p. 263; Kiaer, 1917, p. 54; Poulsen, 1932, p. 35; 1959, p. 195; Lake, 1936, p. 227; Hupé, 1953, p. 133; Raw, 1936, p. 241, 244; 1957, p. 150; Suvorova, 1960, p. 62.

Holmia (Olenellus) Peach (in part), 1894, p. 671-674.

Cephalacanthus Lapworth, 1890, p. 641 (in part; *in* Walcott); 1891, p. 531 (in part).

Esmeraldina Reeser and Howell, 1938, p. 228; Shimer and Shrock, 1944, p. 611.

Type species. *Paradoxides kjerulfi* Linnarsson, 1871.

Discussion. The relationship between *Holmia* and various other genera, such as *Schmidtellus* Moberg, 1906, *Kjerulfia* Kiaer, 1917, *Andalusiana* Sdzuy, 1961, and *Esmeraldina* Reeser and Howell, 1938 must be clarified by a modern study before species such as the present one can be confidently assigned to *Holmia* or *Holmia*-like fossils in the North American Faunal Province.

Holmia rowei Walcott, 1910 (Reeser and Howell's type species for *Esmeraldina*) is the one described species in the North American Faunal Province that bears a close similarity to species assigned to *Holmia* in the Atlantic Faunal Province. The writer has observed this species a short stratigraphic distance above beds containing *Fallotaspis* in the White-Inyo Mountains of California and has seen the same or a similar species in Mackenzie Mountains of Canada. Although numerous cephalons have been found, no pygidia have been seen. This suggests that the pygidium of this species is small, and not the medium sized, *Holmiella*-like pygidium that Walcott (1910, Pl. 29, fig. 11) assigned to it. In both the White-Inyo Mountains and the Mackenzie Mountains the *H. rowei*-like trilobites were found in the lower portion of the *Nevadella* Zone. The range of trilobites of this type is much wider, however, as undescribed cephalons resembling those of *H. rowei* are present in association with *Olenellus truemani* Walcott, 1913 in U.S. National Museum collection 61K made by Walcott from the Mt. Robson area, British Columbia. The writer considers the latter cephalons to belong to the early portion of the *Bonnia-Olenellus* Zone.

The recognition of *Holmia* or *Holmia*-like species in the North American Faunal Province has been unnecessarily complicated by misassignment of some species to either *Holmia* or *Esmeraldina*. Species that should be removed

from these genera are *Holmia macer* Walcott, 1913 (= *Wanneria*), *Holmia mirabilis* Poulsen, 1958 (= *Wanneria*?), and *Esmeraldina hermani* (Kindle and Tasch), 1948 (genus undetermined).

Holmia? sp. 1

Plate 2, figures 1-6

Material. One incomplete cephalon 13.0 mm long, one partial pygidium 2.2 mm long, and several cephalic fragments.

Description. Cephalon convex for olenellid, curvature uniform along front and lateral margins, length-width ratio slightly greater than 1:2. Axis sides subparallel, slightly convex, greatest axial width at level of attachment for eye lobes. Four glabellar lobes separated by locally deep axial furrows; anterior lobe high, front margin strongly rounded and touching border furrow, penetrated by faint pair of furrows entering from base of eye lobe and continuing inward and slightly forward for short distance; posterior three lobes of approximately equal length (sag.), second lobe slightly wider (tr.) than posterior two. Anterior pair of glabellar furrows arcuate, inclined slightly back in average direction, joined by transverse furrow that is of medium depth; second pair of furrows arcuate and parallel to first, shallow near axial furrow, becoming deep inward and then shallowing to extinction; posterior pair shallow near axial furrow, becoming abruptly wide and deep, then shallowing and faintly bifurcating before extinction. Occipital furrow like posterior pair of glabellar furrows but without bifurcation and joined across midline by broad (exsag.), shallow transverse segment. Eye lobes initially directed strongly outward, curved so that posterior ends directed slightly inward, terminating opposite middle of posterior glabellar lobe. Extraocular gena slopes moderately outward, marked by narrow ridge curving out and slightly forward from anterior portion of eye lobe, curvature continues until ridge is inclined back and is last seen entering lateral border furrow at low angle. Anterior, lateral, and posterior border furrows uniformly broad and shallow. Anterior border of medium width (sag.), lateral border of equal width at anterolateral cephalic position, then widening gradually back to genal angle. Posterior border narrow proximally, widening to medium width at short intergenal spine located at border midlength, remaining border of uniformly medium width and curving slightly forward to genal angle. Occipital ring triangular in plan view, tilted moderately upward and back to terminate in short spine. Genal area exhibits small pair of swollen areas located behind interocular area, and second, faint pair of swollen areas centred at two-thirds point out on an imaginary transverse line from posterior end of eye lobe to lateral border furrow.

Pygidium small, convex, as wide as long, lateral margin directed back and slightly outward, posterior margin broadly curved. Axis consists of anterior ring followed by broad, transverse furrow, posterior "ring" consisting of two transversely aligned nodes followed by shallow furrow and posterior "V" shaped ridge. Pleural field slopes steeply outward and back from axis to outer margin.

Discussion. The present species closely resembles *Holmia lundgreni* Moberg, a species from Sweden found (Moberg, 1899, p. 321) in strata older than those containing *Holmia kjerulfi* (Linnarsson). The present species differs from *H. lundgreni* in having shorter eye lobes, an occipital ring that is more triangular in plan view, and a narrower lateral border. Since Kiaer (1971, p. 56) removed *H. lundgreni* from *Holmia* and tentatively placed it in *Kjerulfia*, it follows that the writer might have chosen to place his species in *Kjerulfia* also. However, both the present species and *H. lundgreni* are believed to exhibit features that link them more closely with *Holmia*. Some of these features are a more broadly curved front margin, a shorter (sag.) anterior glabellar lobe, and intergenal spines located closer to the axis.

Occurrence. GSC loc. 86258.

Genus *Judomia* Lermontova

Judomia Lermontova, 1951, p. 48; Poulsen, 1959, p. 193; Suvorova, 1960, p. 64; Lazarenko, 1962, p. 46; Korobov, 1963, p. 64; Demokidov and Lazarenko, 1964, p. 186.

Type species. *Judomia dzevanovskii* Lermontova, 1951.

Discussion. The genus *Judomia* has only been described from Russian material, none of which has been seen by the writer. Tentative assignment of the present species to *Judomia* is based mainly on diagnoses by Korobov (1963) and by Demokidov and Lazarenko (1964). *Sinskia*, a genus erected by Suvorova (1960b) seems to belong under *Judomia*, as Korobov (1963, p. 65) has suggested.

Judomia? absita sp. nov.

Plate 8, figures 1-11

Material. Thirty-nine cephalata 1.2 to 7.0 mm long and six hypostomata.

Description. Cephalon nearly twice as wide as long, curvature along front margin stronger than at sides. Glabella plus occipital ring parallel sided, front broadly curved, terminating near anterior border furrow, jointed to border by low (sag.) ridge. Three pairs of glabellar furrows, all average transverse; posterior two pairs indented slightly into glabella sides, of medium depth distally, and shallowing inward to extinction near axial midline; posterior pair nearly straight; anterior two pairs arcuate, anterior pair shallower than posterior two. Eye lobes originating near front of glabella, terminating slightly posterior to level of occipital furrow. Genae uniformly curved (tr.) and sloping moderately outward. Anterior and lateral border furrow narrow proximally, expanding along initial two-thirds, remaining third of uniform width (exsag.), latter width equaling that of anterior and lateral border. Small and medium sized cephalata exhibit small intergenal spines at terminal end of ridge crossing posterior border at low angle, spines located at two-thirds border length out from axis. Occipital ring of uniform width (exsag.) and bearing small node at midpoint. Occipital furrow of medium width and depth throughout, bowed slightly back on larger cephalata, nearly straight on small cephalata. Genal spines directed slightly outward, tapering at uniform rate, approximately half as long as cephalon. Hypostoma has prominent furrow separating large anterior lobe from small posterior lobe and at least two pairs of spines present on posterolateral margin. Ornamentation consists of terrace lines on anterior and lateral border and on genal spines.

Discussion. The present species differs from all others now assigned to *Judomia* in having a posterior border that is nearly transverse rather than distinctly inclined toward the rear, and in having eye lobes extending farther (tr.) from the axis and terminating at a level opposite the front of the occipital ring rather than opposite the posterior half. *Judomia tera* Lazarenko, 1960 is the species that most clearly resembles the present one.

Occurrence. GSC locs. 86150-86153.

Genus *Nevadia* Walcott

Nevadia Walcott, 1910, p. 256; Swinnerton, 1915, p. 495; Poulsen, 1932, p. 36; 1959, p. 196; Lake, 1936, p. 247; Resser, 1928, p. 5; Hupé, 1953, p. 131; Fritz, 1972, p. 22.

Type species. *Nevadia weeksi* Walcott, 1910.

Discussion. A modern diagnosis of *Nevadia* is needed, but it is felt that the present small collection of immature specimens does not provide an adequate basis for a complete review of the genus.

Nevadia? sp.

Plate 4, figures 16-18

Material. Four cephalon 1.2 to 3.2 mm long.

Discussion. Specimens in the present collections belong either to *Nevadia* or *Nevadella*. The former genus is preferred here because the largest cephalon has a short anterior glabellar lobe, wide genae, and strong venation.

Occurrence. GSC loc. 86250.

Family Dolerolendiae Kobayashi,

Genus *Anadoxides* Matthew

Anadoxides Matthew, 1899a, p. 142; 1899c, p. 87; Sdzuy, 1959, p. 397; 1971, p. 765; 1972, p. 19; Poulsen, 1959, p. 214; Nicosia and Rasetti, 1970, p. 9; Rasetti, 1972, p. 58.

Metadoxides Borenemann, 1891, p. 462; Matthew, 1899a, p. 137; 1899c, p. 83; Lindstrom, 1901, p. 16; Poulsen, 1959, p. 214; Suvarova, 1960, p. 66; Sdzuy, 1959, p. 396; 1961, p. 545; 1971, p. 365; 1972, p. 19; Nicosia and Rasetti, 1970, p. 9; Rasetti, 1972, p. 59.

Type species. *Paradoxides armatus* Meneghini 1881 (designated by Vodges, 1925).

Discussion. Nicosia and Rasetti (1970, p. 9) have restricted *Metadoxides* to the type species and transferred the remaining species to *Anadoxides*.

Anadoxides is known from the Lower Cambrian of Sardinia, the late Overtian Stage in Spain (Sdzuy, 1971, Table 1) and the Atdaban Horizon of the Aldan Stage on the Siberian Shield (Khomentovskiy and Repina, 1965, Table 5).

aff. *Anadoxides* sp. 1

Plate 1, figure e; Plate 7, figures 13-23

Material. Four exfoliated cranidial fragments with estimated complete lengths of 1.4 to 10.0 mm long, three pygidia 1.4 to 2.4 mm long, and one hypostoma.

Description. Cranidium nearly twice as wide as long, of medium relief. Glabella nearly rectangular, sides converging slightly forward, length-width ratio 8:5. Four pairs of narrow glabellar furrows, anterior three pairs of medium depth; anterior pair short and inclined slight forward; second pair inclined slightly forward; third pair inclined back; posterior pair inclined more steeply back, moderately deep, branching, posterior branch continuing arcuate

route and inclined back, anterior branch shallow and inclined forward. Palpebral area nearly half as wide (tr.) as glabella at base, broadly curved (tr.), average slope is slightly outward. Eye ridges strong, of uniform width. Palpebral lobes slightly wider than eye ridges, approximately one-fifth as long as glabella. Anterior border furrow very shallow and poorly differentiated at distal ends from narrow (exsag.) anterior border, deeper in front of glabella. Anterior sections of facial sutures diverging slightly forward from palpebral lobes, curving inward from level of anterior border furrow; posterior sections diverging strongly back from palpebral lobes. Posterior border furrow very wide and shallow; posterior border narrow and transverse along proximal three-fourths, inclined down and slightly forward along distal fourth. Occipital ring short (sag.) and bearing node (broken) or spine with longitudinally elongate base. Hypostoma with weak medial furrow and narrow posterior border.

Pygidium has length-width ratio of approximately 3:7, broadly curved along rear margin, irregular (broken; short spines?) along posterolateral margin. Axis low, consisting of three rings and terminal piece that nearly reaches end of pygidium. Pleural regions marked by three pairs of wide (exsag.), shallow pleural furrows and two pairs of narrow, shallow interpleural furrows. Ornamentation consists of small, closely spaced granules on pygidium and one pair of transversely arranged nodes on each axial ring; outer surface of cranidium unknown, inner surface smooth.

Discussion. The present material is too incomplete for specific or generic designation. The closest resemblance is to *Anadorides*, especially the type species, *Anadorides armatus* (Meneghini) as figured by Bornemann (1891, pl. 38, figs. 1, 2). Cranidia in the present collection differ from those of *A. armatus* in being longer and possessing an additional pair of glabellar furrows.

Occurrence. GSC loc. 86152.

Family uncertain

Genus *Labradoria* Resser

Labradoria Resser, 1936, p. 25; 1937, p. 47; Hupé, 1953, p. 86; Ivshin, 1957, p. 28; Henningsmoen, 1959, p. 212; Suvorova and Chernisheva, 1960, p. 76.

Type species. *Conocephalites misera* Billings, 1861.

Diagnosis. Ptychoparioid of medium size. Cranidium convex, length-width ratio approximately 2:3. Glabella large, extending to anterior border furrow, front margin has medium curvature, sides convex and converging forward. Glabella marked by three pairs of posteriorly inclined glabellar furrows; posterior or both posterior and medial pairs joined across axial midline. Anterior border short (exsag.). Palpebral area has width of between one-third and one-fourth that of glabella at base. Eye ridges distinct and inclined back. Palpebral lobes considerably wider than eye ridges, diverging back, centred well behind level of glabellar midpoint. Anterior segment of facial suture directed nearly straight forward to anterior border; posterior segment directed strongly outward. Occipital ring short and bearing spine or rear margin. Librigena has shallow border furrow, and genal spine that continues curvature of border. Cranidium and librigenae granular.

Discussion. In North America *Labradoria* is known from strata of the medial(?) *Bonnia-Olenellus* Zone in Labrador and from strata equivalent to the *Nevadella* Zone in the Mackenzie Mountains (this paper). In Kazakhstan (Ivshin, 1957, p. 29) *Labradoria* occurs with *Edelsteinaspis* in the late Lower Cambrian and

"early Middle Cambrian". In eastern Siberia Khomentovskiy and Repina (1965, Table 1) report *Labradoria* in the Tarynskiy Horizon with *Triangulaspsis*, *Judomiella*, *Bergeroniellus*, and *Erbiella*.

Labradoria hespera sp. nov.

Plate 4, figures 19-26

Material. Eight cranidia 1.0 to approximately 3.4 mm long and two librigena.

Description. Cranidium convex, length-width ratio slightly less than 2:3. Glabella high, sides convex, converging forward to medium rounded front that barely reaches anterior border furrow, length-width ratio on small (2.4-2.8 mm) cranidia 3:2, on medium (3.0-3.4) cranidia ratio nearly 1:1. Three pairs of narrow, arcuate glabellar furrows, anterior two pairs of medium depth; anterior pair inclined slightly back; medial pair longer than anterior pair and inclined moderately back; posterior pair deep, joined by transverse segment that is half combined furrow length, distal fourths inclined back slightly steeper than medial pair of furrows. Palpebral areas one-third as wide (tr.) as glabella at base, convex, average slope is outward. Eye ridges of medium strength. Palpebral lobes slightly longer than one-third glabellar length, strongly insloping, centred opposite proximal ends of medial glabellar furrow. Anterior border furrow of medium depth and width throughout; adjacent border twice as wide as furrow and tilted slightly back. Anterior section of facial suture directed nearly straight forward from palpebral lobe, curving inward after passing posterior third of anterior border. Posterior border furrow of medium width, deep proximally, of medium depth distally. Posterior border narrow and transverse along proximal two-thirds, of medium width and inclined downward along distal one-third. Occipital furrow of medium width, deep throughout. Occipital ring of medium width (sag.) and bearing small spine on rear margin. Librigena has shallow border furrow, length of spine (broken) unknown. Surface of cranidium and librigena covered by closely spaced, medium granules.

Discussion. *Labradoria misera* (Billings) from Labrador, Newfoundland, is the only other valid North American species in this genus. *L. misera* differs from the present species in having a much lower glabella with more surface contact against the anterior border furrow, narrower (tr.) palpebral areas, anterior glabellar furrows that are inclined more steeply back, medial glabellar furrows that join, and posterior glabellar furrows joined by a medial segment that is bowed back rather than transverse. *L. misera* is believed to belong to the medial portion of the *Bonnia-Olenellus* Zone, and is therefore much younger than the present species. *Labradoria elongata* Resser, from the same locality as *L. misera*, is a junior synonym of *L. misera*. *Labradoria cambridgensis* Lochman is represented by a single, poorly preserved cranidium of small size. Lochman's (1956, p. 1394) reasons for differentiating her "species" from *L. misera* are considered to be of generic importance by the writer, and clearly exclude her specimen from *Labradoria*.

Occurrence. GSC loc. 86151 and 86152.

Family Edelsteinaspidae Hupé

Edelsteinaspis Lermontova

Edelsteinaspis Lermontova (in Vologdin) 1940, p. 146; Lochman-Balk, 1959, p. 515; Survorova and Chernysheva, 1960, p. 76; Egorova *et al.*, 1960, p. 189; Repina, 1964, p. 298; Chernysheva, 1961, p. 104; Suvorova, 1964, p. 63.

Type species. *Edelsteinaspis ornata* Lermontova, 1940.

Discussion. Knowledge gained from studying the present material is too incomplete to warrant remarks on diagnoses by the authors listed in the above synonymy. The present material is tentatively placed under *Edelsteinaspis* rather than *Polliaxis* Palmer, 1968, as cranidia in the latter genus have shorter anterior glabellar lobes, glabellae with more convex sides, and narrower (tr.) palpebral area.

Edelsteinaspis? sp. 1

Plate 8, figures 12-17

Material. Two cranidial fragments, estimated complete lengths 7.0 to 10.0 mm long and one pygidial fragment 5.0 mm long.

Description. Glabella of medium height, parallel sided, front margin has medium curvature and is in contact for nearly entire length with anterior border furrow. Anterior glabellar lobe long, remaining three lobes short and of approximately equal size. Three pairs of glabellar furrows, all of medium depth and width, each pair inclined back slightly more than next anterior pair; anterior pair arcuate, average trend is slightly back, probably (not preserved) joining across axial midline; medial and posterior pairs broadly arcuate to nearly straight and joined across axial midline. Axial furrow of medium depth and width, shallowing and narrowing from posterior margin of eye ridge to anterior border furrow. Eye ridge of medium width, low, inclined steeply back. Anterior border furrow of medium width and shallow along distal segments, of medium depth and bowed forward in front of glabella. Anterior border narrow (exsag.) at distal ends, broadening inward and then narrowing again in front of glabella.

Pygidial outline probably that of elongate (sag.) triangle. Pleural field strongly and uniformly curved (tr.), inclined slightly outward near axis, very steeply near border. At least seven pairs of interpleural furrows present, anterior five pairs of medium depth and uniform width, posterior two pairs broaden slightly away from axis. Interpleural furrows narrow and shallow; interpleural furrows plus adjacent pleural bands have combined width (exsag.) that is slightly greater than width of pleural furrows. Lateral pygidial border weakly defined, smooth, inclined steeply outward, crossed by locally shallow pleural furrows. At least seven pairs of small (broken) spines on border. Cranidium covered by granules that are of small and medium size; pygidium bears like granules on pleural bands.

Discussion. An elongate pygidium with at least seven pairs of border spines differentiates this species from others assigned to *Edelsteinaspis*.

Occurrence. GSC loc. 86152.

Family uncertain

Genus *Sekwiaspis* Fritz

Sekwiaspis Fritz, 1972, p. 38.

Type species. *Sekwiaspis artifrons* Fritz, 1972.

Discussion. The new species described below does not necessitate additions or changes in the generic diagnosis by Fritz (1972).

Sekwiaspis canola sp. nov.

Plate 7, figures 1-12

Material. Eight cranidia 1.8 to 4.0 mm long.

Description. Cranidium convex, length-width ratio approximately 2:3. Glabella has length-width ratio of between 4:3 (cranidial length smaller than 3.2 mm) and 3:2 (cranidial length greater than 3.2 mm). Glabella sides straight to slightly concave, converging slightly forward, front margin has medium curvature. Three pairs of narrow, faint glabellar furrows; anterior two pairs obscure on cranidia longer than 3.4 mm, smaller cranidia show anterior pair inclined slightly forward; medial pair inclined slightly back; posterior pair inclined strongly back. Preglabellar field short, sloping forward, half as long (sag.) as anterior border. Anterior border furrow narrower than adjacent border, shallow; border flat and horizontal. Palpebral area broadly convex (tr.), average slope is horizontal, width half that of glabella at base. Palpebral lobes of medium width, centred short distance ahead of glabellar midpoint, nearly half as long as glabella. Anterior segments of facial suture broadly curved, averaging slightly convergent from palpebral furrow to anterior border furrow; posterior segments directed strongly back. Posterior border furrow of medium depth and width throughout. Occipital furrow narrow at ends, of medium width and depth elsewhere. Occipital ring bears small spine on rear margin. Cranidium marked by closely spaced, small granules.

Discussion. Cranidia of this species differ from *Sekwiaspis artifrons* Fritz, 1972 in having wider (tr.) palpebral lobes, wider (tr.) palpebral areas, narrower (exsag.) posterior border furrows, shallower glabellar furrows, and an ornamentation consisting of fine rather than fine to medium sized granules.

Occurrence. GSC loc. 86152.

Family Conocoryphidae Angelin

conocoryphid sp. 1

Plate 2, figures 7-12

Material. Three partial cephalon with estimated complete lengths of 6, 7, and 8 mm.

Description. Cephalon approximately half as long as wide, relief medium except at sides where distal one-third of genal region slopes steeply outward. Axis at crestline slightly higher than greatest elevation on genae, sides converging forward and slightly convex, front low in side view, front margin strongly curved in plan view and terminating at or near border furrow. Three pairs of deep glabellar furrows, anterior pair located behind level of "eye ridge"-axial furrow intersection, pit-like, not joined to axial furrows; medial pair like anterior pair; posterior pair slightly arcuate and inclined steeply back. Axial furrow broad and shallow. "Eye ridge" inclined forward and bifurcating short distance from axial furrow, posterior band wide, inclined back from bifurcation point for brief distance and terminating; anterior band narrow, continuing forward inclination from bifurcation point and then curving back to make low-angle entry into lateral border furrow. Lateral border furrow shallow and narrow; lateral border of medium width, flat, sloping outward. Anterior border (broken) probably bowed strongly upward in front view of cephalon. Genal region very convex (tr.). Posterior border along proximal two-thirds narrow (exsag.), horizontal, and directed straight out. Occipital ring has anterior

half that is convex (exsag.) and rises medially into large spine (broken); posterior half low and tilted back. Ornamentation consists of three glabellar spines or nodes (broken) on glabellar crestline, each located just anterior to or opposite one pair of glabellar furrows; cephalon covered by pustules of both large and medium size, small granules, and faint anastomosing venation.

Discussion. The combined features that exclude the present cephalon from other conocoryphid genera are a conical glabella that extends to or nearly to the anterior border furrow, two pairs of pits instead of two anterior pairs of glabellar furrows, a flat lateral border, and nodes or spines on the glabella. *Pseudatops* Lake, 1932 is a Lower Cambrian conocoryphid that has a flat border, but has a much larger glabella with different proportions and a different furrow pattern. Lower Cambrian solenopleurid trilobites bearing some resemblance to the present species belong to the genera *Gelasene* Palmer, 1968 and *Keeleaspis* Fritz, 1972.

Occurrence. GSC loc. 86258.

Family Dinesidae Lermontova

Genus *Dinesus* Etheridge

Dinesus Etheridge, 1896, p. 56; Gregory, 1903, p. 154; Walcott, 1905, p. 35; 1913, p. 124; Chapman, 1917, p. 98; Kobayashi, 1935, p. 132; Whitehouse, 1939, p. 228; Lermontova, 1951, p. 113; Lochman, 1959, p. 230; Ivshin *et al.* 1960, p. 124; Palmer, 1968, p. 60.

Type species. *Dinesus ida* Etheridge, 1896.

Discussion. Palmer's (1968, p. 60) diagnosis and discussion were followed in placing the material described below in this genus. Palmer recognized *Dinesus ida* Etheridge, *Dinesus granulosa* (Lermontova), and *Dinesus arcticus* Palmer as belong to the genus. *D. ida* is from the early Middle Cambrian of Queensland, Australia (Whitehouse, 1939, p. 228, 231), *D. granulosa* is reported from the late Lower Cambrian of western Siberia (Khomentovskiy and Repina, 1965, Table 1) and *D. arcticus* from Alaska is believed by the writer (1972, p. 7) to belong to the *Bonnia-Olenellus* Zone of the late Lower Cambrian. When the material below is included, the range of the genus is from the medial Lower Cambrian (equivalent of the *Nevadella* Zone) to the early Middle Cambrian.

Dinesus sp. 1

Plate 6, figures 28-31

Material. One small cranidium 1.6 mm long and one cranidial fragment with an estimated complete length of 5.6 mm.

Description. Small cranidium convex, length-width ratio approximately 3:5. Glabella high, convex in both directions, sides straight and parallel, front margin broadly curved, length-width ratio 3:2. One pair of deep glabellar furrows, inclined steeply back, proximal ends intersecting occipital furrow, length of each furrow approximately equal to distance between proximal ends. Preglabellar field short, front margin of glabella nearly touches anterior border furrow. Axial furrow of medium width and depth, becoming shallow anterior to narrow, low eye ridges. Pair of shallow, narrow furrows originate from anterior portion of axial furrows, diverging to anterior border furrow, and thus form distal sides of two triangles near glabella front. Anterior border

short (exsag.), of uniform width and tilted forward. Palpebral areas convex (tr.), average slope is outward, rear margin nearly as wide (tr.) as glabella at base. Palpebral lobes diverging strongly back, centred ahead of glabellar midpoint, wide (tr.) at midlength, one-third as long as glabella, convex in cross-section (tr.), average slope is strongly outward. Anterior segments of facial suture converging strongly forward from palpebral lobes; posterior segments inclined strongly back. Posterior border furrow of medium depth and width, directed slightly forward from axis, curved strongly and abruptly forward at distal ends. Posterior border narrow at proximal end, expanding to medium width at distal end. Occipital furrow deep and of medium width. Occipital ring of medium width and bearing small, raised spine on posterior margin. Cranidium marked by evenly spaced, medium sized granules; granules on medium sized (5.6 mm) cranidium also visible on inner surface.

Discussion. *Dinesus arcticus* Palmer, 1968 is the closest species to the present one. Cranidia of *D. arcticus* differ from those of *D. sp. 1* in having an anterior border that tilts back, palpebral lobes that are centred farther forward, posterior border furrows that do not turn sharply forward at the distal ends, an occipital furrow that angles sharply forward near the ends, and an ornamentation consisting of coarse rather than medium sized granules.

Occurrence. GSC loc. 86152.

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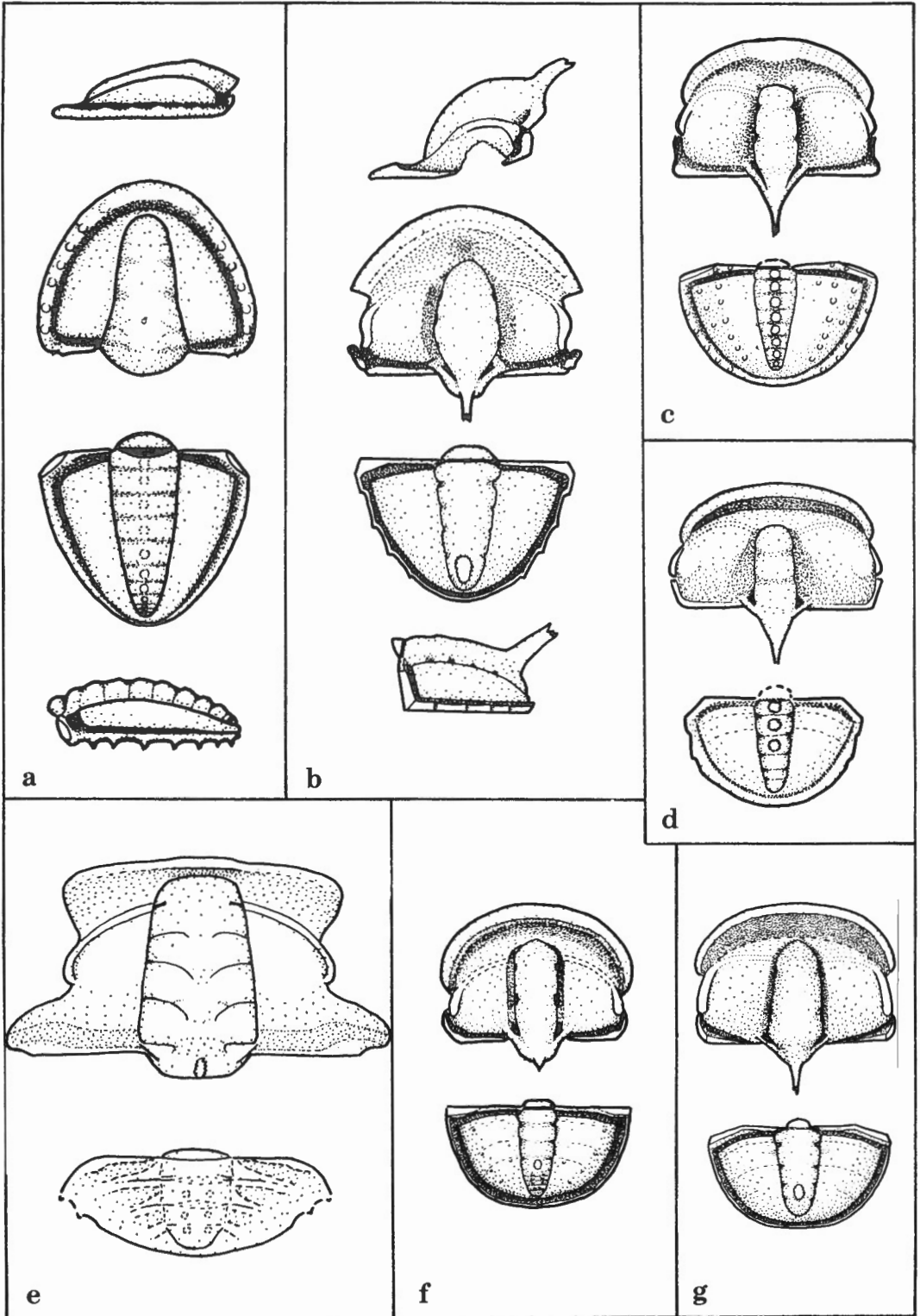


PLATE I

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|-----------|--|---------|
| Figure a. | <i>Serrodiscus mackenziensis</i> sp. nov. | (p. 5) |
| Figure b. | <i>Ekwiipagetia plicofimbria</i> gen. and sp. nov. | (p. 10) |
| Figure c. | <i>Pagetides ornatus</i> sp. nov. | (p. 9) |
| Figure d. | <i>Pagetides asperlimbus</i> sp. nov. | (p. 6) |
| Figure e. | aff. <i>Anadorides</i> sp. 1 | (p. 15) |
| Figure f. | <i>Pagetides abyssistriatus</i> sp. nov. | (p. 7) |
| Figure g. | <i>Pagetides latisulcus</i> sp. nov. | (p. 8) |

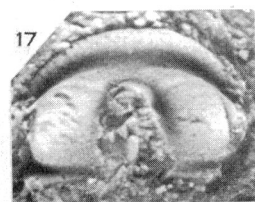
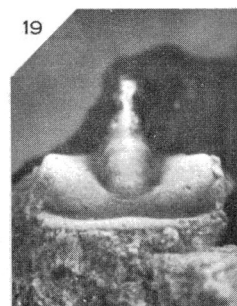
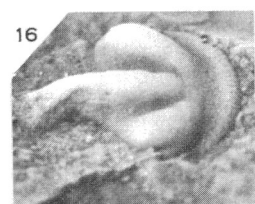
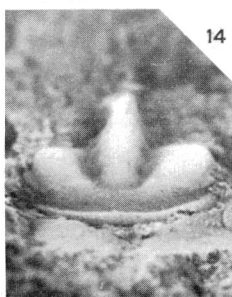
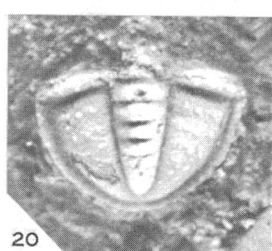
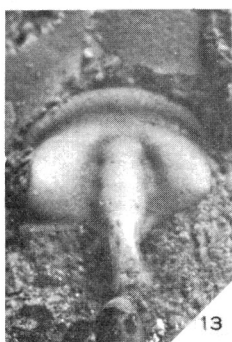
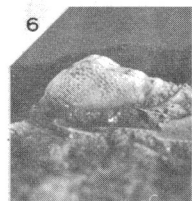
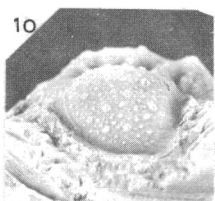
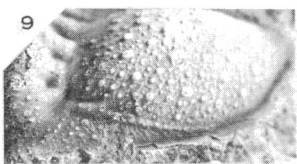
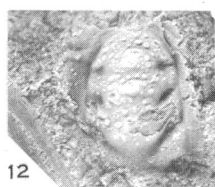
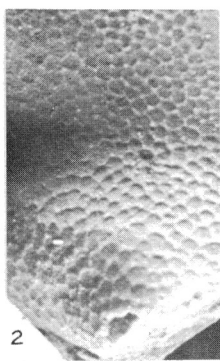
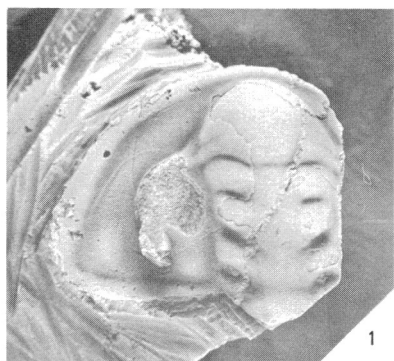


PLATE 2

Figures 1-6. *Holmia?* sp., GSC loc. 86258. (p. 13)

1, 3, 4. Cephalon, plan, front, and side views, x2.8, GSC No. 33144.

2. Enlargement of area on cephalon in Figs. 1, 3, 4, x13.0.

5, 6. Pygidium, plan and side views, x8.2, GSC No. 33145.

Figures 7-12. *Conocoryphid* sp. 1, GSC loc. 86258. (p. 19)

7-10. Cephalon, plan, front, front oblique, and side views, x2.5 (Fig. 9 x4.0), GSC No. 33146.

11. Cephalon, x2.8, GSC No. 33147.

12. Glabella, x2.8, GSC No. 33148.

Figures 13-22. *Pagetides ornatius* sp., GSC Loc. 86258. (p. 9)

13-16. Latex cast of cranidium, plan, front oblique, left side oblique, and right side oblique views, x15.0, GSC No. 33149.

17. Cranidium, x14.5, GSC No. 33150.

18, 19. Cranidium, plan and front views, x12.3, GSC No. 33151.

20-22. Holotype pygidium, plan, rear, and side views, x13.5, GSC No. 33152.

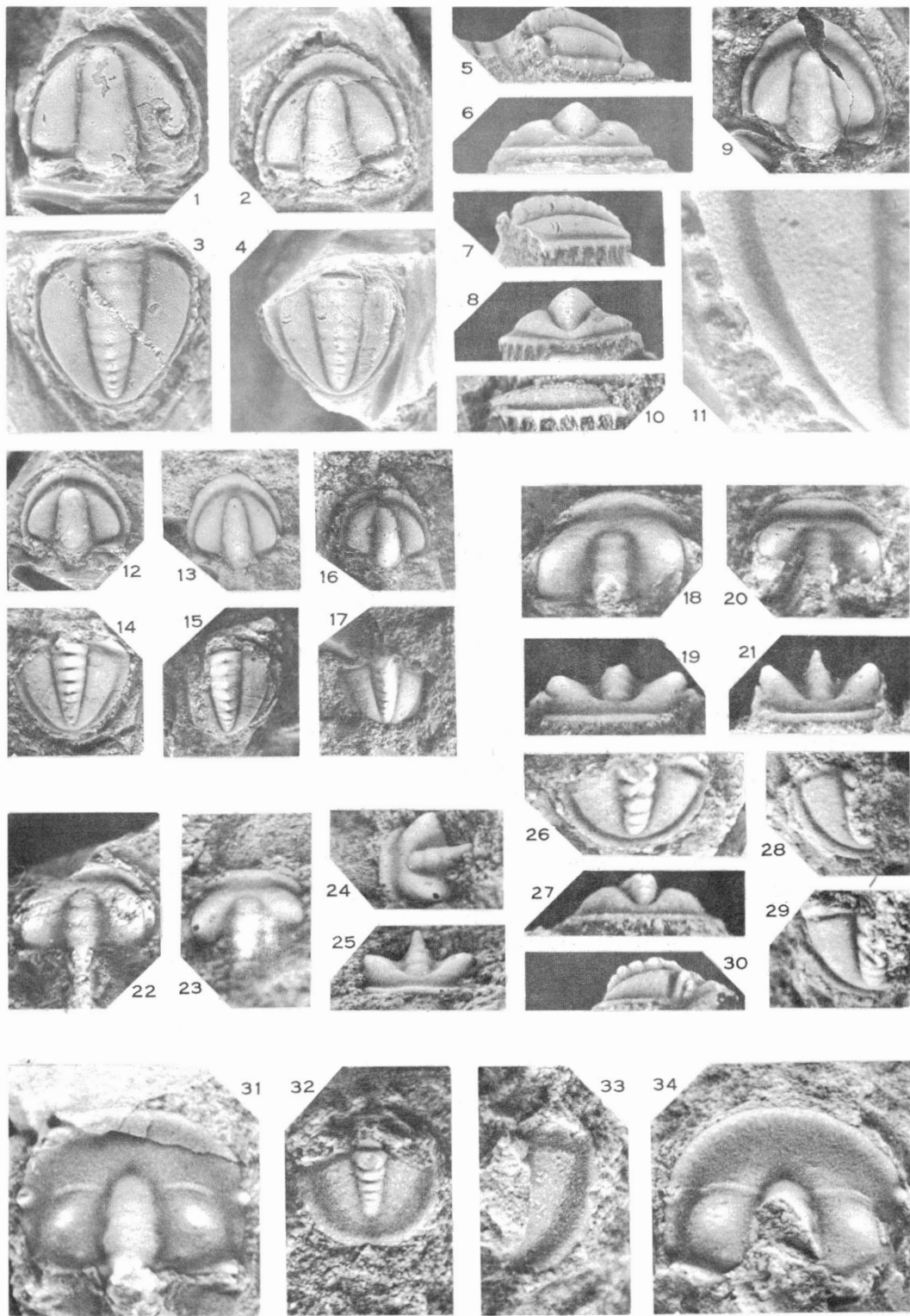


PLATE 3

Figures 1-17. *Serrodiscus mackenziensis* sp. nov.

(p. 5)

1. Paratype cephalon, x4.5, GSC loc. 86149, GSC No. 33153.
- 2, 5, 6. Holotype cephalon, plan, side, and front views, x4.5, GSC loc. 86258, GSC No. 33154.
3. Paratype pygidium, x4.5, GSC loc. 86149, GSC No. 33155.
- 4, 7, 8. Paratype pygidium, plan, side, and rear views, x5.0, GSC loc. 86258, GSC No. 33156.
9. Paratype cephalon, x5.0, GSC loc. 86258, GSC No. 33157.
10. Paratype pygidium, side view, x5.0, GSC loc. 86258, GSC No. 33158.
11. Enlargement of paratype pygidium shown in Figs. 4, 7, 8, x14.0.
12. Paratype cephalon, x5.0, GSC loc. 86258, GSC No. 33159.
13. Latex cast of paratype cephalon, x7.9, GSC loc. 86258, GSC No. 33160.
14. Paratype pygidium, x7.9, GSC loc. 86258, GSC No. 33161.
15. Paratype pygidium, x7.0, GSC loc. 86258, GSC No. 33162.
16. Paratype cephalon, x7.9, GSC loc. 86258, GSC No. 33163.
17. Latex cast of paratype pygidium, x8.7, GSC loc. 86258, GSC No. 33164.

Figures 18-30. *Pagetides asperlimbus* sp. nov., GSC loc. 86258.

(p. 6)

- 18, 19. Cranidium, x15.8, plan and front views, GSC No. 33165.
- 20, 21. Cranidium, x15.8, plan and front views, GSC No. 33166.
22. Cranidium, x16.4, GSC No. 33167.
- 23, 24, 25. Latex cast of cranidium, plan, oblique, and front views, x16.4, GSC No. 33168.
- 26, 27, 30. Holotype pygidium, plan, rear, and side views, x13.5, GSC No. 33169.
28. Paratype pygidium, x12.5, GSC No. 33170.
29. Paratype pygidium, x12.5, GSC No. 33171.

Figures 31-34. *Yukonides lacrinus*? Fritz, GSC Loc. 86149.

(p. 11)

31. Cranidium, x15.0, GSC No. 33172.
32. Small pygidium, x20.0, GSC No. 33173.
33. Partial pygidium, x15.0, GSC No. 33174.
34. Cranidium, x15.0, GSC No. 33175.

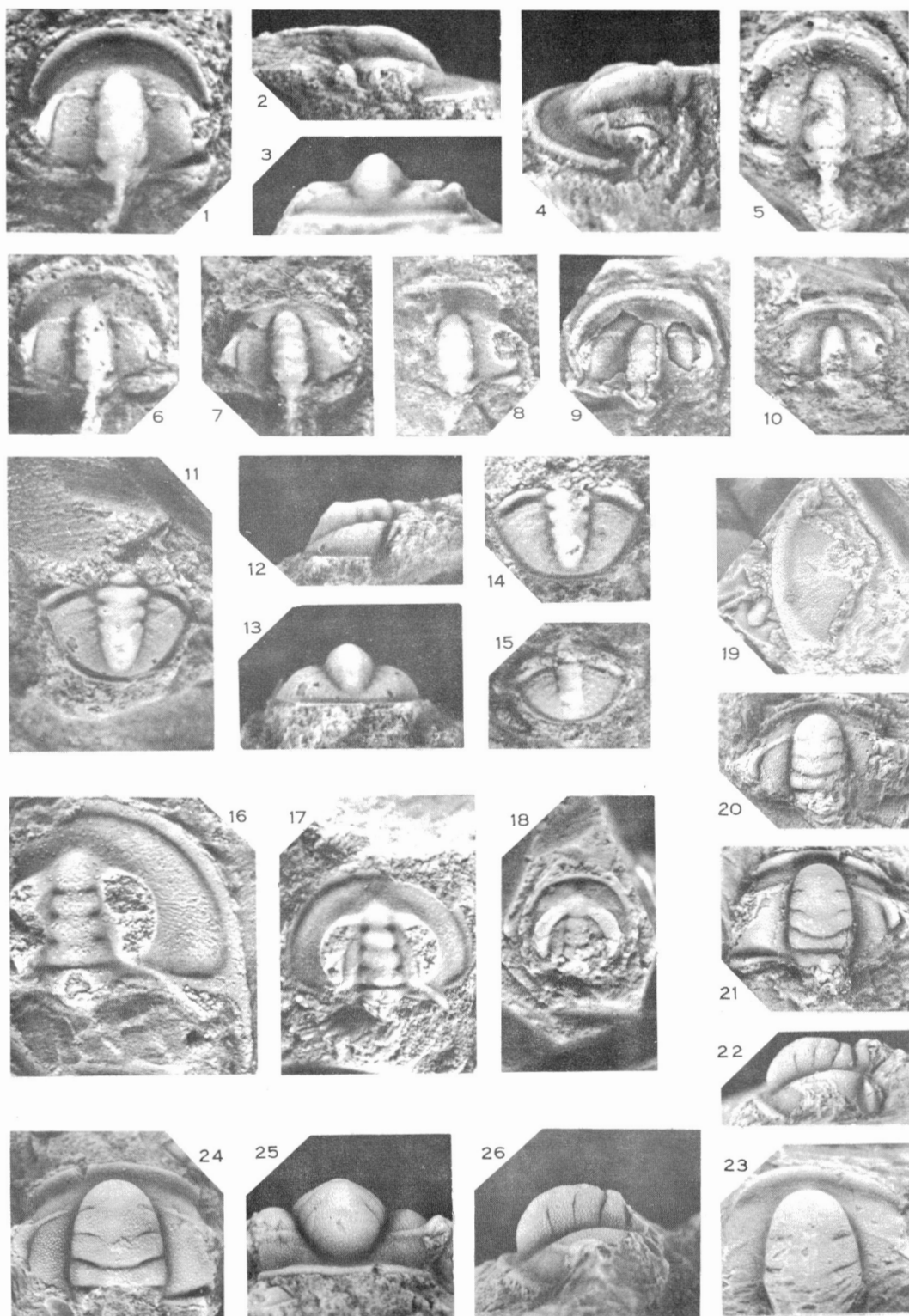


PLATE 4

Figures 1-15. *Pagetides latisulcus* sp. nov., x15.0, (p. 8)
GSC loc. 86150.

1-4. Holotype cranidium, plan, side,
front, and side oblique views, GSC No. 33176.

5. Paratype cranidium, GSC No. 33177.

6. Paratype cranidium, GSC No. 33178.

7. Paratype cranidium, GSC No. 33179.

8. Paratype cranidium, GSC No. 33180.

9. Paratype cranidium, GSC No. 33181.

10. Paratype cranidium, GSC No. 33182.

11-13. Paratype pygidium, plan, side, and
rear views, GSC No. 33183.

14. Paratype pygidium, GSC No. 33184.

15. Paratype pygidium, GSC No. 33185.

Figures 16-18. *Nevadia?* sp., x10.0, GSC loc. 86150. (p. 15)

16. Cephalon, GSC No. 33186.

17. Cephalon, GSC No. 33187.

18. Cephalon, GSC No. 33188.

Figures 19-26. *Labradoria hespera* sp. nov. (p. 17)

19. Paratype librigena, x6.0, GSC loc. 86151,
GSC No. 33189.

20. Paratype cranidium, x7.5, GSC loc. 86152,
GSC No. 33190.

21, 22. Holotype cranidium, plan and side views,
x7.5, GSC loc. 86152, GSC No. 33191.

23. Paratype cranidium, x7.0, GSC loc. 86151,
GSC No. 33192.

24-26. Paratype cranidium, plan, front, and side
views, x7.0, GSC loc. 86151, GSC No. 33193.

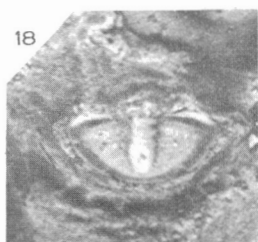
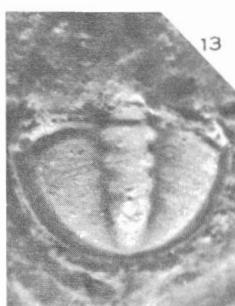
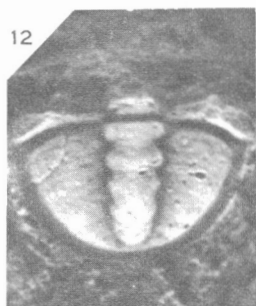
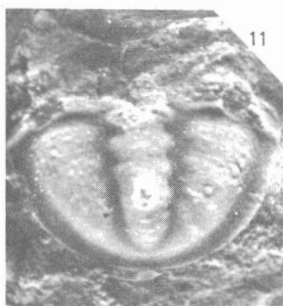
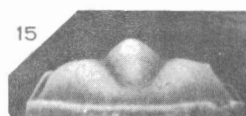
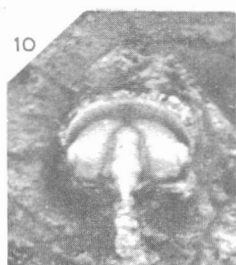
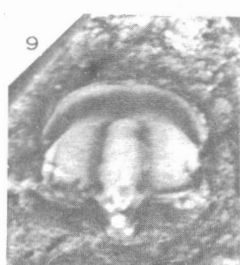
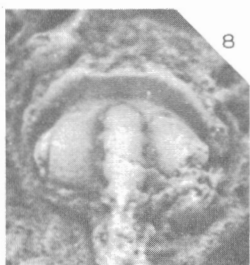
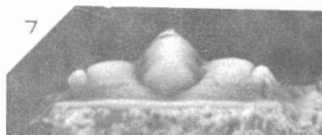
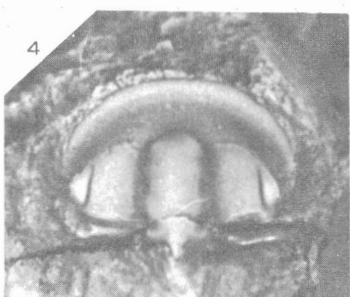
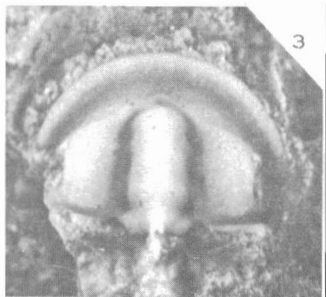
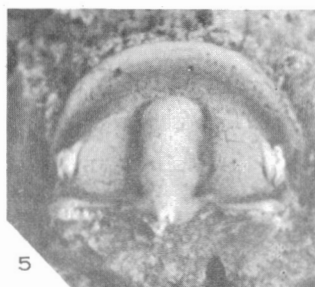
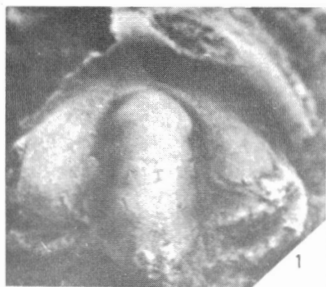


PLATE 5

Figures 1-19. *Pagetidides abyssistriatus* sp. nov.,
GSC loc. 86152.

(p. 7)

1. Paratype cranidium, x14.0, GSC No. 33194.
2. Paratype cranidium, x14.0, GSC No. 33195.
3. Paratype cranidium, x14.0, GSC No. 33196.
- 4, 6, 7. Holotype cranidium, plan, side, and front views, x15.5, GSC No. 33197.
5. Paratype cranidium, x14.0, GSC No. 33198.
8. Paratype cranidium, x15.5, GSC No. 33199.
9. Paratype cranidium, x15.5, GSC No. 33200.
10. Paratype cranidium, x15.5, GSC No. 33201.
11. Paratype pygidium, x15.5, GSC No. 33202.
12. Paratype pygidium, x15.5, GSC No. 33203.
- 13, 14, 15. Paratype pygidium, plan, side, and rear views, x15.5, GSC No. 33204.
16. Paratype pygidium, x15.5, GSC No. 33205.
17. Paratype pygidium, x15.5, GSC No. 33206.
18. Paratype pygidium, x15.5, GSC No. 33207.
19. Paratype pygidia, x15.5, oblique view, GSC No. 33208, and side view, GSC No. 33209.

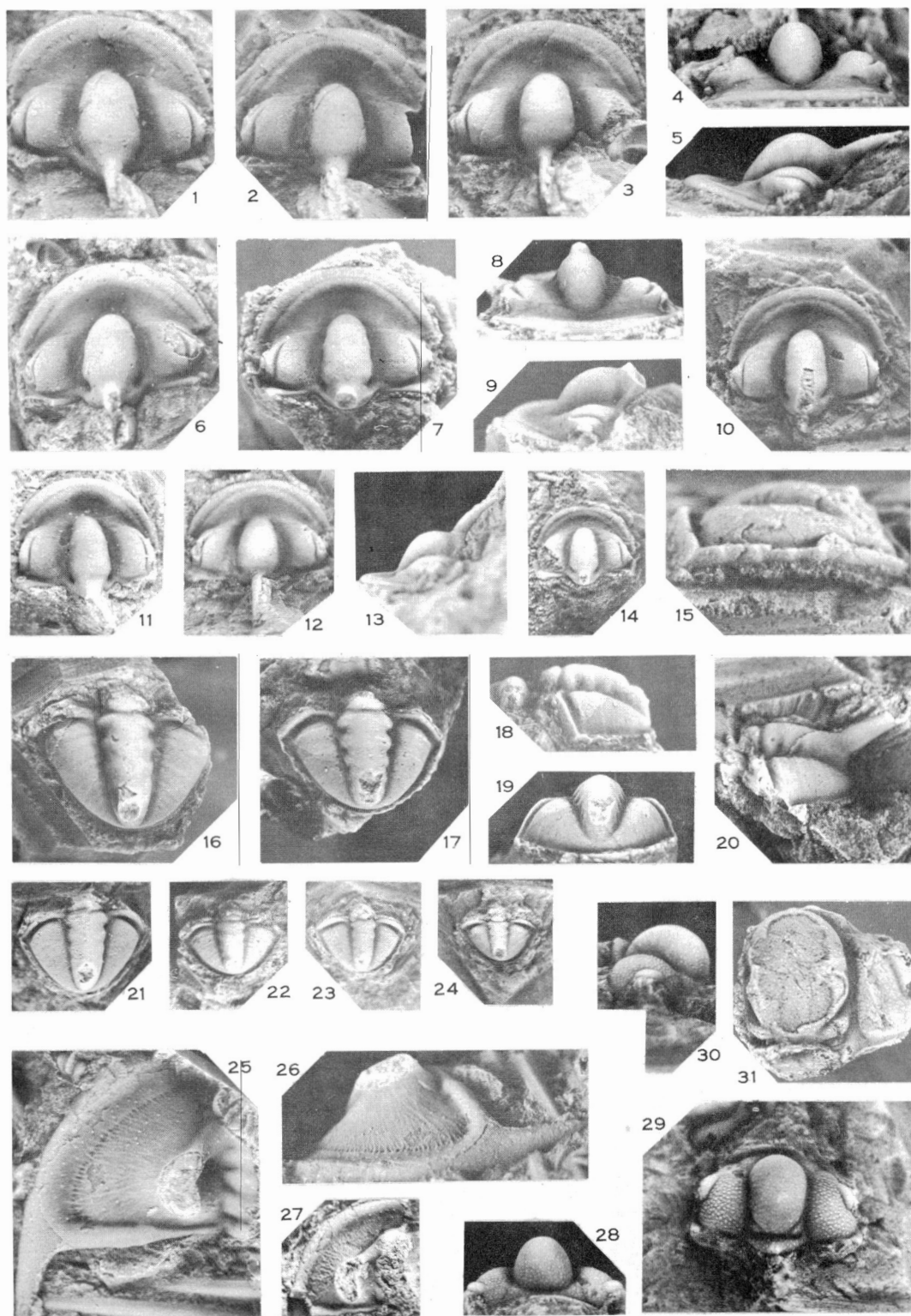


PLATE 6

Figures 1-24. *Ekvipagetia plicofimbria* gen. and sp. nov., (p. 10)
x7.8 (except Fig. 15, x12.8), GSC loc. 86152.

1. Paratype cranidium, GSC No. 33210.
2. Paratype cranidium, GSC No. 33211.
- 3, 4, 5. Paratype cranidium, plan, front, and side views, GSC No. 33212.
6. Paratype cranidium, GSC No. 33213.
- 7-9. Holotype cranidium, plan, front, and side views, GSC No. 33214.
10. Paratype cranidium, GSC No. 33215.
11. Paratype cranidium, GSC No. 33216.
- 12, 13. Paratype cranidium, plan and side views, GSC No. 33217.
14. Paratype cranidium, GSC No. 33218.
15. Paratype pygidium showing border spines, x12.8, GSC No. 33219.
16. Paratype pygidium, GSC No. 33220.
- 17-19. Paratype pygidium, plan, side, and rear views, GSC No. 33221.
20. Paratype pygidium in side view, GSC No. 33222.
21. Paratype pygidium, GSC No. 33223.
22. Paratype pygidium, GSC No. 33224.
23. Paratype pygidium, GSC No. 33225.
24. Paratype pygidium, GSC No. 33226.

Figures 25-27. *Bradyfallotaspis* sp. 3, GSC loc. 86152 (p. 11)

- 25, 26. Latex cast of partial cephalon, plan and side views, x5.2, GSC No. 33227.
27. Partial cephalon, x5.8, GSC No. 33228.

Figures 28-31. *Dinesus* sp. 1, GSC loc. 86152. (p. 20)

- 28-30. Cranidium, front, plan, and side views, x9.3, GSC No. 33229.
31. Cranidium, x4.9, GSC No. 33230.

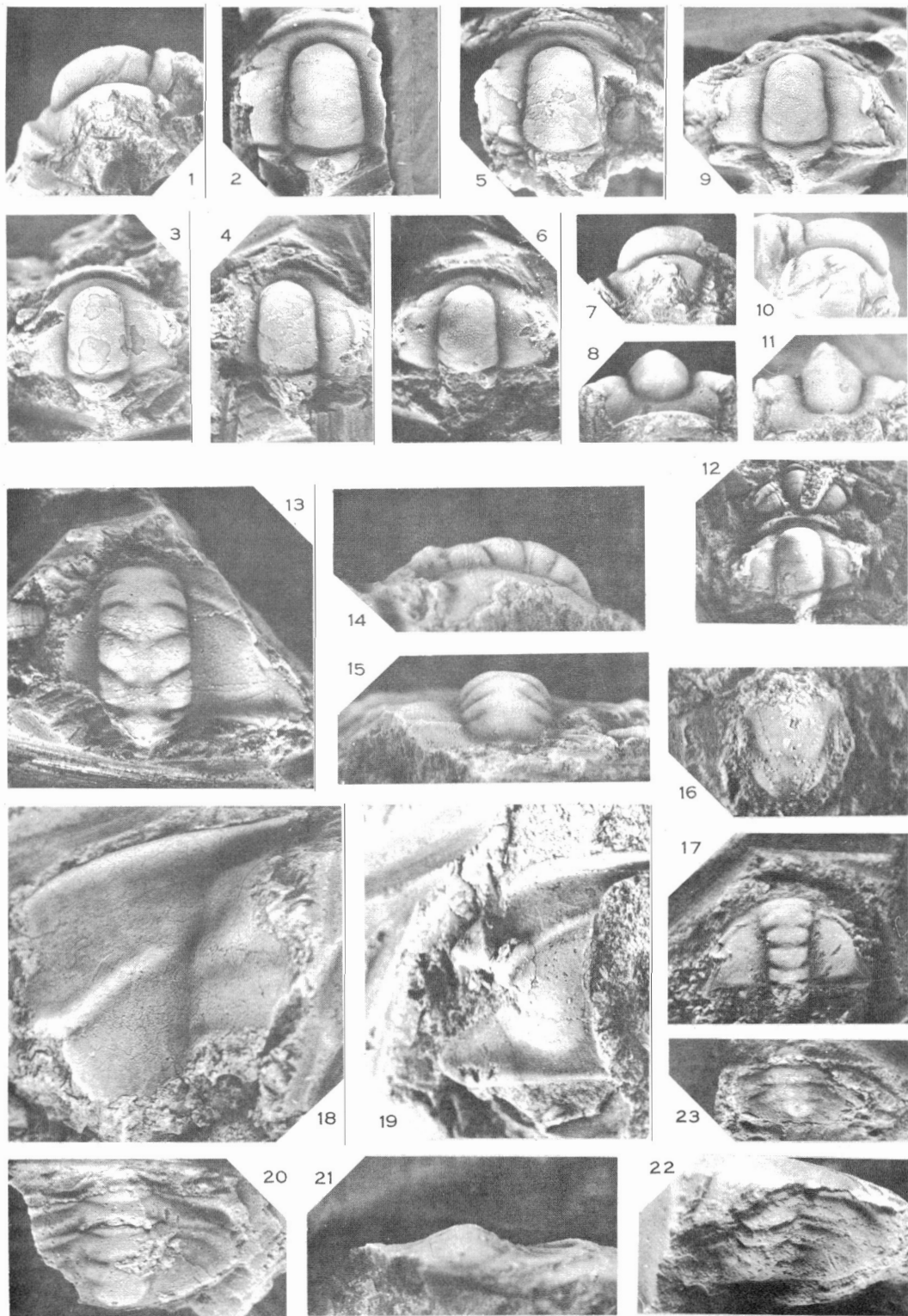


PLATE 7

- Figures 1-12. *Sekwiaspis canola* sp. nov., GSC loc. 86152. (p. 19)
- 1, 2. Paratype cranidium, side and plan views, x5.5, GSC No. 33231.
 3. Holotype cranidium, x7.0, GSC No. 33232.
 4. Paratype cranidium, x5.8, GSC No. 33233.
 5. Paratype cranidium, x6.3, GSC No. 33234.
 - 6-8. Paratype cranidium, plan, side, and front views, x5.8, GSC No. 33235.
 - 9-11. Paratype cranidium, plan, side, and front views, x5.8, GSC No. 33236.
 12. Paratype cranidium, x7.0, GSC No. 33237.
- Figures 13-23. aff. *Anadoxides* sp. 1, GSC loc. 86152, all surface exfoliated except those shown in Figs. 20 and 21. (p. 15)
- 13-15. Cranidium, plan, side, and front views, x7.1, GSC No. 33238.
 16. Hypostoma, x9.4, GSC No. 33239.
 17. Cranidium, x12.0, GSC No. 33240.
 18. Partial cranidium, x6.5, GSC No. 33241.
 19. Partial cranidium, x7.1, GSC No. 33242.
 - 20, 21. Pygidium, partially exfoliated, x7.1, GSC No. 33243.
 22. Latex cast of pygidium, x7.1, GSC No. 33244.
 23. Pygidium, x7.1, GSC No. 33245.

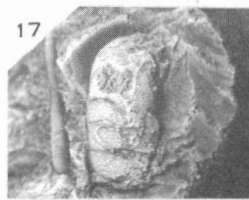
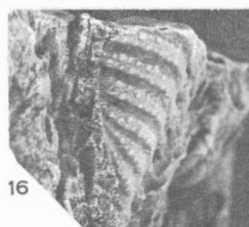
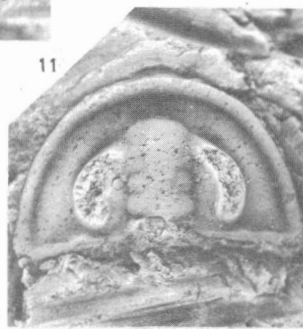
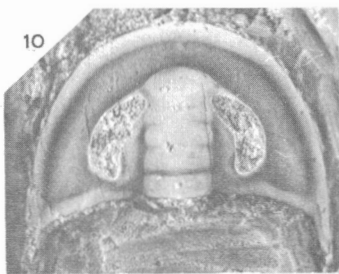
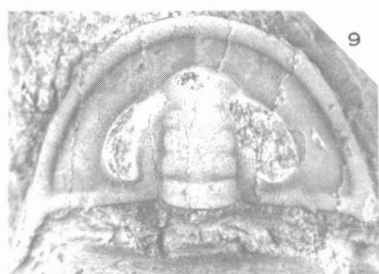
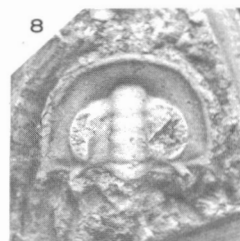
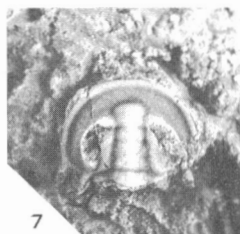
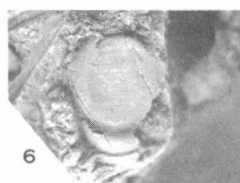
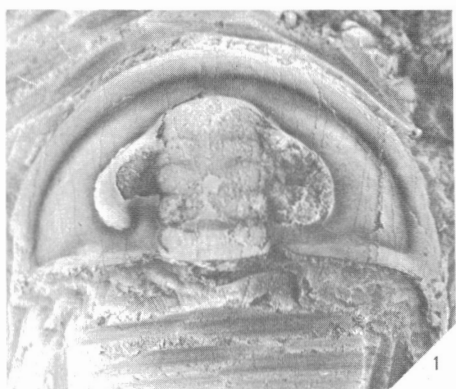


PLATE 8

Figures 1-11. *Judomia? absita* sp. nov., GSC loc. 86152. (p. 14)

1. Paratype cephalon transversely distorted, x4.8, GSC No. 33246.
2. Paratype cephalon longitudinally distorted, x4.8, GSC No. 33247.
- 3-5. Holotype cephalon, plan, front, and side views, x4.8, GSC No. 33248.
6. Paratype hypostoma, x4.2, GSC No. 33249.
7. Paratype cephalon, x8.5, GSC No. 33250.
8. Paratype cephalon, x8.5, GSC No. 33251.
9. Paratype cephalon, x6.8, GSC No. 33252.
10. Paratype cephalon, x6.8, GSC No. 33253.
11. Paratype cephalon, x6.8, GSC No. 33254.

Figures 12-17. *Edelsteinaspis?* sp. 1, GSC loc. 86152. (p. 18)

- 12-14. Partial cranidium, plan, front, and side views, x2.7, GSC No. 33255.
- 15, 16. Partial pygidium, side and plan views, x5.0, GSC No. 33256.
17. Partial cranidium, x4.0, GSC No. 33257.