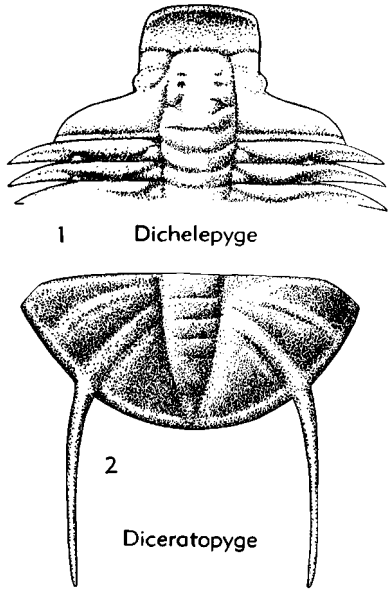


FIG. 272. Ceratopygidae (p. *O363*).

tapering axis of 5 rings and short terminal portion, and pleural fields divided into 3 indistinctly defined pleurae, apparently without spines (59). *L.Ord.(Tremadoc.)*, Arg.——FIG. 274. **P. infidus; a*, cran. (holotype) (reconstr.), ×6.6; *b*, pyg. (exfoliated), ×9.2 (59*).

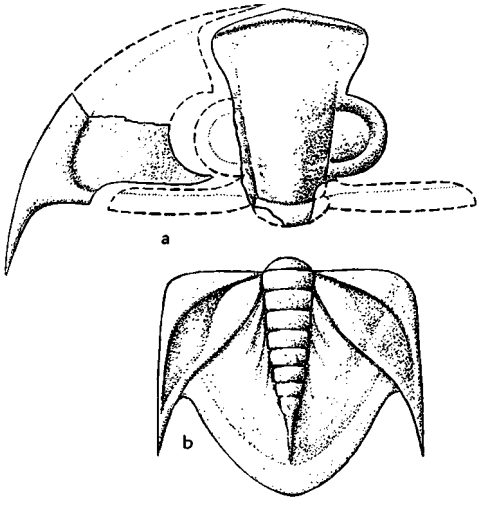


FIG. 273. **Onychopyge riojana* HARRINGTON (Ceratopygidae), L.Ord.(Tremadoc.), Arg.; *a*, cran., ×10; *b*, librigena, ×2; *c*, pyg. (reconstr.), ×1.8 (59*).

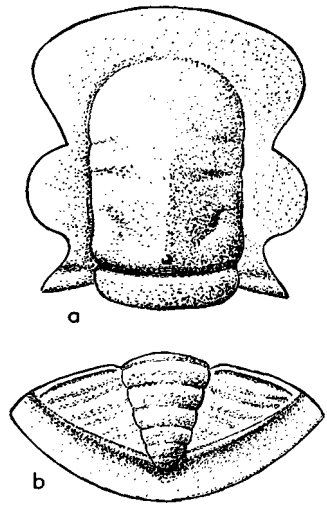


FIG. 274. **Pseudohysterolenus infidus* HARRINGTON & LEANZA (Ceratopygidae), L.Ord.(Tremadoc.), Arg.; *a*, cran. (reconstr.), ×6.6; *b*, pyg. (exfoliated), ×9.2 (59*).

Suborder ILLAENINA Jaanusson, nov.

[Type—*Illaenus* DALMAN, 1827]

Opisthoparian trilobites with large or moderately large rostral shield separated by sutures; one family includes, in current delimitation, some genera with anteriorly fused librigenae. Lateral glabellar furrows commonly faint or absent. Doublure broad. Thoracic segments 6 to 10. Pygidium about equal in size to cephalon or somewhat smaller. Tuberculae ornamentation rare. All typical forms lack eye ridges. *Ord.-M.Perm.*

Superfamily ILLAENACEA Hawle & Corda, 1847

[*nom. correct.* HARRINGTON & LEANZA, 1957 (*pro* Illaenicae WHITTINGTON, 1953, *nom. transl. ex* Illaenides HAWLE & CORDA, 1847)] [=Scutelloidae HUPÉ, 1953]

Exoskeleton of moderate size. Glabella expanding anteriorly, alae commonly well defined, at least on ventral face of cephalon. Thoracic segments 8 to 10; pleural furrows, if present, approximately parallel to margins of segments. *Ord.-Sil.*

Family STYGINIDAE Vogdes, 1890

Cephalon and pygidium moderately convex, subequal in size, outline semicircular, genal regions prolonged behind rest of cephalon as broad-based spines. Glabella

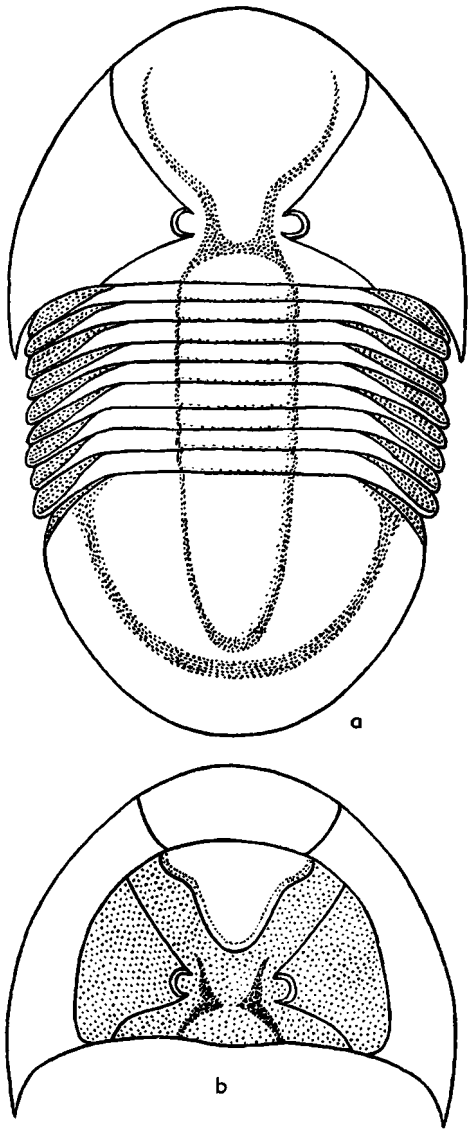


FIG. 275. **Stygina latifrons* (PORTLOCK) (Styginidae), M.Ord.-U.Ord., NW.Eu.; *a,b*, exoskel., dorsal (reconstr.), and ceph., ventral (reconstr.), ×2 (496n).

narrowest just in front of occipital ring, expanding forward, defined by faint to well-marked axial and preglabellar furrows; occipital furrow moderately deep; 4 lateral glabellar furrows may be present, posterior 2 converging to meet just inside axial furrows, anterior 2 short, ovate; preglabellar field short *(sag.)* or absent; genal regions divided into inner convex portion and outer flattened region, with distinct change of slope or faint furrow between them; narrow posterior border may be developed; eye lobes situated close to posterior margins of inner part of genal regions, at varying distance from axial furrows; faint eye ridges may run inward-forward. Sutures opisthoparian, anterior sections divergent, joined along anterior margin by rostral suture. Doublure broad, rostral plate isolated by backwardly convergent connective sutures. Hypostoma shield-shaped, with undivided convex middle body, lateral and posterior borders flattened. Thorax of 7 to 9 segments; fulcrum of pleurae at 0.5 to 0.7 of width from axial furrows, outer parts bent down and faceted. Pygidium with well-defined axis, continued rearward by more or less well-defined postaxial ridge; pleural fields with well-marked facet and shallow furrow behind it. Broad doublure reaching in to tip of axis, border not defined by furrow, but may be gently concave. Surface smooth or with terrace lines, latter characteristic of doublure (278, 350). *L.Ord.-U.Ord.*

Stygina SALTER, 1853 [**Asaphus latifrons* PORTLOCK, 1843; SD VOGDES, 1890]. Four glabellar furrows in some species; no preglabellar furrow; anterior pit situated in axial furrows at distance from anterior margin slightly greater than width of doublure; eye lobes small, elevated, close to rear part of glabella; posterior border faint or absent, genal spines short. Rostral plate subtrapezoid; hypostoma nearly triangular in outline. Thorax with 9 segments; no pleural furrows. Pygidium with axial ring faint or absent, no pleural furrows, broad concave border. *M.Ord.-U.Ord.*, Ire.-Scot.-Wales-Swed.-Norway-Est.——FIG. 275. **S. latifrons* (PORTLOCK); *a,b*, exoskel., dorsal (reconstr.), ceph., ventral (reconstr.), ×2 (496n).

Bronteopsis NICHOLSON & ETHERIDGE, 1879 [**Ogygia? concentrica* LINNARSSON, 1869 (=*B. scotica* NICHOLSON & ETHERIDGE, 1879)] [*Homoglossa* RAYMOND, 1912]. Four pairs glabellar furrows visible; preglabellar field absent; genal spines broader *(tr.)* at base and longer than those of *Stygina*. Thorax with 8 segments; pleurae with shallow pleural furrows extending beyond fulcrum, low ridge immediately posterior to furrow, narrow anterior and posterior bands. Pygidium with 7 or 8 axial rings, tip of axis unfurrowed; pleural fields with broad, gently concave border, 7 pairs of shallow pleural furrows separated by low broad ridges, directed progressively more strongly backward. Dorsal external surface with terrace lines. *M.Ord.*, Scot.-Norway-Swed.-Est.

——FIG. 276. **B. concentrica* (LINNARSSON), Swed.; *a,b,* ceph., dorsal, ventral; *c,* pyg.; all ×1.5 (360*, 496n).

Protostygina PRANTL & PŘIBYL, 1948 [**Illaenus bohemicus* BARRANDE, 1872]. Like *Stygina* but posterior part of glabella parallel-sided, anterior part only slightly expanded; eye lobes farther out; genal spines broad *(tr.)* and long. Pygidium shorter *(sag.)*. *M.Ord.,* Boh.

Raymondaspis PŘIBYL, 1948 [*pro Holometopus* ANGELIN, 1854 (*non* MILNE EDWARDS, 1853)] [**Holometopus limbatus* ANGELIN, 1854; SD MILLER, 1889] [=*Warburgella* RAYMOND, 1937 (*non* REED, 1931)]. Like *Stygina* but posterior part of glabella subparallel-sided and anterior lobe more convex and separated by sharp change in slope from narrow *(sag., exsag.)* preglabellar field; eye lobes larger; genal spines broader *(tr.)* at base, short. Thorax with 7 segments *(R. tennesseensis)*.

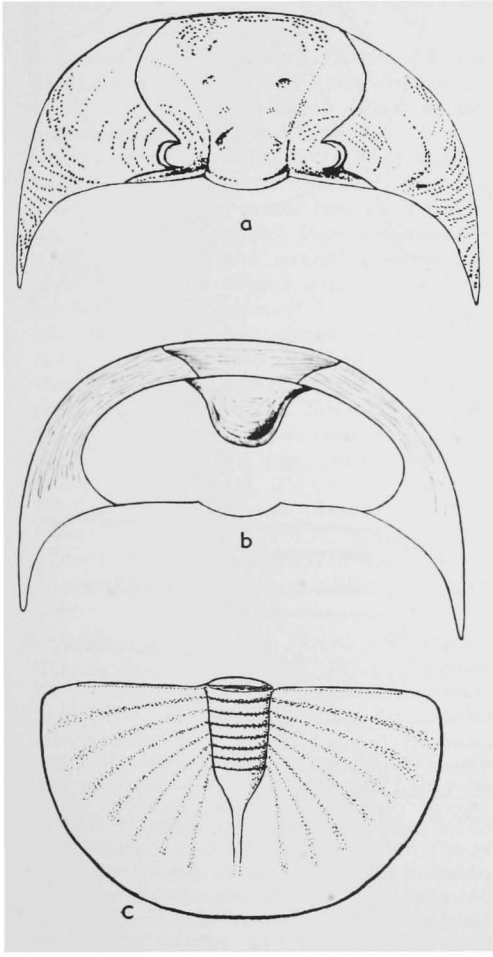


FIG. 276. **Bronteopsis concentrica* (LINNARSSON) (Styginidae), M.Ord., NW.Eu.; *a,b,* ceph., dorsal, ventral, ×1.5 (350,* 496n).

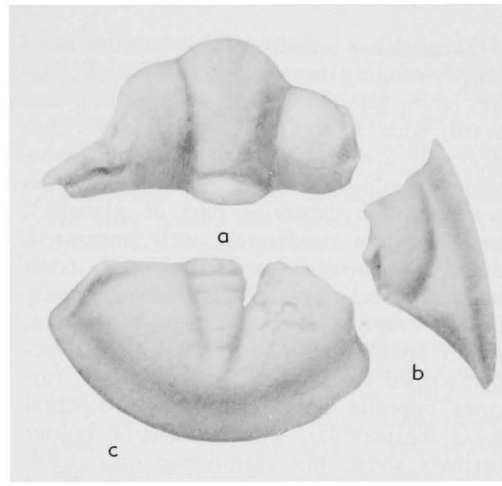


FIG. 277. **Raymondaspis limbata* (ANGELIN) (Styginidae), M.Ord., Norway; *a,c,* cran., pyg., ×3; *b,* librigena, ×4 (278).

Pygidium with axis narrower posteriorly, well-marked postaxial ridge, no border or narrow, faintly concave border. Dorsal external surface with terrace lines (26). *L.Ord.-M.Ord.,* Norway-Swed.-Scot.-E.N.Am.——FIG. 277. **R. limbatus* (ANGELIN), L.Ord., Norway; *a,c,* cran., pyg., ×4; *b,* librigena, ×5 (278*).

Family THYSANOPELTIDAE Hawle & Corda, 1847

[*nom. correct.* MOORE, herein (*pro* Thysanopeltides HAWLE & CORDA, 1847)] [=Bronteidae HAWLE & CORDA, 1847 (*nom. correct.* ANGELIN, 1854, *pro* Bronteides HAWLE & CORDA, 1847); Goldiidae RAYMOND, 1913; Scutellidae RICHTER & RICHTER, 1925 (*non* GRAY, 1825); Eobronteidae SINCLAIR, 1949; Scutelluidae RICHTER & RICHTER, 1955] [Acceptable designation of this family assemblage offers vexatious problems that arise mainly from homonymy and synonymy of names applied to one of the genera elected as type of the family, as well as homonymy and synonymy of published family-group names themselves. HAWLE & CORDA first used Bronteides and Thysanopeltides as family-group names based on genera now recognized as belonging together in this family assemblage. Bronteides was based on *Bronteus* GOLDFUSS, 1843 (=*Brontes* GOLDFUSS, 1839, *non* FABRICIUS, 1801) (=*Scutellum* PUSCH, 1833; *Goldius* DEKONINCK, 1841); Thysanopeltides was based on *Thysanopeltis* HAWLE & CORDA, 1847. ANGELIN'S Bronteidae (1854), whether construed merely as a correction in form of HAWLE & CORDA'S Bronteides, or as a new family-group name introduced by ANGELIN, has priority over other names based on the same genus (Goldiidae, Scutellidae, Scutelluidae) and according to the Copenhagen Decisions, 1953, par. 54(1)(a) is valid even though almost universally discarded in paleontological literature during many decades. Surely it is very undesirable to revive Bronteidae, especially in view of widespread opposition to the Copenhagen Decision providing for retention of family-group names based on junior synonyms; appeal is made for rescission of this rule at the 1958 Zoological Congress in London. Such rescission would make Scutellidae RICHTER & RICHTER, 1925, eligible for acceptance, if this name were not itself a homonym of Scutellidae GRAY, 1825 (based on *Scutella* LAMARCK, 1816, an echinoid). The proposal of RICHTER & RICHTER (1955) to substitute the arbitrarily modified spelling of Scutelluidae, under proposed appeal to ICZN for exercise of Plenary Powers, is far less acceptable as a solution than recognition of Thysanopeltidae HAWLE & CORDA, 1847, which is entirely eligible, and, moreover, is an unclouded family-group name having priority equal to that of Bronteidae HAWLE & CORDA, 1847. Records published in the *Bulletin of Zoological Nomenclature* do not reveal that the RICHTERS' intended application has been filed, and in any case, approval of it is opposed.—Ed.]

Exoskeleton broadly oval in outline, with length ranging from 1.5 to 25 cm. Cephalon large; glabella very large, widening forward, with 3 pairs of lateral furrows that generally are dissimilar (*1p* furrows transverse or curved forward so that *1p* lobes coalesce with posterior part of glabella), axial furrows moderately well impressed, diverging forward and backward from base of glabella; occipital furrow generally broad *(sag.)*, occipital ring prominent, rather broad; fixigenae commonly with circumscribed small areas adjoining axial furrows opposite position of eyes, palpebral lobes semicircular, small; posterior border furrows short, not continuing onto librigenae; posterior borders very narrow; facial sutures curving strongly around eye lobes, with anterior sections crossing front margin so as to run closely parallel to it on underside to point of junction with rostral suture; librigenae very large, triangular, bearing sharp genal angles or spines; eyes small, near posterior margin of cephalon, with ring-shaped holochroal visual areas containing 1,000 to 4,000 lenses. Connective sutures long, converging backward; rostral plate conspicuous, crescentic; hypostoma subrectangular, with well-developed wings, convex central body and crescentic posterior body that bears pronounced maculae, posterior margin rounded or pointed. Thorax with 10 segments of approximately uniform width; pleurae ridged, without furrows (rarely with furrows very indistinctly marked), with narrow anterior and posterior flanges (Fig. 278,*3a-c*) but no facets, ends of pleurae pointed. Pygidium very large, longer than cephalon and commonly equal to 0.5 of length of body, semicircular to semielliptical in outline (except *Koliha-peltis*); axis very short *(sag.)*, subtriangular, with no axial rings (or at most only faint indication of segments), commonly trilobate owing to presence of 2 longitudinal furrows; articulating half-rings and furrows pronounced, but no articulating half-ribs or facets; pleural fields with 6, 7, or 8 radiating lateral ribs that represent simple pleurae (Fig. 278,*2*) and long, simple or bifurcate median rib; pygidial doublure expanded. Surface with irregular terrace lines, punctate or tuberculate. [Extreme width of doublure, extending 0.7 of length of pygidium, generally is associated with thin-shelled flat pygidia bearing strong ribs (*paliferum* type, Fig. 279,*1d,e*), whereas moderate width of doublure (0.3 to 0.5 of length of pygidium) commonly occurs in thick-shelled highly vaulted pygidia with faint ribs (*campani-*

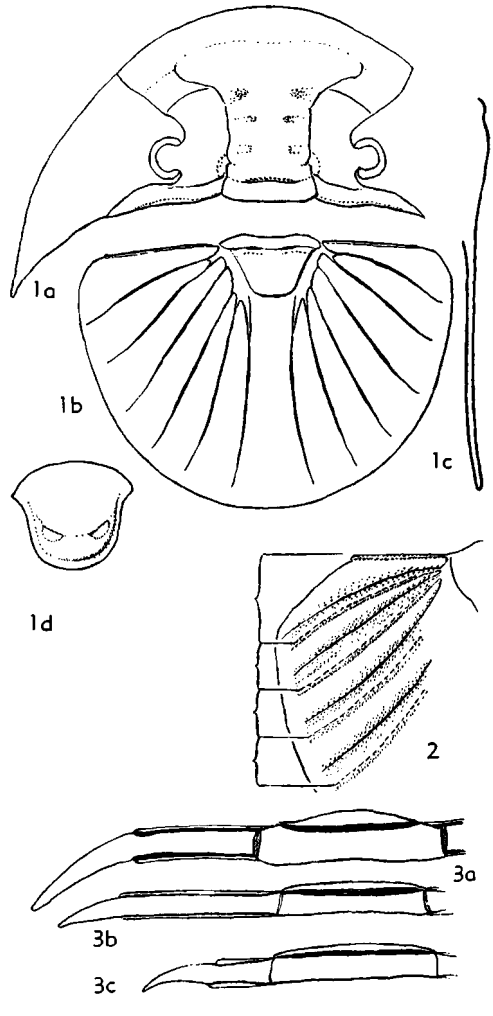


FIG. 278. Thysanopeltidae.——*1a-d, *Eobronteus laticauda* (WAHLENBERG), U.Ord., Swed.——*2,* Left anterior part of thysanopeltid pygidium with anterior flange, instead of articulating half-rib and facet (1-4, outermost 4 pleurae, interpleural sutures presumed to lie along narrow furrow between posterior side of main ribs and adjacent small intercostal ribs), diagrammatic (461n).——*3a-c,* Ridged thoracic pleurae bearing anterior and posterior flanges; *3a, Scutellum (Scutellum) flabelliferum* (GOLDFUSS), M.Dev., Ger.; *3b, *E. laticauda; 3c, *S. (Planiscutellum) planum* (HAWLE & CORDA), Sil., Czech.; all ×10 (461n).

ferum type, Fig. 279,*3*, 280,*3c,d*); statistically determined combinations of characters have taxonomic significance.] *M.Ord.-Low. U.Dev.*

Scutellum PUSCH, 1833 [**S. costatum*] [=*Brontes* GOLDFUSS, 1839; *Goldius* DEKONINCK, 1841; *Bronteus* GOLDFUSS, 1843]. Glabella gradually expanding forward; occipital furrow commonly with tumor-like swelling at each end; anterior areas of fixigenae narrowing forward; posterior sections of facial sutures parallel and close to posterior margin, reaching it by abrupt inward bending (except *Planiscutellum*), anterior sections of sutures approaching axial furrows forward; oblique eye ridges commonly present. Thoracic axis narrower than pleurae (except *Paralejurus*). Pygidium with 7 lateral ribs, median rib simple or bifurcate. Surface may bear tubercles on glabella, occipital ring, palpebral lobes, and axis of thorax and pygidium. *Sil.-U.Dev.*, cosmop.

S. (Scutellum) [=*Dicranactis* HAWLE & CORDA, 1847]. Cephalon flat or only moderately convex; frontal area narrow or absent; lateral furrows differentiated (*1p* curving forward to join *2p* furrows in manner reducing *2p* lobes to small tubercles, *3p* furrows not distinctly limited adaxially, supplementary groove between *2p* and *3p* furrows commonly present). Pygidium rather flat, commonly with central elevated platform surrounded by flat or concave zone; ribs well developed; doublure extremely broad. Shell thin. *Sil.-U.Dev.(Adorfian-1)*, cosmop.——FIG. 279, *1a,b*. **S. (S.) costatum*, M.Dev.(Givet.), Ger. (Iserlohn); *1a,b*, exoskel. (reconstr.), rostral plate, ×1 (257).——FIG. 279,*1c-f*. *S. (S.) paliferum* (BEYRICH), L.Dev.(Koněprusy Ls.), Czech.; *1c*, ceph.; *1d,e*, pyg., dorsal, profile; *1f*, hypostoma; all ×1 (3, 257).——FIGS. 278,*3a*; 279,*1g*. *S. (S.) flabelliferum* (GOLDFUSS), M.Dev. (Couvin.), Ger.(Eifel); 278,*3a*, ridged thoracic pleura with anterior and posterior flanges, ×1.5; 279,*1g*, exoskel. (reconstr.), profile, ×1 (243, 257).

S. (Kolihapeltis) PRANTL & PŘIBYL, 1947 (**Bronteus parabolinus* BARRANDE, 1882]. Pygidium narrow, tongue-shaped or lanceolate, maximum width about 0.5 of length, rather flat; anterior margin short *(tr.)*, mostly occupied by broad axis, with angular anterolateral wings; lateral ribs diverging very slightly, nearly parallel to median rib, outermost ribs angulated, following anterior margin and coalescing with axis so as to cut off ribs 2 and 3 (counting inward). Cephalon and thorax poorly known. *L.Dev.-M. Dev.*, C.Eu.——FIG. 280,*4*. *S. (K.) parabolinum* (BARRANDE), M.Dev.(g alpha), Czech.(Malá Chuchle); pyg., ×1.5 (159, 177, 257).

S. (Paralejurus) HAWLE & CORDA, 1847 [**Bronteus campanifer* BEYRICH, 1845; SD RUD. RICHTER, 1923] [=*Holomeris* HAWLE & CORDA, 1847; *Paralejulus* PRANTL & PŘIBYL, 1947]. Exoskeleton vaulted. Lateral glabellar furrows and lobes absent or faint; librigenae smaller than in *S. (Scutellum)*, with sharp but not pointed genal angles; occipital furrow and ring very broad *(tr.)*. Rostral plate large, very convex. Thoracic axis much broader than pleurae. Pygidium bell-shaped; axis mostly indistinct, without trilobation or observable segmentation; ribs broad, flat, only outermost pair strikingly convex and separated by broad furrow, other intercostal furrows merely thin lines that are proximally indistinct. Doublure moderately broad. Shell thick. *L.Dev.-M.Dev.*, Eu.-N.Afr.——FIG. 280,*3*. **S. (P.) campanifer* (BEYRICH), L.Dev.(Koněprusy Ls.), Czech.; *3a,b*, ceph., dorsal, profile; *3c,d*, pyg., dorsal, long. sec.; *3e*, rostral plate (*RS*, rostral suture; *CS*, connective suture) all ×0.7 (3, 257).——FIGS. 278,*3c*, 279,*3*. *S. (P.) brongniarti* (BARRANDE), M.Dev., Czech.; 278,*3c*, ridged thoracic pleurae with anterior and posterior flanges, ×2.5; 279,*3*, exoskel. (reconstr.), profile, ×1 (243, 257).

S. (Planiscutellum) RICHTER & RICHTER, 1956 [**Bronteus planus* HAWLE & CORDA, 1847]. Cephalon very flat; frontal area broad; lateral furrows primitive (*1p* directed slightly forward, *2p* and *3p* transverse, all isolated), glabellar lobes not limited adaxially, no supplementary grooves; eyes not so far backward as in other subgenera; posterior sections of facial sutures oblique. Pygidium very flat; median rib simple, broadening strongly backward; lateral ribs broad, flat, intercostal furrows narrow. Doublure broad. Shell thin. *Sil.*, Eu.-N.Am.——FIG. 279,*2*. **S. (P.) planum* (HAWLE & CORDA), Czech. (Sedlec); *2a-c*, ceph., pyg., hypostoma, ×1.5 (3, 257).

S. (Scabriscutellum) RICHTER & RICHTER, 1956 [**Bronteus scaber* GOLDFUSS, 1843]. Exoskeleton resembling that of *S. (Thysanopeltis)* but pygidium without marginal spines. *L.Dev.-M.Dev.*, N.Hemis.——FIG. 280,*2*. **S. (S.) scabrum* (GOLDFUSS), M.Dev.(Couvin.), Ger.(Eifel); *2a,b*, ceph., pyg., ×2 (257).

S. (Thysanopeltis) HAWLE & CORDA, 1847 [**Thysanopeltis speciosa*]. Glabella small at base, with lateral furrows *1p-3p* connected by longitudinal furrow, lateral *3p* lobe being distinctly circumscribed and extended exsagittally, *2p* lobe a minute tubercle, no supplementary grooves. Thoracic axis very much narrower than pleurae. Axis of pygidium trilobate; lateral ribs appear as narrow prominent ridges, median rib scarcely broader than others, mostly bifurcate distally; intercostal furrows broad, with flat or evenly convex bottom (so-called intercostal ribs); margin with spines. *L.Dev.-M.Dev.*, N.Hemis.——FIG. 280,*1*. **S. (T.) speciosum* (HAWLE &

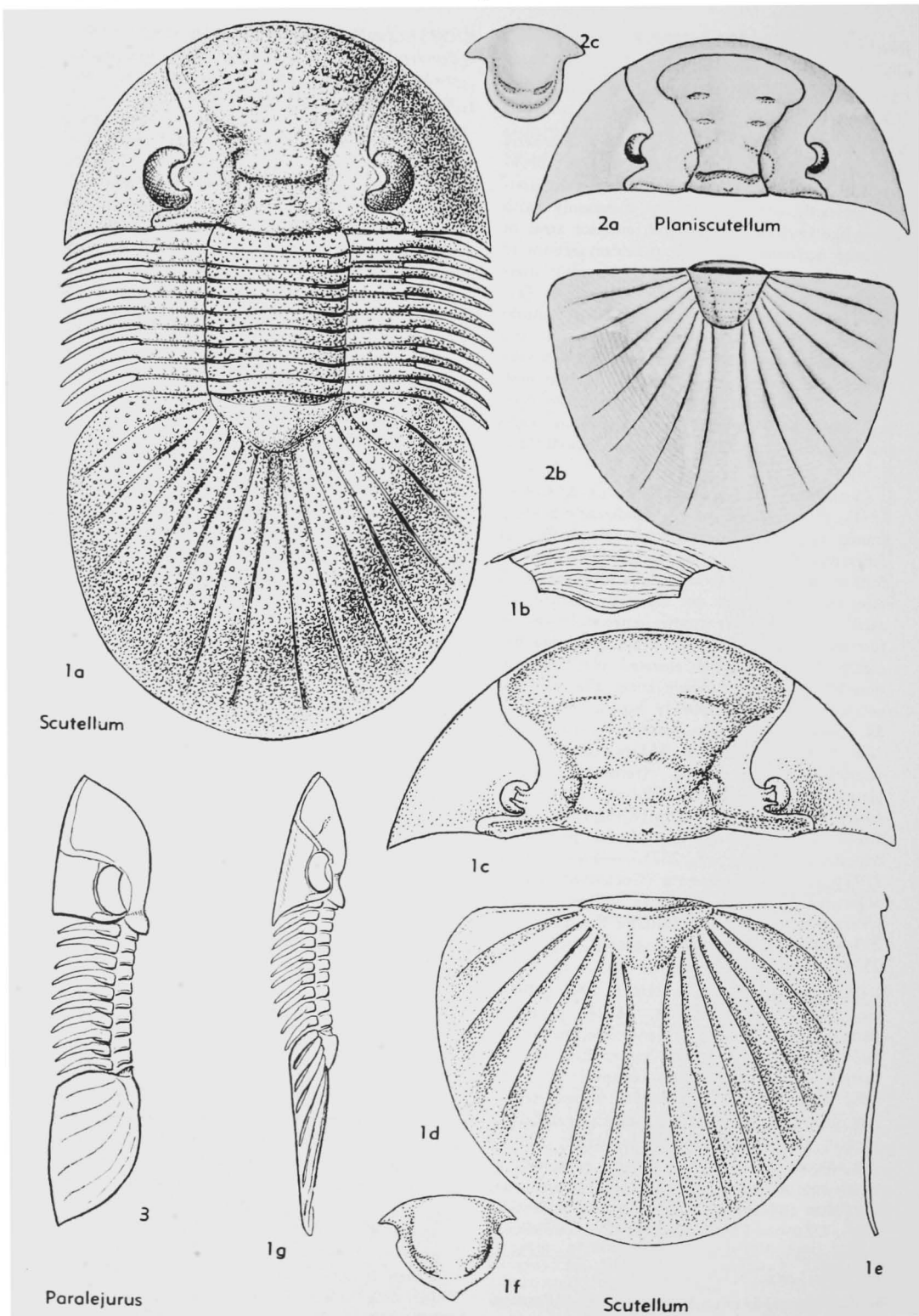


FIG. 279. Thysanopeltidae (p. O369).

CORDA), M.Dev.(Couvin.), Ger.(Wildungen); exoskel. (reconstr.), ×1 (257).

Eobronteus REED, 1928 [**Entomostracites laticauda* WAHLENBERG, 1821]. Glabella mushroom-like, anterior portion (consisting only of frontal lobe) short, abruptly expanded, posterior portion very long, parallel-sided, with 3 pairs of little-differentiated lateral furrows, directed transversely, isolated from one another and deepening inward, *3p* furrow at base of anterior expansion of glabella;

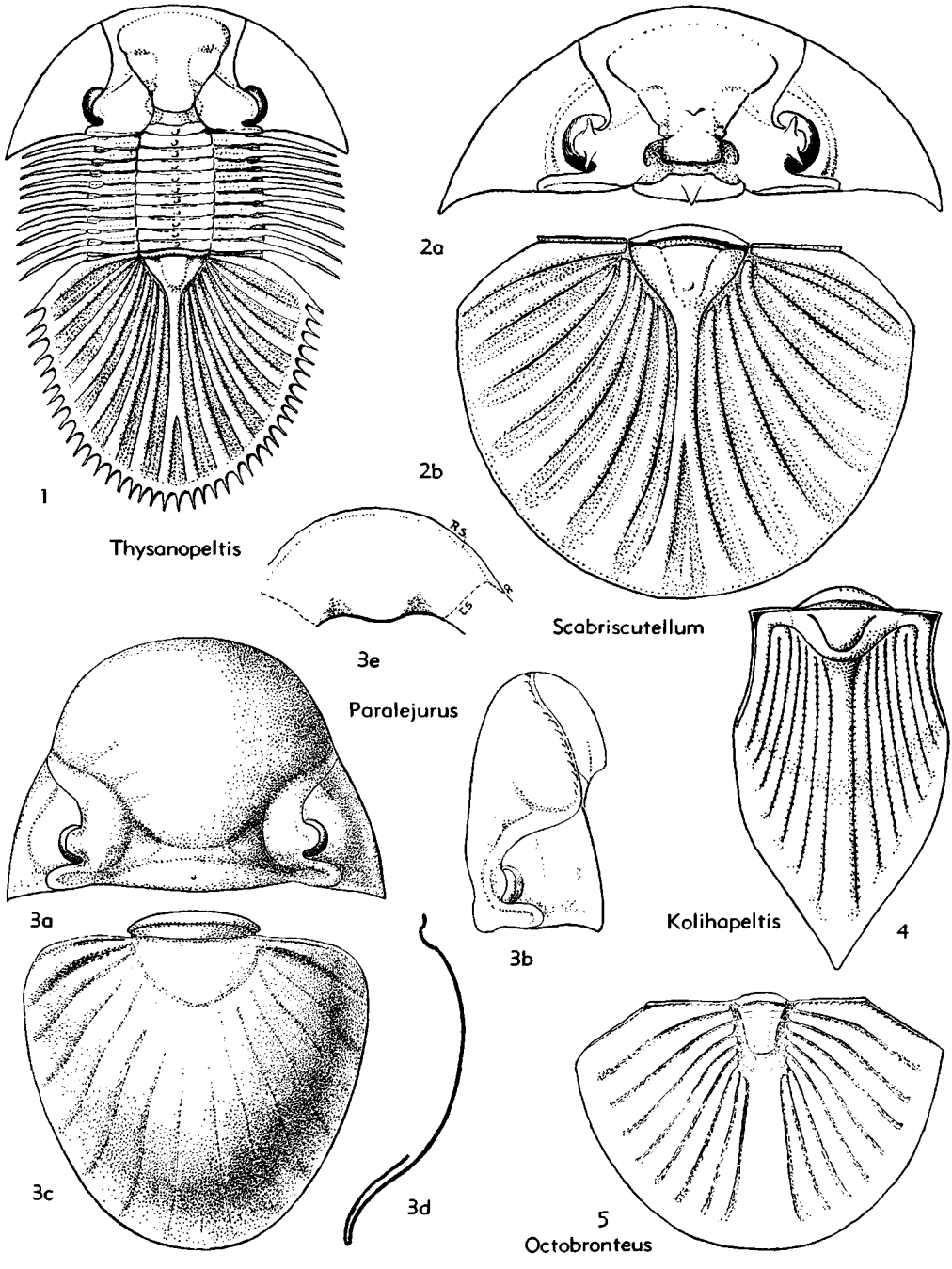


FIG. 280. Thysanopeltidae (p. O369, O372).

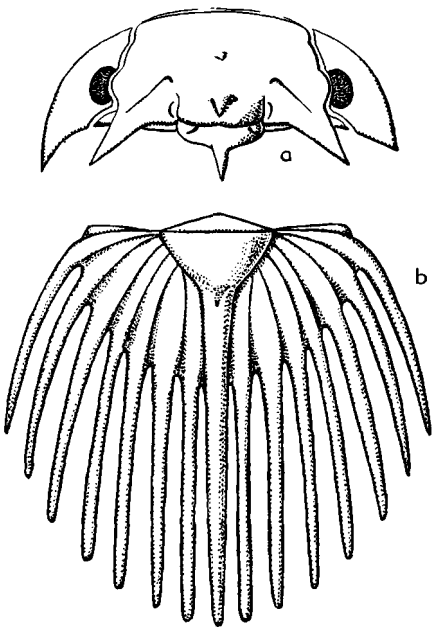


FIG. 281. **Weberopeltis aculeata* (WEBER) (Thysanopeltidae), U.Sil., USSR; *a,b,* ceph., pyg., ×0.7, ×1.3 (490, 1945).

fixigenae of considerable and equal breadth, divided by furrows that start from lateral *3p* furrows curving backward; anterior sections of facial sutures parallel to axial furrows, therefore diverging strongly forward. Pygidium slightly elongate semicircular; with 6 broad flattened lateral ribs, median rib much broader than others, only faintly bifurcated or not at all; intercostal furrows linear (350). *U.Sil.-M.Ord.*, Eu.-N.Am. FIG. 278,*1,3b*. **E. laticauda* (WAHLENBERG), U. Ord.(Leptaena Ls.), Swed.; *1a,* cran. with librigena, ×1; *1b,* pyg., ×1.4; *1c,* section of tall pygidium, ×0.75; *1d,* hypostoma, ×0.75; *3b,* ridged thoracic pleurae with anterior and posterior flanges, ×1.3 (257).

Weberopeltis MAKSIMOVA, 1957 [**Bronteus aculeatus* WEBER, 1945]. Cephalon short and wide, glabella narrow, posteriorly rectangular; fixigenae broad, produced backward into stout spines. Pygidium with broad ribs between narrow furrows; marginal spines strongly developed as prolongations of ribs; middle rib divided distally in some. *Sil.-M.Dev.*, Eu.——FIG. 281. **W. aculeata* (WEBER), U.Sil., USSR(N.Urals); *a,* ceph., ×1; *b,* pyg., ×1.7 (490).

Octobronteus WEBER, 1945 [**O. khodalevitchi*] [=*Stoermeria* PRANTL & PŘIBYL, 1946; *Stoermeraspis* PRANTL & PŘIBYL, 1947]. Supposed cephalon rather similar to that of *Eobronteus*. Thorax unknown. Pygidium semicircular, with broad concave limb; 8 slightly raised lateral ribs; median rib much broader than laterals, not bifurcate; intercostal furrows scarcely 0.5 of width of ribs. *Ord.-Sil.*, C.Eu.-USSR(Urals)-N.Am.—— FIG. 280,*5*. *O. franconicus* (GÜMBEL), Sil., Ger.; pyg., ×3 (257).

Family ILLAENIDAE Hawle & Corda, 1847

[*nom. correct.* ANGELIN, 1854 (*ex* Illaenides HAWLE & CORDA, 1847)]

Axial region of cephalon smooth, merging forward into frontal area without boundary; instead of glabellar and occipital furrows, 4 pairs of muscle scars can be observed in well-preserved specimens; facial sutures opisthoparian. Rostral shield broad *(tr.);* posterior margin of hypostoma rounded. Thorax with 8 to 10 segments; pleurae without pleural furrows or exceptionally with faint transverse furrows. Axis and pleural fields of pygidium smooth or with very faint traces of unfurrowed ribs. Surface ornamented with terrace lines or small pits, or both, no tuberculate or granulose ornamentation. *L.Ord.(Arenig.)-Sil. (Ludlov.).*

Subfamily ILLAENINAE Hawle & Corda, 1847

[*nom. transl.* GÜRICH, 1908 (*ex* Illaenides HAWLE & CORDA, 1847)]

Eyes well developed; glabella club-shaped or ovoid where indicated, commonly expanding in front of eyes and narrowing close to anterior cephalic margin. Rostral shield with more or less convex posterior margin in ventral view and rostral flange. Thorax with 8 to 10 segments, axial furrows generally well defined. *L.Ord. (Arenig.)-Sil.(Wenlock.).*

Illaenus DALMAN, 1827 [**Entomostracites crassicauda* WAHLENBERG, "1818" (=1821); SD MILLER, 1889] [*non Cryptonymus* EICHWALD, 1825 (suppressed, ICZN opinion 508)] [=*Deucalion* STSCHEGLOFF, 1827; *Actinolobus, Actinobolus* EICHWALD, 1860 (*non* MÖRCH, 1853); *?Svobodapeltis* SNAJDR, 1957]. Thorax with 10 segments. Eyes of moderate size. Rostral flange long, hourglass-shaped. Anterior wings of hypostoma broad *(tr.),* quadrangular. Pygidium about as large as cephalon or slightly smaller; axis short, narrowing toward rear. *Ord.(Arenig.-Llanvirn.-Ashgill.),* cosmop.——FIG. 282,*1a-c*. **I. crassicauda* (WAHLENBERG); *1a,b,* ceph., dorsal, ventral, ×1.5; *1c,* pyg., ×1.5 (414).——FIG. 282,*1d*. *I. sarsi* JAANUSSON; hypostoma, ×2 (414).

Cekovia SNAJDR, 1956 [**Illaenus transfuga* BARRANDE, 1852]. Like *Illaenus* but with smaller eyes. Poorly known; rostral shield and hypostoma unknown. *M.Ord.-U.Ord.* Boh.-Eng.

Nanillaenus JAANUSSON, 1954 [**Illaenus conradi* BILLINGS, 1859]. Thorax with 8 segments. Pygidium considerably smaller than cephalon, axis well defined, longer than postaxial field. Eyes of moderate size; posterior parts of cephalic axial furrows converging forward. Rostral shield and hypostoma unknown. *M.Ord.*, N.Am.-?S.Am.-Scot.——FIG. 282,*3*. **N. conradi* (BILLINGS); *a,b*, ceph., thorax and pyg., ×2 (414).

Octillaenus SALTER, 1867 [**Illaenus hisingeri* BARRANDE, 1846] [=*?Alceste* HAWLE & CORDA, 1847 (based on larval specimen); *Octoillaenus* BIGSBY,

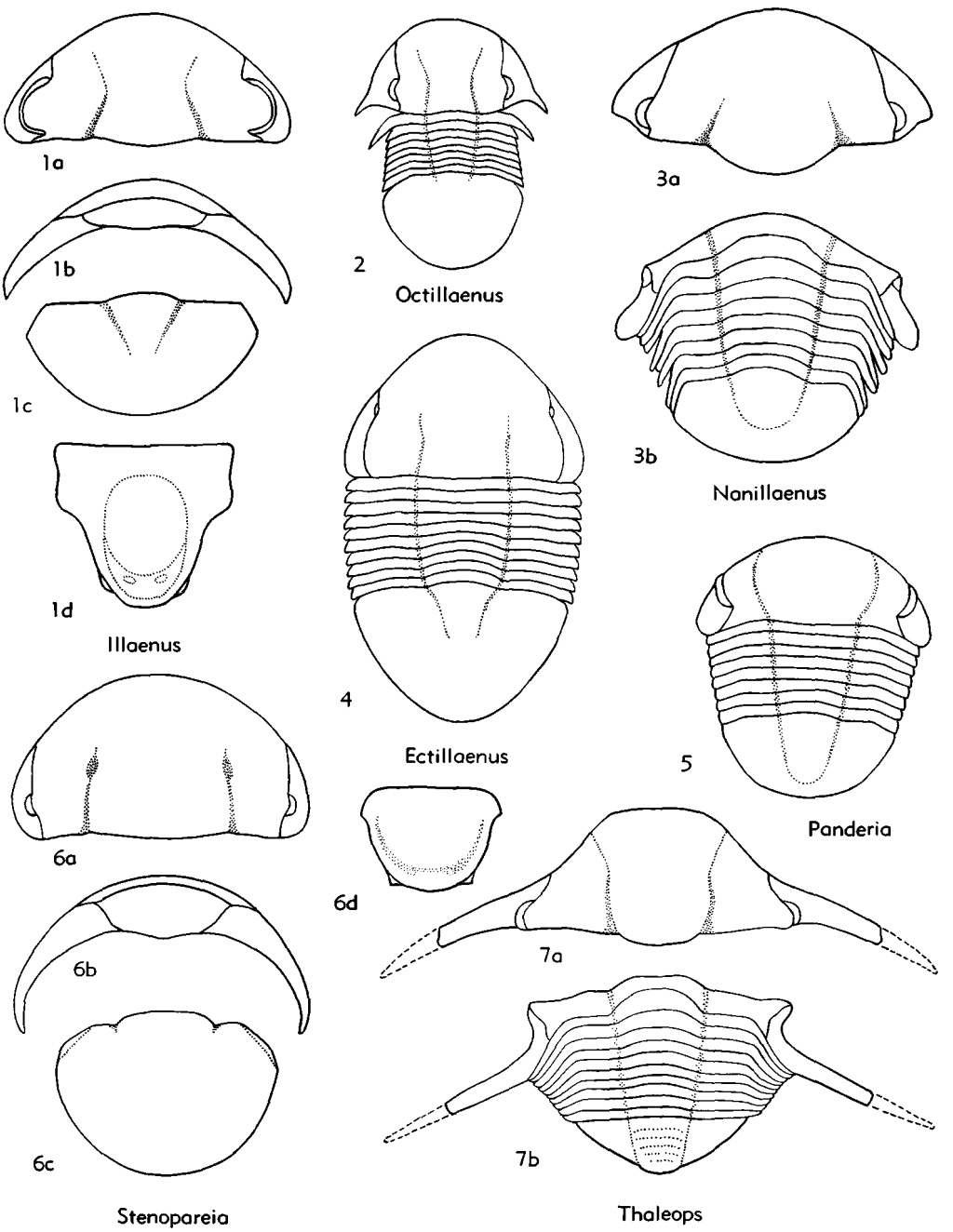


FIG. 282. Illaenidae (Illaeninae) (p. O372-O374).

1868 *(nom. null.)*]. Thorax with 8 segments; 1st extended into spinelike process (macropleura). Eyes moderately large. Pygidial axis short, poorly defined. Rostral shield and hypostoma unknown. *U.Ord.*, Czech.-S.Swed.——Fig. 282,2. **O. hisingeri* (Barrande); exoskel., ×1 (414).

Panderia Volborth, 1863 [**P. triquetra;* SD Vogdes, 1890] [=*Rhodope* Angelin, 1854 *(non* Kölliker, 1847)]. Thorax with 8 segments. Posterior parts of cephalic axial furrows diverging forward; eyes long, narrow. Pygidium considerably smaller than cephalon; axis well defined, considerably longer than postaxial field. Hypostoma unknown. *L.Ord.(Llanvirn.)-U.Ord.*, Eu.——Fig. 282,5. **P. triquetra;* exoskel. (reconstr.) (414).

Stenopareia Holm, 1886 [**Illaenus linnarssonii* Holm, 1882]. Thorax with 9 segments. Eyes small, visual surface strongly convex. Rostral flange short, connecting sutures converging until they reach inner margin of cephalic doublure. Hypostoma short, subquadrate, anterior wings narrow *(tr.)*, triangular. Pygidium slightly smaller than cephalon; axis short, poorly defined. *M.Ord.-Sil. (Wenlock.)*, Eu.-Asia-N.Am.(Que.).——Fig. 282, 6. **S. linnarssonii* (Holm); *6a,b*, ceph. dorsal, ventral, ×1; *6c*, hypostoma, ×1; *6d*, pyg., ×1 (414n).

Thaleops Conrad, 1843 [**T. ovata*] [=*Hydrolaenus* Salter, 1867]. Thorax with 10 segments. Eyes of moderate size, comparatively high. Pygidium much smaller than cephalon, with axis well defined, much longer than postaxial field. Rostral shield and hypostoma unknown. *M.Ord.*, N.Am.-Greenl.——Fig. 282,7. **T. ovata; 7a,b*, ceph., enrolled exoskel., ×2 (414).

Subfamily BUMASTINAE Raymond, 1916

Foremost portions of cephalic axial furrows in front of eyes, when present, diverging forward. No rostral flange. *M.Ord.-Sil.*

Bumastus Murchison, 1839 [**B. barriensis*]. Thorax with 8 to 10 segments; axis very broad, axial furrows poorly defined. Pygidial axial furrows generally not developed. *M.Ord.-Sil.*, cosmop.

B. (Bumastus). Thorax with 10 segments. Eyes large; at least posterior part of cephalic axial furrows distinct. Rostral plate convex, strongly narrowing *(tr.)* toward inner margin of cephalic doublure; anterior wings of hypostoma triangular. *U.Ord.-Sil.(Ludlov.)*, cosmop.——Fig. 283, *3a.* **B. (B.) barriensis;* exoskel., ×0.5 (466). ——Fig. 283,*3b. B. (B.)* cf. sp., *B. (B.) barriensis;* hypostoma, ×4 (424).

B. (Bumastoides) Whittington, 1954 [**Illaenus milleri* Billings, 1859]. Thorax with 8 to 10 segments. Cephalic axial furrows very faint, in most species developed as pair of oblong impressions; eyes of moderate size. Rostral shield and hypostoma unknown. *M.Ord.-U.Ord.*, N. Eu.-N.Am.-Greenl.——Fig. 283,6. *B. (B.) bellevillensis* Raymond & Narraway; ceph., ×2 (451).

Dysplanus Burmeister, 1843 [**Asaphus (Illaenus) centrotus* Dalman, 1827] [=*Zetillaenus* Snajdr, 1957]. Thorax with 9 segments. Eyes small; posterolateral corners of librigenae pointed or with genal spines. Rostral shield faintly convex, wide at posterior margin; anterior wings of hypostoma broad *(tr.)*, lateral part elongated into hollow tube at least in early species. Thoracic axial furrows well defined, axis moderately broad *(tr.)*. Pygidium about equal in size to cephalon, with short axis. *L.Ord.(Arenig.)-U.Ord.*; Baltoscandia-Boh.-Kazakh.——Fig. 283,7. **D. centrotus* (Dalman); *7a-b*, ceph., dorsal, ventral; *7c*, hypostoma, ×1; *7d*, pyg., ×1.5 (414).

Illaenoides Weller, 1907 [**I. triloba*]. Cephalic axial furrows long, well defined; distinct posterior border furrow present. Rostral shield, hypostoma, and thorax unknown. Pygidium without trace of axis; with well-developed concave border.

I. (Illaenoides). Palpebral lobes narrow, short, at about transverse mid-line of cranidium or slightly in front of it. *?U.Ord., L.Sil.*, N.Am.——Fig. 283,2. *I. (I.) triloba; 2a,b*, cran., pyg., ×1 (491).

I. (Goldillaenus) Schindewolf, 1924 [**Trinucleus? nilsoni* Münster, 1840]. Palpebral lobes moderately long, behind transverse mid-line of cranidium. *Sil.*, Eu.-N.Am.——Fig. 283,4. **I. (G.) nilsoni* (Münster); *4a,b*, cran., pyg., ×3, ×2 (414n).

Platillaenus Jaanusson, 1954 [**Illaenus ladogensis* Holm, 1886]. Thorax with 10 segments. Eyes of moderate size; cephalic axial furrows long, continuing laterally in shallow but distinct anterior border furrow; genal corners rounded. Rostral shield, hypostoma, thoracic axis, and pygidium generally as in *Dysplanus*. *L.Ord.(Llanvirn.)*, Baltoscandia. —— Fig. 283,*1.* **P. ladogensis* (Holm); *1a,b*, ceph., dorsal, ventral; *1c*, hypostoma (414); *1d*, pyg. (409); all ×1.5.

Thomastus Öpik, 1953 [**T. thomastus*]. Similar to *Bumastus (Bumastus)* but without eyes. *L.Sil.*, Austral.

Subfamily ECTILLAENINAE Jaanusson, nov.

Eyes very small or absent; outline of glabella club-shaped, as in *Illaenus*, rostral shield trapezoidal, with straight or slightly concave posterior margin and without rostral flange. Thorax with 9 or 10 segments; axis moderately broad to narrow, well defined. *L.Ord.(Llanvirn.)-U.Ord.*

Ectillaenus Salter, 1867 [**Illaenus perovalis* Murchison, 1839] [=*Wossekia* Raymond, 1916]. Thoracic segments 10. Eyes very small, commonly at about transverse mid-line of cephalon, or absent; genal corners rounded. Anterior wings of

the hypostoma broad *(tr.)*, quadrangular. Pygidium about equal in size to cephalon; semicircular to subtriangular outline, as in *Illaenus*. *Ord.(Llanvirn.-Ashgill.)*, Boh.-Pol.-Bornholm-S. Swed.-Eng.——FIG. 282,*4*. *E. katzeri* (BARRANDE), ×0.7 (414).

Zbirovia SNAJDR, 1956 [**Illaenus aratus* BARRANDE, 1872]. Thoracic segments 10. Pygidium smaller than the cephalon, pentangular in outline, with narrow *(tr.)* long facets. Eyes lacking; facial sutures crossing cephalon almost in straight line; genal corners rounded. Hypostoma unknown. *M. Ord.(Llandeil.-L.Caradoc.)*. Boh.

Zdicella SNAJDR, 1957 [**Illaenus zeidleri* BARRANDE, 1872]. Thoracic segments 10. Pygidium somewhat smaller than the cephalon. Cephalic

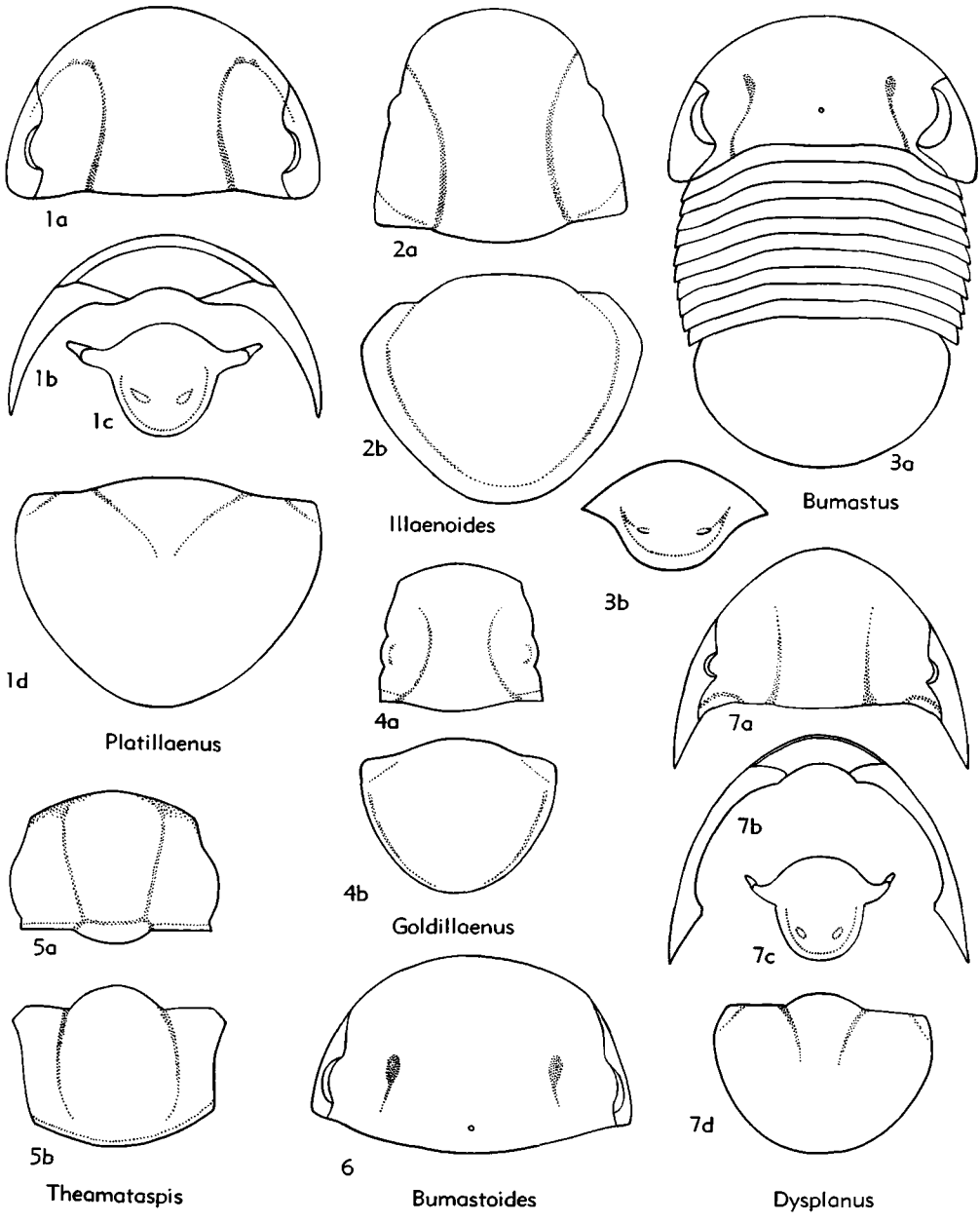


FIG. 283. Illaenidae (Bumastinae, Theamataspidinae) (p. O374-O376).

axis narrow, almost parallel-sided; eyes lacking, anterior portion of librigenae small, posterior portion elongated into long and fairly broad genal spines which reach pygidium. Hypostoma generally as in *Ectillaenus*. Thoracic axis narrow. *U. Ord.(Ashgill.)*, Boh.

?Subfamily THEAMATASPIDINAE Hupé, 1953

[*nom. transl.* JAANUSSON, herein (*ex* Theamataspididae, *nom. correct.* JAANUSSON, herein *ex* Theamataspidae HUPÉ, 1953)]

Characters of *Theamataspis*. *M.Ord.-U. Ord.*

Theamataspis ÖPIK, 1937 [**T. illaenoides*]. Only cranidia known with certainty; palpebral lobes long; cephalic axial furrows long, their rear portions diverging backward and front portions converging forward; strong occipital furrow present. [Cranidium similar to *Panderia* except for strongly developed occipital furrow, unknown in illaenids proper. Taxonomic position of genus not determinable without knowledge of other parts of exoskeleton.]. *M.Ord.-U.Ord.*, Baltoscandia.——FIG. 283,*5*. **T. illaenoides; 5a,b*, cran., dorsal (×12), anterior (×10) (439).

Subfamily UNCERTAIN

Hyboaspis RAYMOND, 1925 [**H. shuleri*] [=*Hyboaspis* RAYMOND, 1920 (*nom. nud.*, no figs.)]. Only pygidia known. Axis short, well defined; postaxial field very long. [May be synonym of *Illaenus* or *Platillaenus*, both of which include species with similar pygidium.] *Ord.(Chazy.)*, N. Am.(Va.-N.Y.).

Superfamily BATHYURACEA Walcott, 1886

[*nom. transl.* WHITTINGTON, herein (*ex* Bathyuridae WALCOTT, 1886)]

Exoskeleton opisthoparian, heteropygous to subisopygous. Cephalon large, convex, with distinct border that may be broad and concave (Bathyuridae) or narrow (Lecanopygidae); glabella well defined, parallel-sided or with anterior part widened or narrowed, lateral glabellar furrows 3 or fewer, mostly faint. Occipital ring well defined; eye lobes close to glabella, opposite or behind its mid-length; librigenal spines short (Lecanopygidae) to long (Bathyuridae). Thorax (where known) with 9 or 10 segments, pleurae with distinct furrows. Pygidium gently convex, with short or long axis that may be prolonged into axial spine; pleural fields not delimited by border furrow. *U.Cam.-M.Ord.*

Family BATHYURIDAE Walcott, 1886

[*emend.* WHITTINGTON, 1953]

Cephalon subsemicircular or nasute in outline, moderately to strongly convex, with long, broad genal spines in some; well-marked occipital furrow; glabella expanding forward or subparallel-sided, 3 or fewer faint lateral furrows; eye lobes large, situated far back and generally close to glabella, eyes with many minute facets; opisthoparian facial sutures, anterior sections widely or slightly divergent; rostral suture marginal and rostral plate with lateral margins convexly incurved. Hypostoma (where known) with short middle furrow and crescentic convex posterior lobe of middle body. Thorax of 9 or 10 segments, commonly deep pleural furrows but no long pleural spines. Pygidium of 5 or 6 segments; backward-directed axial or terminal-axial spine may be present (354). *L.Ord.-M.Ord.*

Bathyurus BILLINGS, 1859 [**Asaphus? extans* HALL, 1847). Glabella with expanded frontal lobe and 2 pairs of lateral furrows; genal spines curved, long. Hypostoma with short deep furrows in middle body opposite inflated lateral borders. Thorax with 9 segments. Pygidium triangular, axis with prominent termination. *M.Ord.*, N.Am. ——FIG. 284,*1*. **B. extans* (HALL), Blackriv., N.Y.-Ont.; exoskel., ×1.5 (496n).

?Agerina TJERNVIK, 1956 [**A. erratica*]. Subrectangular glabella with 3 pairs of lateral furrows; rostral plate triangular; genal spines short. Thorax of 8 segments (species from USSR). Pygidium short, with 3 or 4 axial rings. *L.Ord.*, Eu.(Swed.-USSR).

Bathyurellus BILLINGS, 1865 [**B. abruptus;* SD RAYMOND, 1905]. Like *Uromystrum* but cephalon lower; glabella shorter and parallel-sided; anterior sections of sutures less divergent; with broad concave cephalic border. Outer parts of thoracic pleurae bent downward. Pygidium with pleural regions sloping gently outward. *L.Ord.-Low.M. Ord.*, N.Am.-Greenl.-Ire.——FIG. 284,*4*. **B. nitidus* (BILLINGS), *Low.M.Ord.*, Newf.; *4a,b*, exoskel., dorsal, lateral, ×4 (354*).

Bathyurina POULSEN, 1937 [**B. megalops*]. Cranidium with convex glabella expanding slightly forward, with 3 or ?4 pairs of faint lateral furrows; short *(sag.)* steep preglabellar field; large strongly curved eye lobes. Other parts of exoskeleton not certainly known. *L.Ord.(U.Canad.)*, Greenl., ?N. Am.

Bolbocephalus WHITFIELD, 1890 [**Bathyurus seelyi* WHITFIELD, 1886]. Cephalon convex; glabella narrowing in front of occipital ring, then expand-

ing forward and projecting beyond anterior border, without lateral furrows; eye lobes small, situated at cephalic mid-length; genal spines short. Thorax unknown. Associated pygidium semicircular, with 4 axial rings and terminal; pleurae with oblique furrows. Surface with raised lines. *L.Ord. (M.-U.Canad.)*, N.Am.-Greenl.——Fig. 285,*1*. **B. seelyi* (Whitfield), U.Canad., Vt.; *1a,b*, ceph., lateral, dorsal, ×1; *1c*, associated pyg., ×1 (354*).

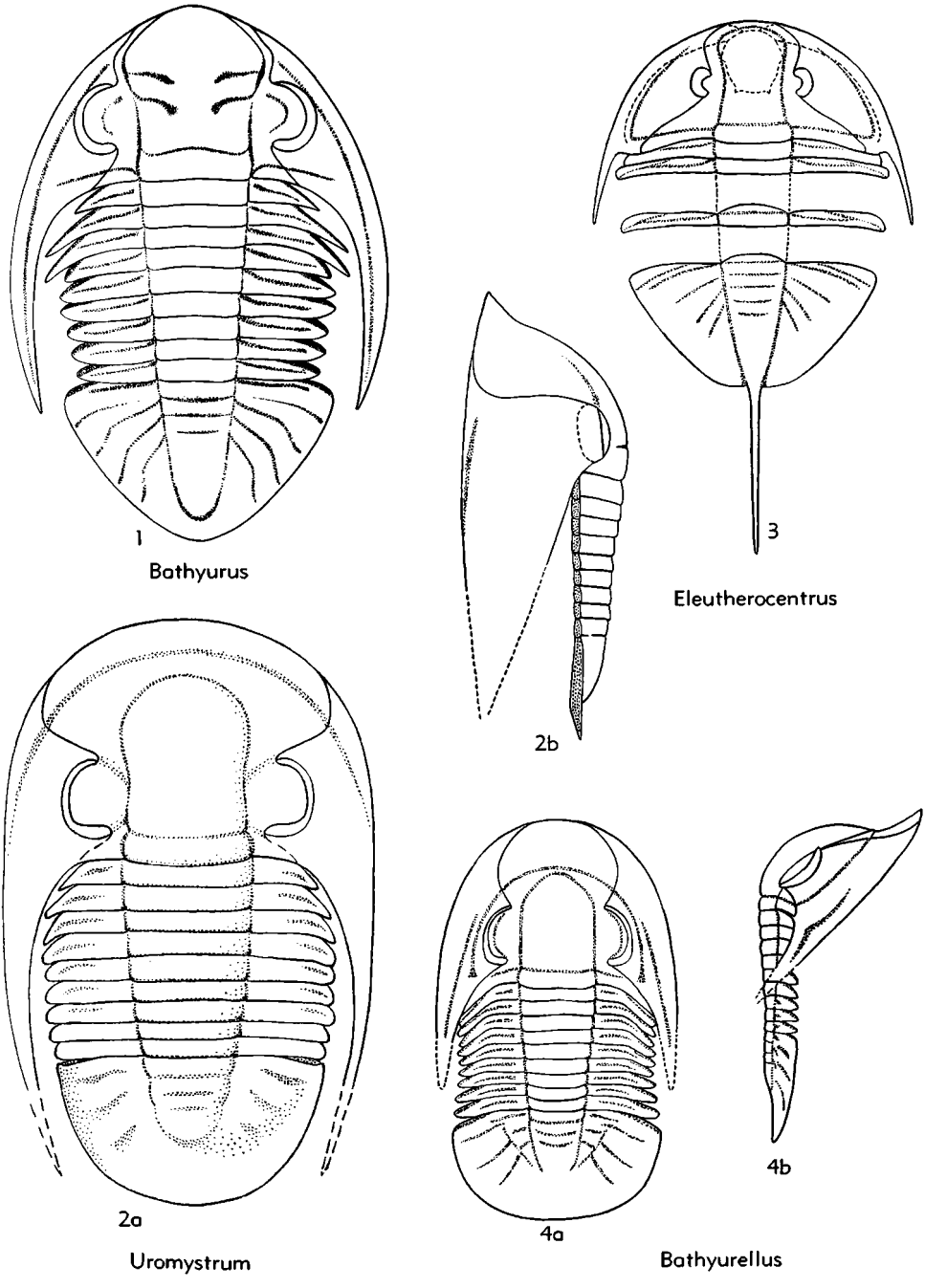


Fig. 284. Bathyuridae (p. O376-O380).

Eleutherocentrus CLARK, 1935 [**E. petersoni*]. Axis relatively narrow; glabella narrowest at half cephalic length between small eye lobes. Hypostoma as in *Goniotelina* but with broader anterior wings and short posterolateral spines. Number of thoracic segments unknown. Pygidium large, subtriangular, with long, slim terminal axial spine. *Low.M.Ord.*, Utah.——FIG. 284,*3*. **E. petersoni*;

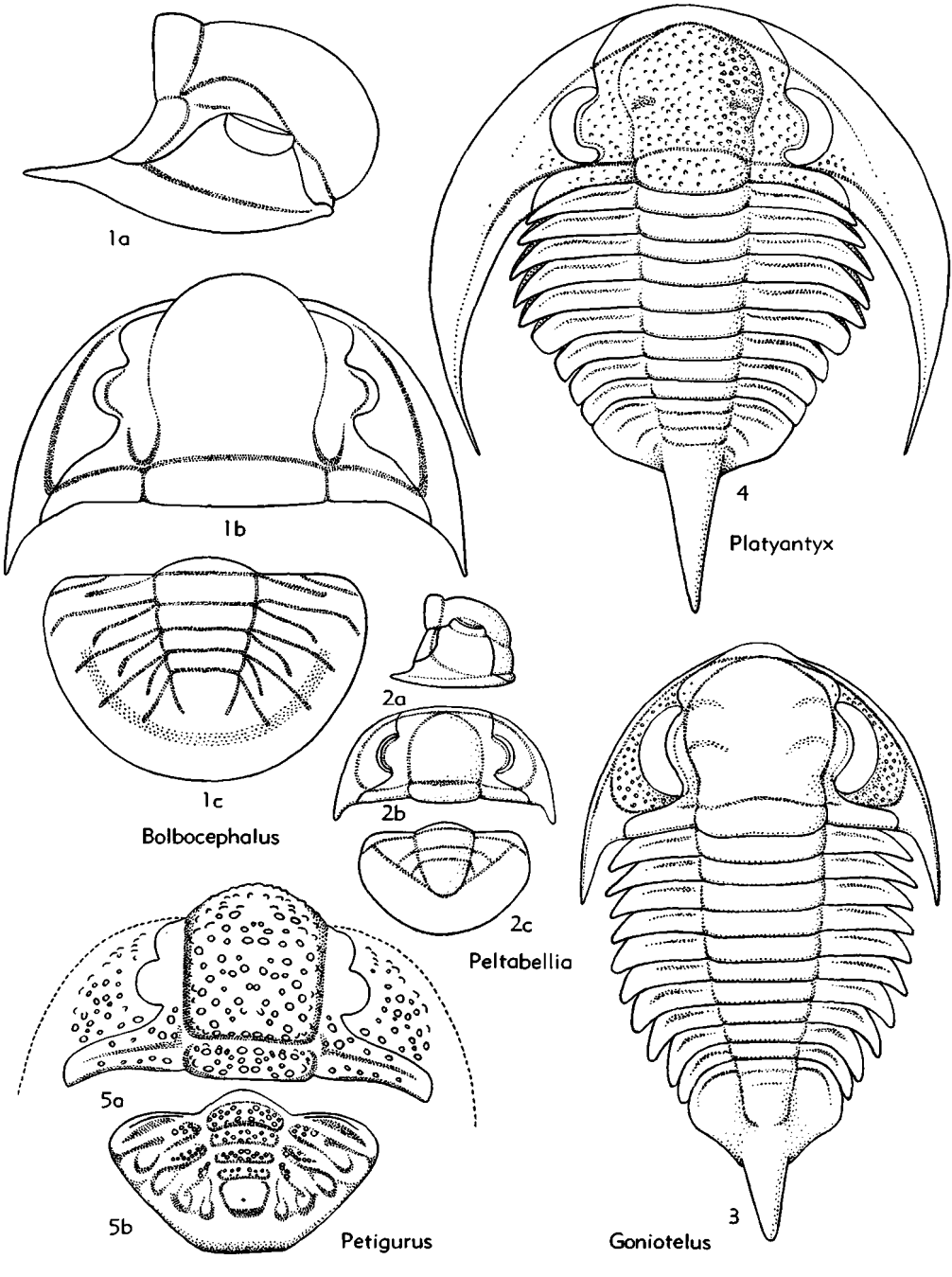


FIG. 285. Bathyuridae (p. O376, O379).

incompl. exoskel. (reconstr.), connective sutures, hypostoma, inner edge of doublure, part of thoracic axis shown by broken lines, ×0.7 (354*).

Goniotelina WHITTINGTON & ROSS in WHITTINGTON, 1953 [**Eleutherocentrus williamsi* ROSS, 1951] [?=*Acidiphorus* RAYMOND, 1925]. Like *Goniotelus* but glabella parallel-sided, not overhanging anterior border, without lateral furrows; short *(sag.)* preglabellar field; eye lobes far back and more strongly curved; genal spines variable. Hypostoma oval, with short diagonal furrow on middle body and long straplike anterior wing. Number of thoracic segments unknown. Pygidium with deep axial and 4 pleural furrows, variable terminal-axial spine. Surface tuberculate. *L.Ord.(U. Canad.)*, N.Am.-Greenl.——FIG. 286,*1*. **G. williamsi* (ROSS), Utah; *1a*, cran., ×6; *1b*, pyg., ×5 (258*).

Goniotelus ULRICH, 1927 [**Bathyurus perspicator* BILLINGS, 1865] [*pro Goniurus* RAYMOND, 1913 *non* HÜBNER, 1819] [=*Gonotelus* STRAND, 1932; ?*Acidiphorus* RAYMOND, 1925]. Glabella large, subrectangular, overhanging preglabellar furrow, widest in front of mid-point, wtih 2 pairs of lateral furrows faint on external surface; genal regions small; eye lobes large, curved, long; anterior sections of facial sutures curving inward to narrow *(tr.)* convex rostral plate; genal spines short. Thorax of 10 segments; pleural furrows deep; outer parts of pleurae falcate. Pygidium small, triangular, with thick terminal-axial spine. Surface with raised anastomosing lines, genae tuberculate. *Low.M.Ord.*, Que.-Newf. —— FIG. 285,*3*. **G. perspicator* (BILLINGS), Que.; exoskel. (reconstr.), ×4.7 (496n).

Jeffersonia POULSEN, 1927 [**J. exterminata*]. Only pygidium known. *L.Ord.(U.Canad.)*, Greenl.

Licnocephala ROSS, 1951 [**L. bicornuta*]. Like *Bathyurellus*, but convexity of cephalon low and cephalic border narrow; glabella varying in length and convexity, narrowing slightly forward, weakly or clearly outlined by furrows. Hypostoma subcircular in outline, anterior part of middle body prolonged in vertical direction, with short middle furrow; lateral border broad, posterior narrower; long, slender anterior wing directed upward, short posterior wing. Pygidium with well-marked axis and ring furrows, short pleural furrows and longer interpleural grooves on inner part of pleural region, broad outer part flattened and smooth; broad doublure. *L.Ord.(U.Canad.)*, USA(Utah-Nev.). ——FIG. 286,*2*. **L. bicornuta*, Utah; *2a,b*, cran., librigena, ×5; *2c*, pyg. (tentatively assigned to species), ×6 (258*).

Lutesvillia CULLISON, 1944 [**L. bispinosa*]. Like *Peltabellia* but cephalon gently convex. Pygidium with pair of backward-directed spines on border. External surface ?smooth. *L.Ord.(M.Canad.)*, Mo.

Peltabellia WHITTINGTON, 1953 [**Jeffersonia peltabella* ROSS, 1951]. Cephalon strongly convex; glabella parallel-sided, without lateral furrows; long

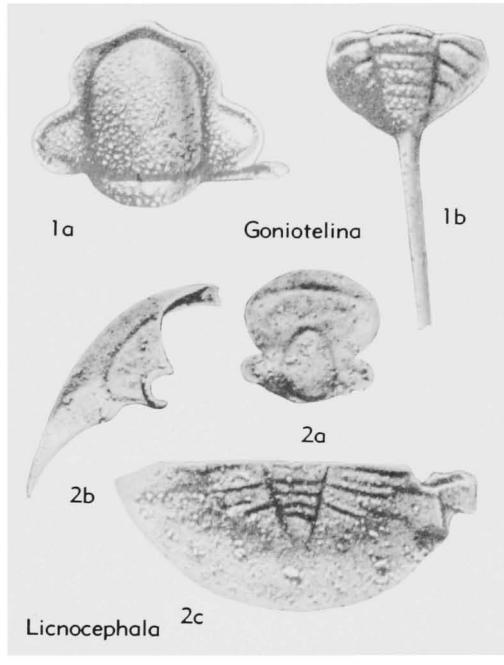


FIG. 286. Bathyuridae (p. O379).

(sag.) preglabellar field; anterior sections of facial sutures slightly divergent; genal spines short. Thorax unknown. Pygidium with broad smooth border. Surface tuberculate. *L.Ord.(M.Canad.-U. Canad.)*, N.Am.——FIG. 285,*2*. **P. peltabella* (ROSS), U.Canad., Utah; *2a,b*, ceph., lateral, dorsal, ×2; *2c*, pyg., ×2 (496n).

Petigurus RAYMOND, 1913 [**Bathyurus nero* BILLINGS, 1865]. Like *Bolbocephalus* but glabella parallel-sided. Associated pygidium with 4 broad deep pleural furrows. Surface tuberculate. *L.Ord. (U.Can.)*, N.Am.-Greenl-Scot.——FIG. 285,*5*. **P. nero* (BILLINGS), Newf.; *5a*, ceph., ×1.5; *5b*, pyg., ×1.25 (354*).

Platyantyx WHITTINGTON, 1953 [**Bathyurus arcuatus* BILLINGS, 1865]. Glabella expanding forward, anterior lobe bluntly pointed and overhanging anterior border, single pair of faint lateral furrows; eye lobes large, curved, well out from glabella; anterior sections of facial sutures curving inward; flat cephalic border continuous with broad falcate genal spine. Thorax with 9 segments, pleurae furrowed. Pygidium small, triangular, with long thick terminal-axial spine. Surface of glabella and genae tuberculate, remainder smooth. *Low.M.Ord.*, Que.——FIG. 285,*4*. **P. arcuatus* (BILLINGS); exoskel. (reconstr.), ×2.3 (496n).

Rananasus CULLISON, 1944 [**R. conicus*]. Like *Bolbocephalus* but glabella relatively larger and projecting farther beyond anterior border. Associated pygidium with few faint pleural furrows. *L.Ord.(M.Canad.)*, Mo.-Tex.

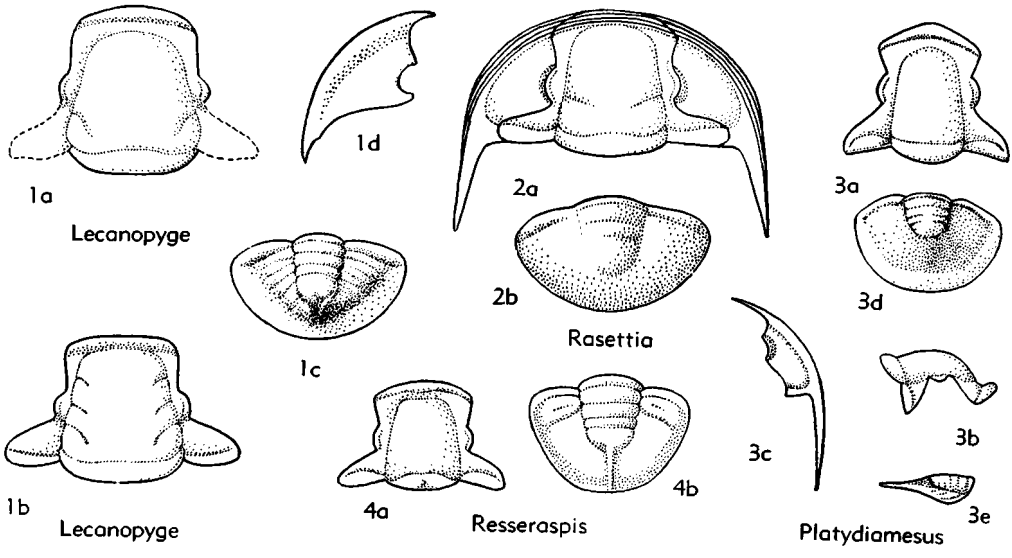


FIG. 287. Lecanopygidae (p. O380-O381).

Raymondites SINCLAIR, 1944 [**Bathyurus ingalli* RAYMOND, 1913]. Like *Bathyurus* but with frontal glabellar lobe less inflated and with single pair of lateral glabellar furrows; eye lobes farther back; anterior sections of facial sutures diverging forward; border of cephalon and pygidium broad. Surface with tubercles; axial spines may occur on occipital ring and pygidium. *M.Ord.(Blackriv.-Trenton.)*, N.Am.

Uromystrum WHITTINGTON, 1953 [**Bathyurellus validus* BILLINGS, 1865]. Cephalon high; genal spines broad, long; glabella long *(sag.)*, expanding slightly forward, without furrows; anterior sections of facial sutures widely divergent. Thorax with 9 segments, tips of pleurae upturned. Pygidium with pleural regions concave faintly furrowed. Surface with raised lines. *Low.M.Ord.*, N. Am.-Greenl.——FIG. 284,2. **U. validum* (BILLINGS), Newf.; *2a,b*, exoskel. (reconstr.), dorsal, lateral, ×1.7, ×1.5 (354*, 496n).

Gonioteloides KOBAYASHI, 1955 [**G. monoceros*]. *L. Ord.*, W.Can.(B.C.).

Family LECANOPYGIDAE Lochman, 1953

Exoskeleton opisthoparian, subisopygous. Glabella broadly tapering to subquadrate, all furrows narrow and shallow; occipital node may be present; preglabellar field present or absent; eyes of medium size, usually opposite center of glabella; fixigenae with very narrow palpebral areas, posterior areas straplike; librigenae with short slender genal spines. Thorax unknown. Pygidium semicircular; axis wider or narrower than pleural fields, length variable, commonly with low postaxial ridge, usually 3 axial rings; no border furrow, other furrows may be present, border medium in width. Surface smooth. Derived from Asaphiscidae. *U.Cam.-L.Ord.*

Lecanopyge RAYMOND, 1937 [**L. expansa*]. Glabella low, broadly tapering, front broadly curved, with 3 pairs of short faint lateral furrows; short *(sag.)* preglabellar field may be present, axial and anterior border furrows faint and shallow; fixigenae horizontal. Pygidium with axis wider than pleural fields, extending more than 0.5 of pygidial length, with 3 axial rings and terminal with low short postaxial ridge; 3 broad pleurae, pleural furrows shallow or obsolete (188). *U.Cam.(Trempeal.)*, E.USA.——FIG. 287,*1a*. **L. expansa*, Vt.; *1a*, cran., ×0.75 (188).——FIG. 287,*1b-d*. *L. prolifica* RASETTI, Que.; *1b,c*, cran., pyg., ×0.75; *1d*, librigena, ×1 (188).

Platydiamesus RAYMOND, 1937 [**P. depressus*]. Glabella convex, tapering without lateral furrows; preglabellar field present; occipital furrow faint or obsolete, other furrows shallow; eyes slightly in front of center of glabella; fixigenae upsloping. Pygidium with axis narrower than pleural fields, 0.5 or less of pygidial length, with 2 or 3 faint axial rings and terminal with low short postaxial ridge; pleural fields with furrows and grooves faint or obsolete border concave (189). *U.Cam.(Trempeal.)*, E.USA.——FIG. 287,*3*. **P. depressus*, Vt.; *3a,b*, cran., ×3, ×2; *3c*, librigena, ×3; *3d,e*, pyg., ×3, ×2 (189).

Rasettia LOCHMAN, 1953 [*pro Platycolpus* RAY-

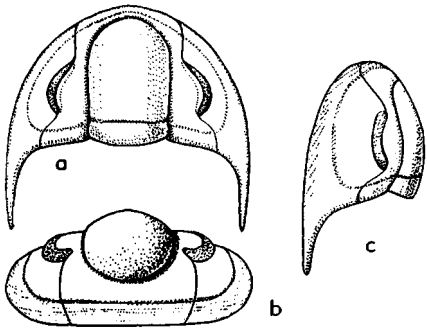


FIG. 288. **Strigigenalis cassinensis* WHITTINGTON (Lecanopygidae), L.Ord.(Canad.), Vt.; *a-c*, ceph., dorsal, anterior, side, ×2 (496).

MOND, 1913 (*non* DONALD, 1901)] [**Bathyurus capax* BILLINGS, 1860]. Glabella low, subquadrate, front rounded or nearly straight, without glabellar furrows; preglabellar field may be present, border downsloping, crossed by ridges, furrows shallow; eyes slightly behind center of glabella; fixigenae upsloping; librigenae with short genal spines and ridged border; median facial sutures on doublure fused. Pygidium with axis narrower than pleural fields, slightly more than 0.5 of pygidial length, with 2 or 3 faint axial rings and terminal; pleural fields with single anterior interpleural groove; no border furrow (188). *U.Cam.(Trempeal.)*, N.Am. S.Am.——FIG. 287,*2*. **R. capax* (BILLINGS), Que.; *2a*, ceph., ×1; *2b*, pyg., ×0.5 (188).

Resseraspis RASETTI, 1945 [**R. carinata*]. Glabella low, tapering, front nearly straight, without lateral furrows; preglabellar field present, all furrows shallow, small occipital node present; fixigenae upsloping. Pygidium with axis wider than pleural fields, extending more than 0.5 of pygidial length, with 3 axial rings and terminal with prominent postaxial ridge extending to margin; 2 or 3 broad pleurae; no border furrow, border concave (189). *U.Cam.(Trempeal.)*, E.Can.——FIG. 287,*4*. **R. carinata*, Que.; *4a,b*, cran., pyg., ×1 (189).

Strigigenalis WHITTINGTON & ROSS, 1953 [**S. cassinensis* WHITTINGTON in WHITTINGTON & ROSS, 1953]. Glabella low, subquadrate, front rounded, no lateral furrows; preglabellar field of medium width *(sag.)*, anterior border narrow, dying out laterally; eyes slightly above medium size, a little behind center of glabella; fixigenae horizontal, with arcuate, palpebral areas almost 0.5 of width of glabella, posterior areas narrow *(exsag.)*, of medium length *(tr.)*; rostrum broadly triangular, undercurved; librigenae elongate, with short genal spines or rounded genal angles. Thoracic pleurae with broad furrows, tips pointed, with wide doublure. Pygidium with axis narrower than pleural fields, tapered 0.5 of length, with 5 faint to obsolete axial rings; pleural fields with several interpleural grooves anteriorly; no border furrow. Outer surface smooth, with narrow ridges on border and doublure (354). *L.Ord.(Canad.)*, N.Am. ——FIG. 288. **S. cassinensis*, Vt.; *a-c*, ceph., dorsal, anterior, side, ×2 (354).

Superfamily HOLOTRACHELACEA Warburg, 1925

[*nom. transl.* JAANUSSON, herein (*ex* Holotrachelidae WARBURG, 1925)]

Cephalon large, surrounded by distinct border; cephalic axis long, rather strongly convex, narrowing forward, smooth, with-

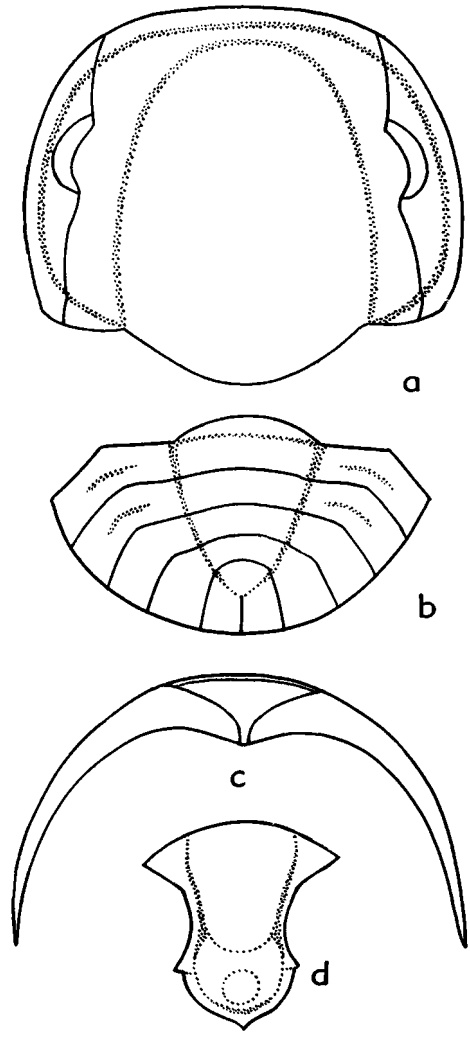


FIG. 289. **Holotrachelus punctillosus* (TÖRNQUIST) (Holotrachelidae), U.Ord., Swed.; *a,c*, ceph., dorsal, ventral, ×1.5; *b*, pyg., ×4.5; *d*, hypostoma, ×1.5 (489).

out glabellar or occipital furrows; facial sutures opisthoparian. Rostral shield wide *(tr.)* anteriorly, strongly narrowing backward, hindmost part forming a very short rostral doublure; hypostoma with strong lateral and middle furrows, posterior lobe with prominent rounded boss, anterior wings triangular. Thorax with 8 segments (in type genus); pleurae with distinct diagonal pleural furrows and well-developed facets. Pygidium (in type genus) with gently convex axis, composed of 3 rings and terminal; pleural fields without border, bearing 4 pairs of flattened tergites, anterior pairs carrying pleural furrows, boundaries between pygidial tergites sharp and suture-like. Surface ornamented by terrace lines and small pits. [Assignment to Illaenina is very uncertain.] *U.Ord.*

Family HOLOTRACHELIDAE Warburg, 1925

Characters of superfamily. *U.Ord.*

Holotrachelus LINNARSSON in TÖRNQUIST, 1919 [**Homalonotus punctillosus* TÖRNQUIST, 1884]. *U. Ord.,* N. Eu. (Ire.-Eng.-Swed.)-Sib. (Kuznetsk-Kirghiz)-N.Am.(Que.).——FIG. 289. **H. punctillosus* (TÖRNQUIST); *a,c,* ceph., dorsal, ventral, ×1.5; *b,* 8th thoracic seg. and pyg., ×4.5; *d,* hypostoma, ×1.5 (489).

Superfamily PROETACEA Salter, 1864

[*nom. transl.* KOBAYASHI, 1935 (*ex* Proetidae SALTER, 1864)] [=Proetoidae HUPÉ, 1953] [*Authorship.*—Diagnosis of superfamily by RICHTER & RICHTER with additions by W. STRUVE]

Exoskeleton opisthoparian, small to moderately large (average length 1 to 4 cm., exceptional maximum about 12 cm.). Cephalon semicircular, semielliptical, parabolic, or ogival in outline, but not rectangular or trapezoidal; cephalic border well developed in most genera (in plan view somewhat overlapped by glabella in some Otarionidae, *Celmus,* some Proetinae, suppressed by frontal lobe in several Phillipsiidae); preglabellar field narrow to very large *(sag.);* glabella semielliptical, conical, ogival, pear-, egg-, club-, or fiddle-shaped, with more or less enlarged frontal lobe (*Phillipsinella,* Phillipsiidae), front generally rounded, exceptionally truncated (*Plethopeltis, Celmus,* few Proetidae), with 1 to 4 pairs of lateral glabellar furrows that are parallel, or in many genera, increasingly oblique in posteromesial direction from *4p* to *1p, 4p* furrows present only exceptionally, *3p* and *2p* tending to disappear and *1p* to fuse with occipital furrow so that *1p* lateral lobes are detached; all furrows obsolete in Plethopeltidae, most Dimeropygidae, *Phillipsinella,* few Proetidae; holochroal eyes of considerable size in most genera (0.3 to more than 0.5 of glabellar length), close to glabella and behind mid-length of cephalon (except for Plethopeltidae, *Celmus,* Otarionidae with small eyes and reduced-eyed or blind Proetidae, e.g., *Drevermannia, Typhloproetus, Pteroparia*), no eye ridges (except in *Cyphaspides* and a few Proetidae); posterior sections of facial sutures generally shorter than anterior sections and diverging more obliquely than anterior sections, which are notably distant from each other at anterior margin, as especially in *Pteroparia* (sutures ankylosed in Brachymetopidae and few Proetidae); librigenae generally larger than fixigenae; genal spines mostly well developed. Thorax with 6 to 17 segments (average about 10); pleurae furrowed. Pygidium transversely to longitudinally semielliptical in outline, length 0.3 to slightly more than equal that of cephalon; segmentation typically well developed with about 4 to 10 pairs of ribs (many more in some Phillipsiidae). *U.Cam.-M.Perm.*

The Cambrian family Plethopeltidae and the Ordovician families Celmidae and Phillipsinellidae differ so much from other Proetacea that they should be regarded only as an annex to this superfamily. Very closely allied are the Proetidae and Phillipsiidae, next to them the Brachymetopidae; somewhat more distant are the Dimeropygidae and Otarionidae.

Family PROETIDAE Salter, 1864

[=Prionurides HAWLE & CORDA, 1847 (invalid name; based on junior homonym); Proetiden HAWLE & CORDA, 1847 (invalid vernacular name)] [*Authorship.*—Generic diagnoses by RICHTER & RICHTER with additions by W. STRUVE; assignments of genera to subfamilies mainly by STRUVE]

Exoskeleton elongate elliptical (1 to 12 cm. in length). Cephalon semicircular to parabolic; glabella tapering to inverse pyriform, mostly suboval, with 3 or 4 pairs of lateral furrows, indistinct in some, *1p* furrows tending to develop an adaxial branch that causes basal deterioration ("basisolution") of glabella in some late genera, increased width of furrows in basal

part of glabella leading ultimately to their coalescence, with development of small remnant separated lobes (Fig. 290,*E,E',F,F'*); occipital ring defined, commonly with lobes; facial sutures opisthoparian; eyes close to glabella, opposite or behind its mid-length; fixigenae narrow, in some genera of Cyrtosymbolinae with disappearance of sutures over eyes (allowing them to migrate outward, Fig. 291); visual areas ring-shiped, holochroal, with prismatic lenses, proximally convex; librigenae broad (except narrow in eyeless Cyrtosymbolinae), genal angles mostly with spine, seldom rounded. Rostral plate narrow, transversely extended, rostral suture long, parallel to frontal margin, connective sutures short, slightly converging (Fig. 292*A*); hypostoma subrectangular, elongate, with conspicuous wings, posterior margin mostly with paired teeth, central body vaulted. Thorax with 8 to 10 segments (typically 10), pleurae with

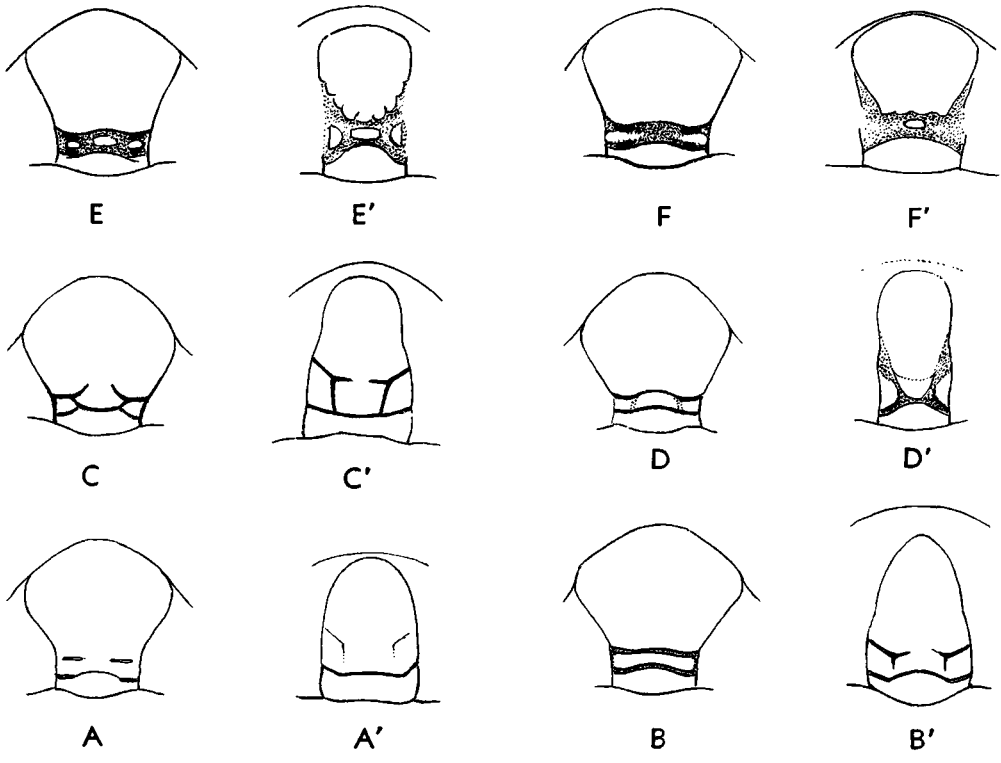


FIG. 290. Deterioration ("basisolution") of basal part of glabella in Proetidae and Phacopidae. The diagrams show homologous evolutionary changes but arrangement of the illustrated forms indicating neither chronologic nor phylogenetic sequences; furrows in front part of glabella omitted (461n).

A-F, PHACOPIDAE.——A, U.Dev., furrows *(p1)* in front of occipital furrow short slits ending blind.——B, *Phacops confluens,* Up.L.Dev., transglabellar furrow in front of occipital furrow.——C, *Trimerocephalus caecus,* U.Dev., linkage of furrows at and near base of glabella with development of small lobes circumscribed by furrows.——D, *Phacops granulatus,* U.Dev., pattern of furrows related to both B and C. ——E, *P. papulatus,* M.Dev., like D but with widened furrows isolating 3 small lobes.——F, *P. accipitrinus,* U.Dev., like E but showing coalescence of furrows through disappearance of median small lobe.

A'-F', PROETIDAE.——A' *Proetus (Proetus) cuvieri,* M.Dev., with short oblique furrows in front of occipital furrow.——B', *Cyrtosymbole gotica,* U.Dev., short glabellar furrows inwardly forked but separate.—— C', *Schizoproetus celechovicensis,* M.Dev., posterior branch of glabellar furrows extended to occipital furrow.——D', *Phillipsia* sp., Low.U.Carb.(Namur.), like C' but with furrows widened and extended.—— E', *Pseudophillipsia sumatrensis,* Carb., like D' but with marked enlargement of furrows leaving 3 small lobes as isolated remnants of basal glabellar ring.——F', *Ditomopyge artinskiensis,* M.Perm.(Artinsk.), like E' but with only median small lobe remaining in broad coalesced groove area.

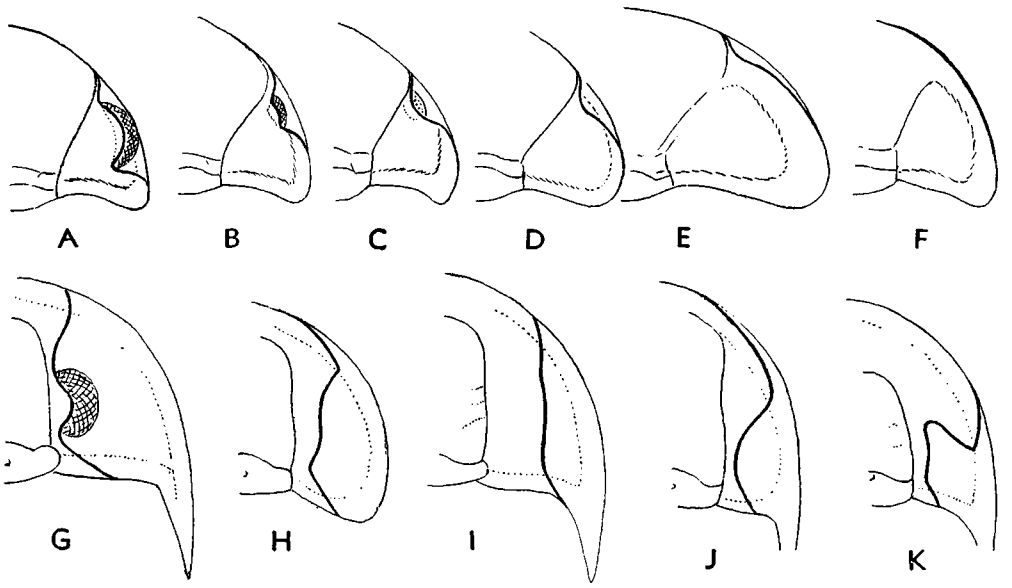


FIG. 291. Migration of facial sutures in relation to degeneration of eyes in Proetidae and Phacopidae, illustrated by Upper Devonian species (461n).

A-F, PHACOPIDAE (*Ductina* series), showing progressive straightening of facial sutures.——A, *Phacops circumspectans,* eyes and palpebral lobes large.——B, *P. wedekindi,* eyes reduced in size, palpebral lobes flattened.—C, *Cryphops? ensae,* small eyes with elliptical visual area, palpebral lobes vanished (*cryptophthalmus* pattern).——D, *Trimerocephalus mastophthalmus,* eyes lacking, course of facial sutures close to border.——E, *Dianops limbatus,* like D but sutures nearly marginal throughout.——F, *Ductina ductifrons,* like E but sutures entirely marginal.

G-I, PROETIDAE (*Drevermannia* series), showing tendency toward straightened facial sutures.——G, *Cyrtosymbole (Waribole) warsteinensis,* eyes large, palpebral lobes prominent, facial sutures strongly sinuous.——H, *Drevermannia (Palpebralia) palpebralis,* eyes lost, palpebral lobes much reduced, facial sutures somewhat straight.——I, *D. (Drevermannia) schmidti,* like H but palpebral lobes disappeared and sutures very straight.

G,J,K, PROETIDAE (*Pteroparia* series), showing accentuation in curvature of facial sutures.——G, as in *Drevermannia* series.——J, *Typhloproetus subcarintiacus,* lacking palpebral lobes and eyes, anterior segments of facial sutures deflected so as to approach border closely.——K, *Pteroparia columbella,* like J except for marked change in course of facial sutures, with anterior segments intersecting cephalic margin far back of frontal extremity.

pleural furrows; mesotergite in many genera bipartite, with praeannulus and postannulus (Fig. 292*B*). Pygidium mostly semicircular, with few segments, but in some late genera long, parabolic, with up to 28 segments. *M.Ord.-L.Carb.(Miss.)*

Subfamily PROETINAE Salter, 1864

[*nom. transl.* PŘIBYL, 1947 (*ex* Proetidae SALTER, 1864)]

Cephalon vaulted; exterior border convex, border furrow sharp; no preglabellar field; glabella large, suboval to rectangular, glabellar region in front of *3p* furrows short, similar to length of *1p* glabellar lobes; anterior sections of facial sutures slightly diverging; librigenae with genal angles rounded or with short spines. Thorax with 10 segments, ends truncate, axis as wide or wider than pleurae. Pygidium vaulted, semicircular, entire; axis broad, with 6 to 9 rings; 5 to 7 ribs, nearly parallel, slightly curved backward, segmental bands little different in size, pleural and interpleural furrows merely incised lines. *M.Ord.-M.Dev.*

Proetus STEININGER, 1831 [**Calymene concinna* DALMAN, 1827] [=*Aeonia* BURMEISTER, 1843 (obj.); *Gerastos* GOLDFUSS, 1843; *Forbesia* M'COY, 1846; *Trigonaspis* SANDBERGER & SANDBERGER, 1850]. Glabella touching border furrow, glabellar furrows *1p* more or less distinct; occipital ring not narrowed laterally but may have lobes laterally. *Ord.-M.Dev.*, cosmop.

P. (Proetus) [=*P. (Euproetus)* RUD. RICHTER, 1913]. Cephalon strongly vaulted; glabellar fur-

rows faint or missing; occipital ring with or without lobes; genal angles rounded or with short spine. Hypostoma with median spine on central body (FIG. 293,*1h*). *Ord.M.Dev.*, cosmop.——FIG. 293,*1a-e*. **P. (P.) concinnus* (DALMAN), Sil., Gotl.; *1a-c*, ceph.; *1d*, pyg; *1e*, hypostoma; all ×3.5 (461).——FIG. 293,*1f,g*. *P. (P.) bohemicus* HAWLE & CORDA, L.Dev., Czech.(Koněprusy Ls.); *1f,g*, ceph., pyg., ×4 (3).——FIG. 293,*1h*. *P. (P.) cuvieri* STEININGER, M.Dev., Ger.; hypostoma from side, ×4 (460).

P. (Cyphoproetus) KEGEL, 1927 [**Cyphaspis depressa* BARRANDE, 1846; SD PŘIBYL, 1946]. Cephalon vaulted; border furrow broadened in front of glabella; lateral furrows *1p* pronounced, separating lateral lobes *1p*; with occipital lobes; librigenae with genal spines. Pygidium moderately vaulted; axis with 6 to 8 rings; pleural fields with 3 to 6 ribs. *Sil.*, Eu.——FIG. 293,*3*. **P. (C.) depressus* (BARRANDE), Czech.; exoskel., ×2 (3).

?**Crassiproetus** STUMM, 1953 [**Proetus (Crassiproetus) traversensis* STUMM, 1953]. Highly vaulted cephalon typical of Proetinae combined with pygidium of type characteristic of Dechenellinae; glabella quadrate, lateral furrows obsolete; occipital lobes developed; anterior sections of facial sutures scarcely diverging, short; genal angles rounded. Pygidium as long as wide, highly convex; axis broad and long; segmentation weakly defined, with 14 to 16 rings; pleural fields with 9 to 12 ribs. *M.Dev.*, N.Am.——FIG. 293,*5*. *C. traversensis* (STUMM), Mich.; *5a,b*, small ceph., large pyg., ×2, ×1 (476).

?**Isbergia** WARBURG, 1925 [**I. planifrons*]. Cephalon (length 1.5 to 3 mm.) like that of *Proetus* but with long preglabellar field bent vertically downward and genae steeply inclined; occipital ring narrowed laterally; posterior sections of facial sutures directed sharply outward as straight line from eyes to points on posterior margins just inside genal angles; no genal spines. Thorax and pygidium unknown. *Ord.(Ashgill.)*, Swed.-Ire.——FIG. 293,*2*. **I. planifrons*, Swed.(Dalarne); *2a,b*, ceph., ×6 (323).

?**Unguliproetus** ERBEN, 1951 [**Proetus unguloides* BARRANDE, 1846]. Cephalon with somewhat ogival outline; border wide, convex, preglabellar field of same width *(sag.)*; glabella slender, tapering to narrow front; anterior sections of facial sutures moderately long, diverging, posterior sections short; librigenae narrow, with long genal spines. Thorax with 10 segments rounded at ends. Pygidium 0.5 as long as broad, truncated, depressed; axis narrow, without axial ridge, rings 7 or more; pleural fields with faint ribs, segmental bands equally developed; pleural and interpleural furrows very narrow, faint. *L.Dev.-M.Dev.*, Eu.——FIG. 293,*4*. **U. unguloides* (BARRANDE), L.Dev., Czech.; *4a,b*, ceph., thorax and pyg., ×3, ×4.5 (3).

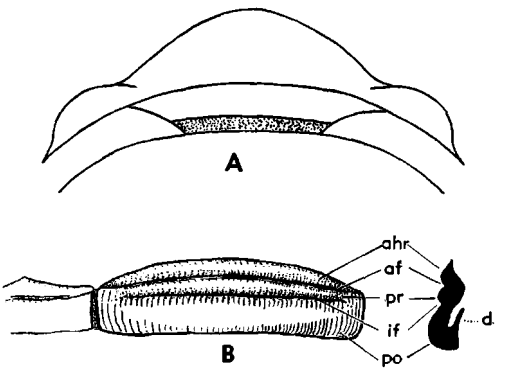


FIG. 292. *Proetus (Proetus) cuvieri*, M.Dev., showing (A) rostral plate (stippled) *in situ*, ×6, and (B) mesotergite with bipartite axial ring or annulus, ×10 (*ahr*, articulating half-ring; *af*, articulating furrow; *if*, intra-annular furrow; *po*, postannulus; *pr*, pre-annulus; *d*, doublure) (461n).

Subfamily CORNUPROETINAE Richter & Richter, 1956

Exoskeleton depressed. Cephalon with moderate-sized preglabellar field or none; glabella scarcely tapering, with broad front and restricted sides, 3 faint lateral furrows or obsolete; occipital ring remarkable in width *(tr.)*, not narrowed *(sag.)* laterally; anterior sections of facial sutures slightly diverging; librigenae broad, extended into long, furrowed genal spines. Hypostoma without spine on central body. Thorax with 10 (seldom 9) segments, ending in obtuse or sharp points; axis as wide or wider than pleurae, which are flat. Pygidium wide *(tr.)*, short, entire, without distinct border or border furrow; axis short, wide, with blunt end, remarkably elevated above flat pleural fields, showing 4 to 6 rings; pleural fields with 4 to 6 nearly parallel straight ribs, curved backward only near ends. *Ord.-U.Dev.*

Cornuproetus RICHTER & RICHTER, 1919 [**Proetus cornutus* GOLDFUSS, 1843]. Cephalon with exterior border demarcated by sharp border furrow; preglabellar field minute or lacking; occipital ring without lobes. Hypostoma without spine on central body. Thorax with 9 or 10 segments; axis scarcely narrowing backward. Pygidium shorter than semicircle; axis nearly reaching posterior margin, no axial ridge. *Sil.-U.Dev.*, Eu.-N.Afr.-N. Am.

C. (Cornuproetus) [=*P. (Sculptoproetus)* ERBEN, 1951]. Glabella nearly rectangular, somewhat

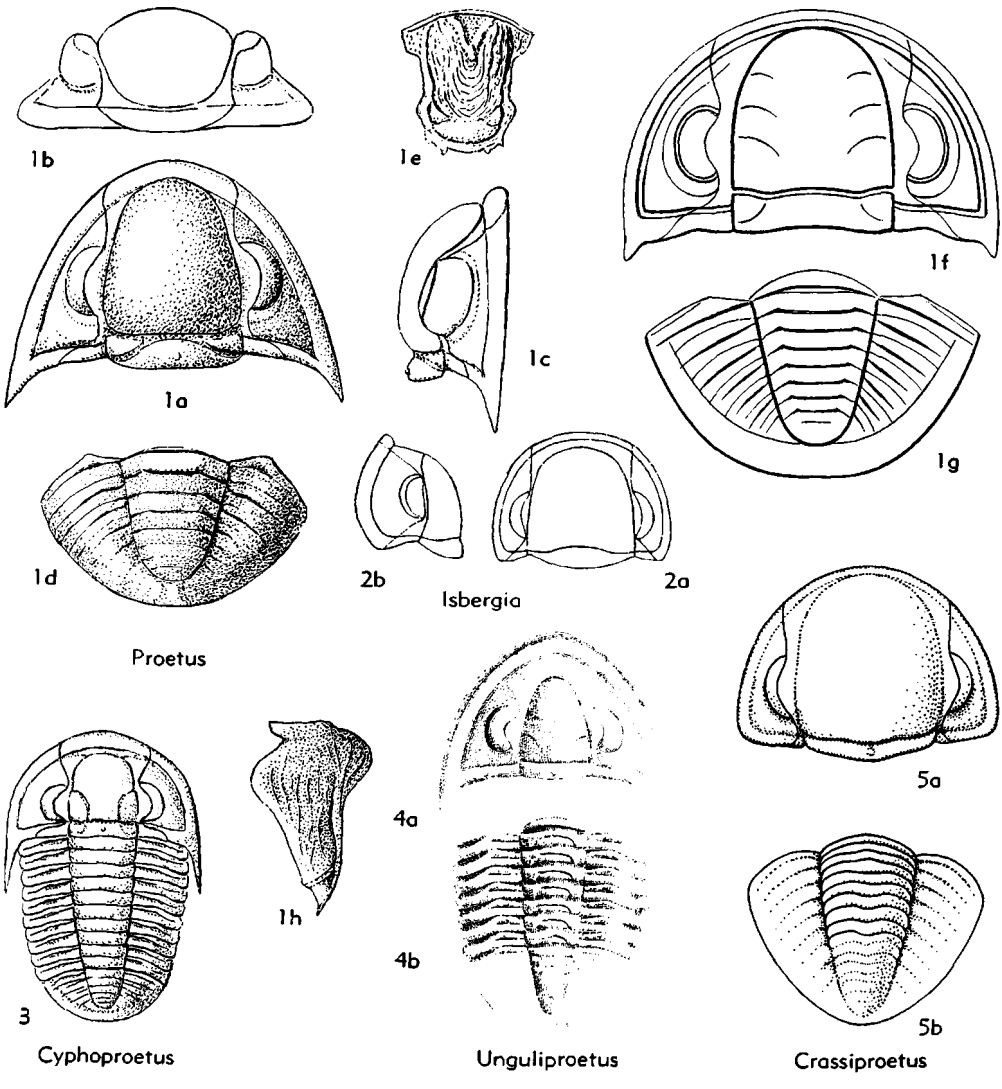


FIG. 293. Proetidae (Proetinae) (p. O384-O385).

fiddle-shaped; palpebral lobes nearly reaching posterior border furrow; librigenae uniformly and moderately vaulted. *Sil.-U.Dev.*, Eu.-N.Afr.-N. Am.——FIG. 294,*1*. **C. (C.) cornutus* (GOLDFUSS), M.Dev., Ger.(Gerolstein); *1a,b*, exoskel., hypostoma, ×1.5 (461).

C. (Piriproetus) ERBEN, 1952 [**Proetus (Piriproetus) pirus*]. Glabella tapering slightly, though with broad front, palpebral lobes distant from posterior border furrow. Thorax and pygidium unknown. *Up.L.Dev.-Low.M.Dev.*, C.Eu.——FIG. 294,*2*. **C. (P.) pirus* (ERBEN), L.Dev., Ger. (Harz); cran., ×16 (397, mod.).

C. (Lepidoproetus) ERBEN, 1951 [**Proetus lepidus* BARRANDE, 1846]. Like *C. (Cornuproetus)* but with concave preglabellar field; no demarcated border or sharp border furrow in front; librigenae steeply sloping to flat border. *Sil.-M.Dev.*, C.Eu.——FIG. 295,*4*. **C. (L.) lepidus* (BARRANDE), Sil. (e gamma Zone), Czech.; exoskel., ×3 (3).

Phaetonellus NOVÁK, 1890 [**Phaeton planicauda* BARRANDE, 1846; SD VOGDES, 1925]. Cephalon with narrow exterior border and incised border furrow, preglabellar field short; glabella rectangular, sides well marked. Thorax with 10 distally pointed segments, posterior ones with spined ends. Pygidium semicircular; axis with 5 rings; pleural fields with 2 to 4 pleurae that continue into spines. *Ord.-M.Dev.*, Eu.——FIG. 295,*2*. *P. rhenanus*

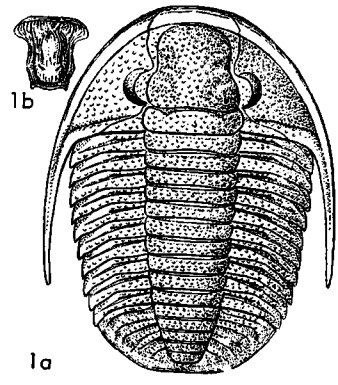
Novák, M.Dev., Ger.(Bicken); *2a,b,* exoskel., ×2.8, with detail of sculpture, enlarged (437).

Xiphogonium Hawle & Corda, 1847 [**Proetus loveni* Barrande, 1846; SD Vogdes, 1893]. Cephalon with broad flat anterior border and very broad anterior border furrow, preglabellar field moderate in size; glabella rectangular. Thorax with 10 segments; axis anteriorly broad, narrowing backward; pleurae flat, heteromeric, nos. 1 to 6 pointed, 7 to 10 with spines. Pygidium shorter than semicircle, no border. *M.Dev.,* C.Eu. ——Fig. 295,*3.* **X. loveni* (Barrande), g alpha Z., Czech.(Hostin); exoskel., ×2 (3).

?**Eremiproetus** Richter & Richter, 1919 [**Proetus eremita* Barrande, 1852]. Glabella approximately rectangular, nearly reaching convex frontal border; occipital ring directed laterally forward, presence of lobes indicated. Thorax with 10 segments like those of *Cornuproetus.* Pygidium depressed, semicircular in outline or shorter, anterior margin straight, outer edge sharp, entire; axis short, prominent, with 4 to 6 rings that bear recurved median tubercles, succeeded by long axial ridge; pleural fields slightly concave near margin; with 3 or 4 distant ribs consisting only of anterior straight segmental bands, that bend abruptly backward distally. [This genus combines cephalic and thoracic features of Cornuproetinae with pygidial characters of Tropidocoryphinae and thus presumably is the root of these subfamilies.] *Sil.-M. Dev.,* Eu.——Fig. 295,*5.* **E. eremita* (Barrande), *L.Dev.-M.Dev.* near boundary; *5a, ceph.,* Ger. (Greifenstein), ×1 (437); *5b,* pyg., Czech. (Koněprusy Ls.), ×2 (3).

?**Pribylia** Erben, 1951 [*pro Přibylia*] [**Proetus inaequicostatus* Barrande, 1846]. Pygidium lenticular, anterior and posterior margins curved similarly, uniting in sharp angular corners, without distinct border; axis somewhat wider than pleural fields, with 7 rings followed by stout short axial ridge; pleural fields with anterior and posterior segmental bands developed as 4 or 5 strong semipleural ribs of nearly equal size, pleural and interpleural furrows equally distinct. *L.Dev.,* C. Eu.——Fig. 295,*1.* **P. inaequicostata* (Barrande), Czech.(Koněprusy Ls.); pyg., ×3 (3).

?**Perliproetus** Richter & Richter, 1926 [**Calymene marginata* Münster, 1842]. Late genus with some features of Phillipsiinae. Cephalon with concave outer border; glabella long, scarcely tapering, region in front of *3p* lateral furrows long, *1p-3p* glabellar furrows sharp, *1p* with separate adaxial branch, *1p* glabellar lobes separated; occipital ring narrowing laterally; palpebral lobes far removed from posterior border furrow; anterior sections of facial sutures scarcely diverging; genal spines stout, short. Hypostoma like that of *Cornuproetus.* Pygidium with 6 to 9 rings and 6 or 7 strong ribs with posterior segmental bands longer and higher than anterior, border very narrow. *U.Dev.,* C.Eu.



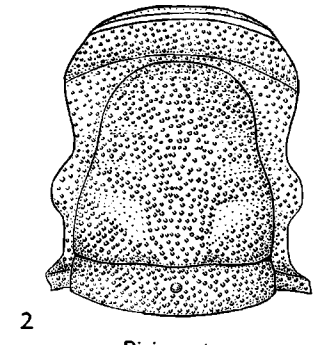


Fig. 294. Proetidae (Cornuproetinae) (p. O385-O386).

——Fig. 296,*1.* **P. marginatus* (Münster), Up. U.Dev., Ger.(Warstein); *1a-d,* cran., librigena, pyg., hypostoma, all ×3 (461, mod.).

Subfamily DECHENELLINAE Přibyl, 1946

Glabella tapering, pear-shaped or subtrapezoidal, with 3 or 4 pairs of mostly deep lateral furrows, *1p* with adaxial branch; occipital lobes developed; anterior sections of facial sutures long, markedly diverging; eyes large, crescentic close to axial furrows, palpebral lobes large; librigenae with strong genal spines. Thorax with 10 segments. Pygidium large, elongate; border distinct, at least marked by abrupt disappearance of segmentation of pleural fields; axis long, narrow, with 12 to 19 rings, no axial ridge; pleural fields with 7 to 14 ribs. *Up.L.Dev.-U.Dev.*

Dechenella Kayser, 1880 [**Phillipsia verneuili* Barrande, 1852; SD Vogdes, 1890]. Glabella with 3 or 4 distinct, mostly deep lateral fur-

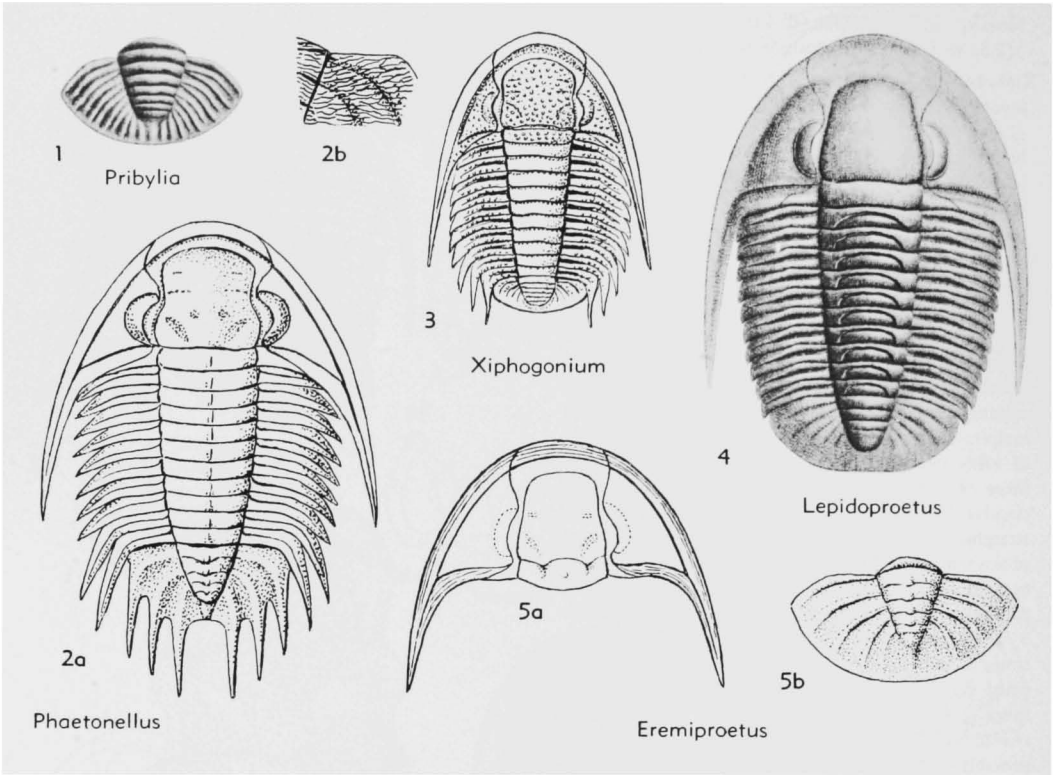


FIG. 295. Proetidae (Cornuproetinae) (p. *O386-O387*).

rows; anterior sections of facial sutures angulated at border furrow; librigenae with flat, convex, or keeled platforms. Hypostoma elongate, with long, oval anterior lobe that is sharply defined anteriorly, equally convex and without spine, with middle furrow, posterior margin bearing pair of points. Pygidium very elongate; anterior part of axis more tapering than posterior. *Up.L.Dev.-M.Dev.*, N.Hemis.

D. (Dechenella) [=*D. (Eudechenella)* RUD. RICHTER, 1912 (obj.)]. Cephalon with convex exterior border and distinct border furrow, lacking preglabellar field; glabella pear-shaped, with *1p* lobes projecting, frontal region narrower, lateral furrows very deeply incised; occipital lobes separated; genal platforms convex or keeled. Pygidium long, strongly segmented; axis with 14 to 19 rings; pleural fields with 10 to 14 sigmoidal ribs. *M.Dev.*, N.Hemis.——FIG. 297,*1*. **D. (D.) verneuili* (BARRANDE), Ger.(Gerolstein); exoskel., ×2 (460n).——FIG. 297,*6*. *D. (D.) burmeisteri* (RUD. RICHTER), Ger.(Hagen); *6a,b*, ceph., pyg., ×2 (460).

D. (Basidechenella) RUD. RICHTER, 1912 [**D. (Basidechenella) kayseri;* SD VOGDES, 1925]. Glabella tapering rather gradually, lateral furrows faint; occipital lobes not separated; genal platforms plane. Pygidium moderately elongate; axis with 12 or 13 rings; pleural fields with about 8 ribs. *Up.L.Dev., ?M.Dev.*, Eu.-N.Am.——FIG. 297,*3*. **D. (B.) kayseri*, L.Dev., Ger.(Eifel); *3a-d*, cran., librigena, pyg., internal mold of pygidial axis, ×4 (460n).

D. (Monodechenella) STUMM, 1953 [**Proetus macrocephalus* HALL, 1861]. Glabella semioval, barely tapering, moderately to highly convex, *1p* lateral furrows deeply incised, *2p* and *3p* faint or obsolete, *1p* lateral lobes separated; occipital lobes isolated. Pygidium similar to that of *D. (Dechenella)*, large, vaulted. *M.Dev.*, N.Am.——FIG. 297,*2*. **D. (M.) macrocephala* (HALL), Mich.; exoskel. lacking librigenae, ×1 (476).

D. (Praedechenella) MAKSIMOVA, 1952 [*————————]. *M.Dev.*, Sib.(Altai).

Paradechenella RUD. RICHTER, 1912 [**Dechenella tschernyschewi* RUD. RICHTER, 1909]. Preglabellar field minute; glabella long, sides nearly straight, with 3 lateral furrows similar to those of *D. (Dechenella)*, occipital lobes present; anterior sections of facial sutures sigmoidal; fixigenae very convex and librigenae equally globose. Pygidium as in *D. (Dechenella)* but with stout terminal spine projecting from distinct, convex border; axis with 13 to 17 rings; pleural fields with 7 to

11 ribs. *M.Dev.(Givet.)*, USSR(Urals).——Fig. 297,*5*. **P. tschernyschewi* (Rud. Richter); *5a-c*, cran., librigena, pyg., ×3.3 (141, 460 mod.).

Schizoproetus Rud. Richter, 1912 (**Proetus čelechovicensis* Smyčka, 1895]. Glabella parallel-sided to tapering, anterior end broadly rounded, with 4 pairs of sharp lateral furrows, *1p* lobes separated; occipital ring broad, narrowing laterally, with very distinct lobes; posterior sections of facial sutures long, located near glabella; librigenae broad, with angulated keel and small genal spines. Pygidium very convex; axis strongly raised, reaching border, with 13 or 14 rings; pleural fields with 7 to 9 prominent ribs separated by sharp pleural furrows. *M.Dev.*, Eu.——Fig. 297,*4*. **S. celechovicensis* (Smyčka), Czech.; *4a,b*, ceph., pyg., ×2.7 (460n).

Subfamily CYRTOSYMBOLINAE Hupé, 1953

[*nom. transl.* Richter & Richter, herein (*ex* Cyrtosymbolidae Hupé, 1953)]

Exoskeleton mostly minute; glabella long, tapering, in some late genera becoming nearly rectangular, with 3 or 4 pairs of distinct to fading lateral furrows, without basal deterioration ("basisolution"); occipital ring typically narrowing laterally, without lobes; eyes degenerating in some groups, giving way to straightening of facial sutures so as to migrate outward or coalesce. Thorax with 8 or 9 segments. Pygidium generally not longer than semicircle; with few segments, axis having at most 6 to 11 rings and pleural fields 4 to 10 (or ?11) ribs. [The Cyrtosymbolinae contain homeomorphic genera of perhaps different origin and others with trend toward Tropidocoryphinae and Phillipsiinae, from which they are distinguished mainly by features of the pygidium.] *L.Dev.-L.Carb.*

Cyrtosymbole Rud. Richter, 1913 [**Dechenella escoti* Koenen, 1886]. Exoskeleton of moderate size, some species minute. Cephalon without distinct frontal border, preglabellar field more or less developed, concave; glabella tapering, with 3 pairs of generally pronounced lateral furrows; occipital ring narrowing laterally, occipital lobes not present; anterior sections of facial sutures long, diverging; eyes not far from axial furrows, palpebral lobes distinctly curved; librigenae broad, with genal spines. Thorax with 8 to 10 segments. Pygidium semicircular to slightly elongate, with few segments; pleural fields with 5 (seldom 9) transversely directed ribs, segmental bands not very different in width *(exsag.)* and height, pleural and interpleural furrows distinct; doublure convex upwards. *M.Dev.-L.Carb.*, Eu.

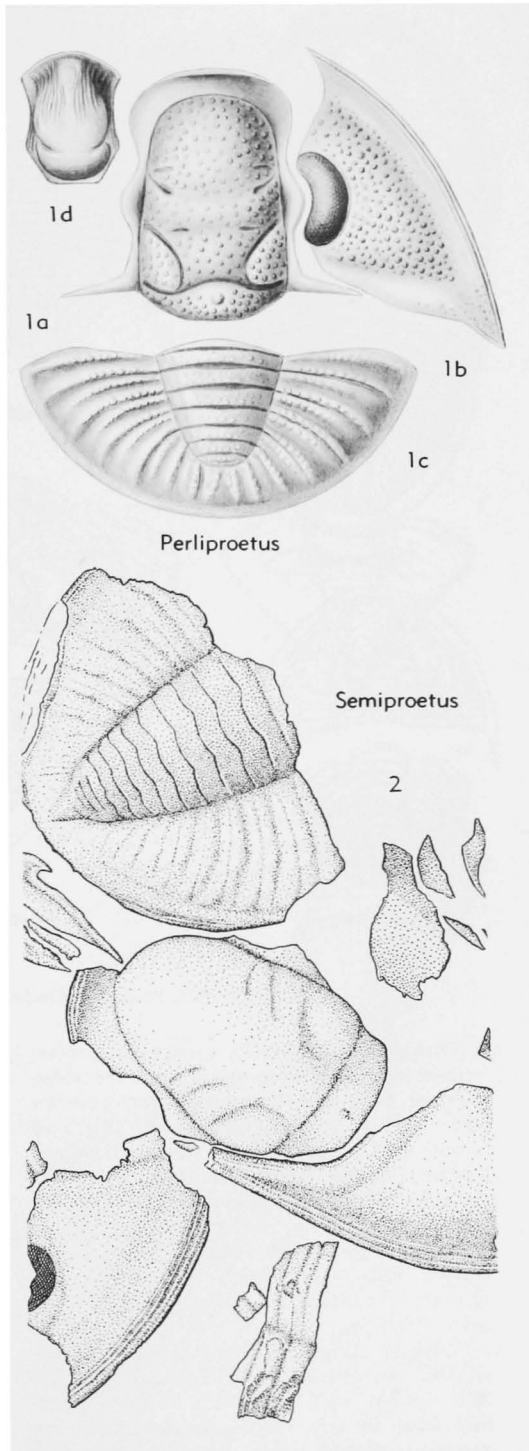


Fig. 296. Proetidae (Cornuproetinae, Cyrtosymbolinae) (p. O387, O392).

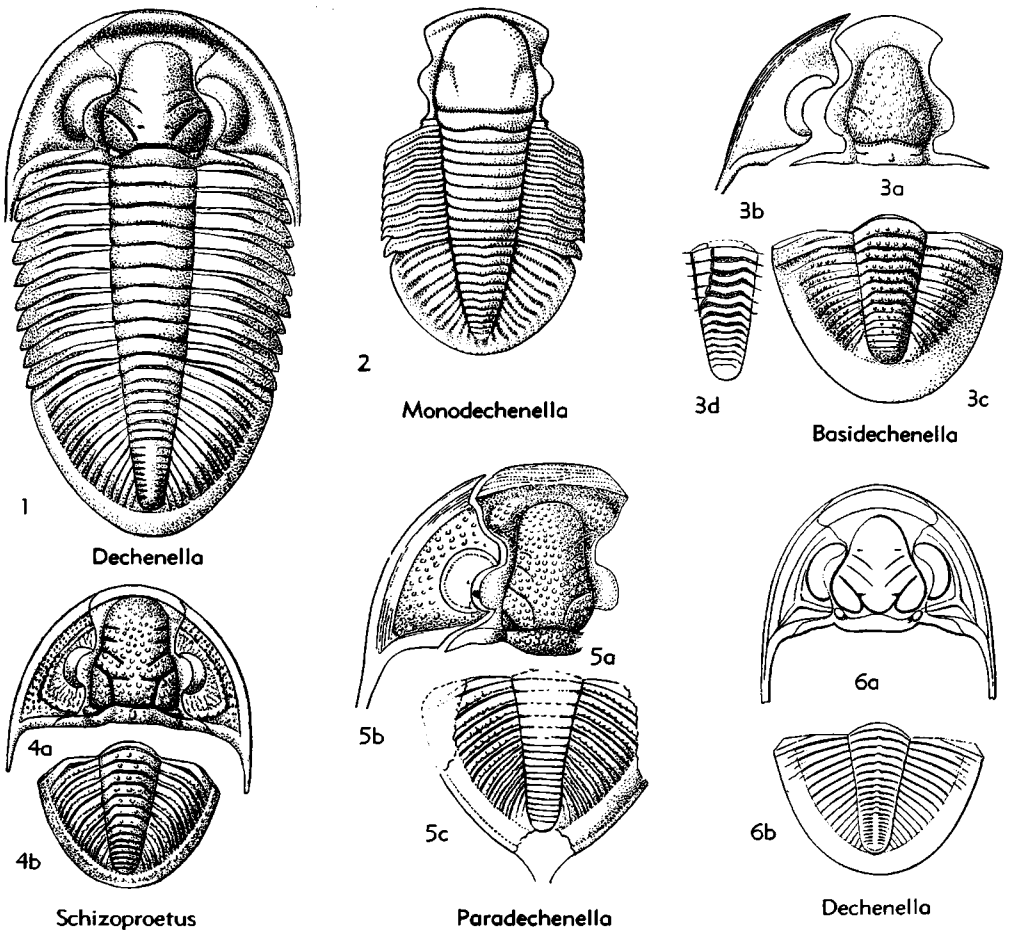


FIG. 297. Proetidae (Dechenellinae) (p. O388-O389).

C. (Cyrtosymbole). Glabella moderately slender; occipital ring narrowing strongly toward sides; palpebral lobes somewhat distant from posterior border furrow; facial sutures mainly near axial furrows but anterior sections strongly diverging forward, posterior sections diverging only slightly for short distance behind eyes but then turning abruptly outward in border furrow. Pygidium semicircular, border and doublure rather narrow. *U.Dev.*, Eu.——FIG. 298,*1*. **C. (C.) escoti* (KOENEN), Fr.(Cabrières); *1a*, cran., ×8; *1b*, pyg., ×4 (460, mod.).

C. (Calybole) RICHTER & RICHTER, 1926 [**Cyrtosymbole calymmene* RUD. RICHTER, 1913]. Glabella slender, with deep lateral furrows; palpebral lobes in type species elevated above apparently coalesced genae. Pygidium with very pronounced ribs; border not differentiated from pleural fields; doublure narrow. *U.Dev.*, Eu.——FIG. 298,*2*. **C. (C.) calymmene* (RUD. RICHTER), Ger.(Oberscheld); *2a,b*, incompl. ceph., pyg., ×8 (460, mod.).

C. (Cyrtodechenella) RICHTER & RICHTER, 1950 [**C. (Cyrtodechenella) cyrto*]. Cephalon with broad *(sag.)* preglabellar field, frontal border missing or very narrow rim present; *2p* and *3p* lateral furrows indistinct; occipital ring abruptly narrowing toward sides and then expanding near ends; palpebral lobes extending far backward with anterior ends rather distant from glabella; posterior sections of facial sutures close to glabella and then turning outward nearly at right angles; librigenae slightly vaulted. Pygidium relatively long, with broad steeply sloping border that is not delimited from pleural fields by furrow; axis with 10 or 11 rings; pleural fields with 7 distinct ribs. *M.Dev.-Low.U.Dev.*, Eu.——FIG. 298,*10*. **C. (C.) cyrto*, M.Dev.(Givet.), Ger.(Eifel); *10a-c*, cran., librigena, pyg., ×6 (474n).

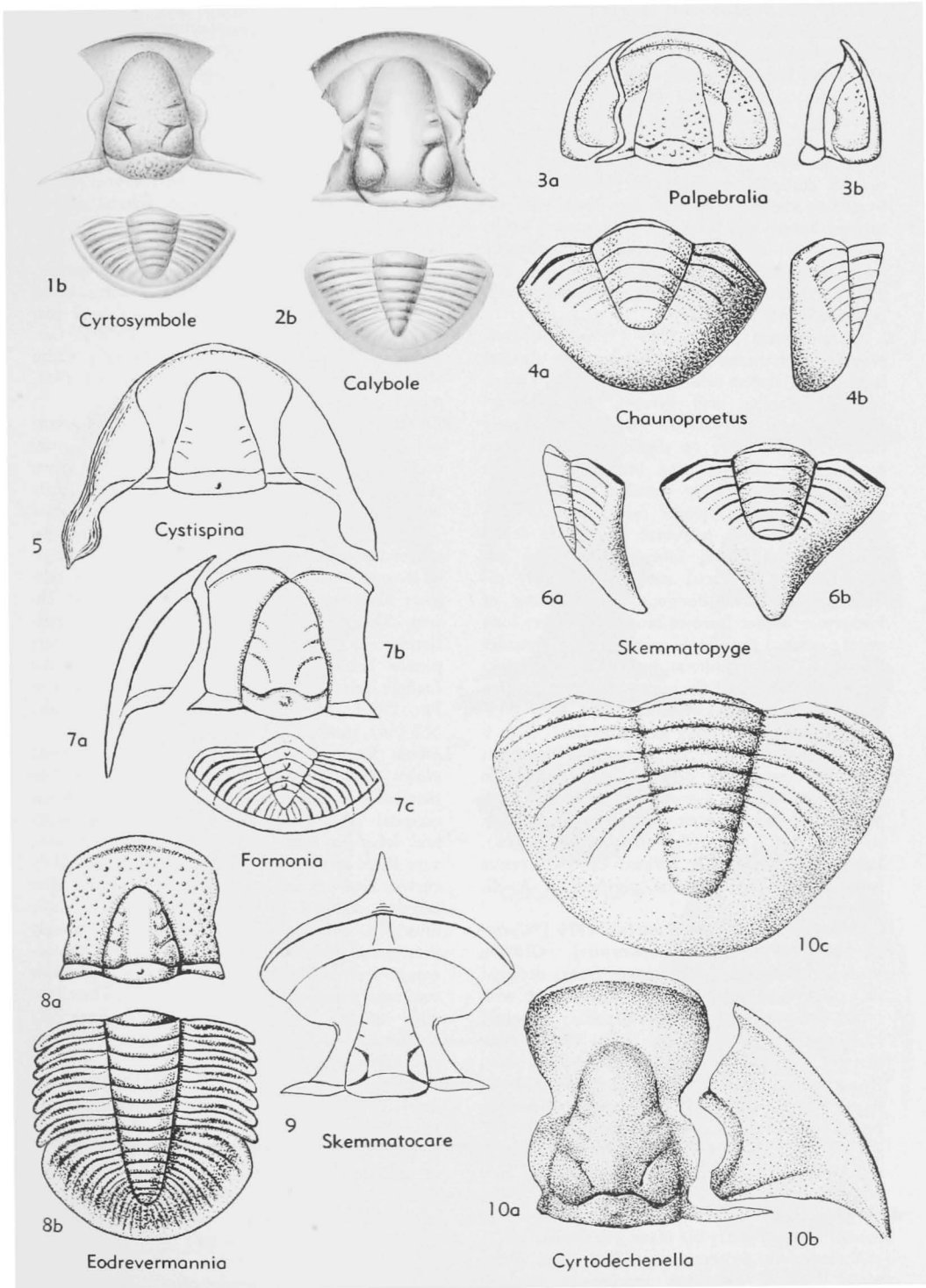


FIG. 298. Proetidae (Cyrtosymbolinae) (p. O390-O394).

C. (Macrobole) RICHTER & RICHTER, 1951 [**Cyrtosymbole (Macrobole) drewerensis*]. Glabella moderately tapering, with obtuse front; palpebral lobes at mid-length of cephalon, narrow, moderately curved; anterior sections of facial sutures moderately divergent, posterior sections long, parallel to axial furrows behind eyes, turned abruptly outward in border furrow. Pygidium somewhat broader than long, with indistinct border and long axis that bears 9 rings; pleural fields with 10 ribs, posterior segmental bands predominating. *Low.L.Carb.*, Ger.——FIG. 299,*1*. **C. (M.) drewerensis*, Ger.(Sauerland); cran., ×3.3 (461, mod.).

C. (Semiproetus) REED, 1943 [**Proetus (Semiproetus) twistonensis*]. Cephalon with distinct border, preglabellar field moderately broad *(sag.)*, concave; glabella well defined, slightly pear-shaped, lateral furrows *3p* and *1p* moderately distinct, lateral lobes *1p* slightly detached from central area; occipital ring broad *(sag.)*, with lateral parts indistinctly detached from middle part and somewhat broader *(sag.)*, median occipital node present; palpebral lobes well developed, opposite lateral lobes *3p* and *2p;* anterior sections of facial sutures moderately diverging; eyes well developed on swelling of librigenae; border furrows broadly concave; long genal spines. Pygidium semielliptical, broader than long; axis prominent, broad, tapering backward; with about 13 flat rings, posterior margins of which curve backward mesially; with postaxial ridge; pleural lobes gently vaulted; 7 to 9 pairs of broad *(sag.)*, flat ribs that show slight swelling where they begin to slope down to border; interpleural furrows faint; border flatly padded; no border furrow. *L.Carb.*, Eng.-?Ger.——FIG. 296,*2*. **C. (S.) twistonensis* (REED), Lancs.; fragments, ×4 (drawn by W. STRUVE from cast of type material, courtesy of A. G. BRIGHTON).

C. (Waribole) RICHTER & RICHTER, 1926 [**Cyrtosymbole (Waribole) warsteinensis*]. Glabella moderately tapering, with obtuse front; occipital ring narrowing laterally from middle but with broad ends, wider *(tr.)* than glabella; palpebral lobes reaching far backward; facial sutures close to axial furrows just in front and behind eyes, thence rather strongly diverging sideward. Pygidium with broad indistinct border; doublure broad, very convex upward. *U.Dev.-L.Carb.*, Eu.——FIG. 299,*5*. **C. (W.) warsteinensis*, L.Carb., Ger.(Warstein); *5a*, cran. and librigenae, ×4; *5b*, pyg., ×4.5 (461, mod.).

Archegonus BURMEISTER, 1843 [**Calymene? aequalis* MEYER, 1831; SD HAWLE & CORDA, 1847] [=*Cylindraspis* SANDBERGER, 1850 (*non* FITZINGER, 1836)]. Cephalon moderately vaulted; frontal border a narrow rim; glabella slender, tapering, not rounded anteriorly or reaching the distinct but rather narrow anterior border furrow; occipital ring maintaining width *(sag.)* laterally or slightly broadening; palpebral lobes distinct, slightly behind mid-length of glabella; anterior sections of facial sutures moderately divergent, posterior sections directed posterolaterally; librigenae with short, sharply pointed genal spines. Pygidium rather flat, slightly longer than semicircle; axis slender, well above pleural fields, with 8 or 9 distinct rings; abaxial part of pleural fields gently sloping, with 5 to 9 flat ribs consisting of nearly balanced anterior and posterior segmental bands, pleural furrows narrow, distinct, passing onto indistinct border, interpleural furrows visible only in anterolateral part of pleural fields; no border furrow. *L.Carb.*, Ger.——FIG. 299,*9*. **A. aequalis* (MEYER), Culm (III), Herborn; *9a,b*, cran., librigena, ×4 (461, mod.).

Phillibole RICHTER & RICHTER, 1937 [**P. aprathensis*]. Glabella slightly pear-shaped to tapering; occipital ring with broad ends, lacking lobes; palpebral lobes opposite mid-length of glabella with anterior ends nearest to glabella; anterior sections of facial sutures moderately long and divergent, posterior sections long, close and subparallel to axial furrows; posterior part of fixigenae narrow; librigenae with genal spines present or absent. Thorax with 9 segments. Pygidium semicircular or slightly elongate, without border; pleural fields with 11 or more segments. [Like *Liobole*, related to Phillipsiinae.] *L.Carb.*, Eu.——FIG. 299,*4*. **P. aprathensis*, Ger.(Aprath); cran., ×2 (461, mod.).

Liobole RICHTER & RICHTER, 1949 [**Phillipsia glabra* HOLZAPFEL, 1889]. Glabella with subparallel sides; ends of occipital ring very wide, occipital lobes present but not separated; palpebral lobes in front of mid-length of cranidium, very short and narrow, with margins only slightly curved and anterior ends nearest to glabella; anterior sections of facial sutures short, little divergent, posterior sections very long, strongly divergent; posterior part of fixigenae long, broadening uniformly to posterior margin. [*Liobole* combines pygidial features of the Cyrtosymbolinae with cephalic characters of the Phillipsiinae.] *L. Carb.*, Eu.——FIG. 299,*2*. **L. glabra* (HOLZAPFEL), Ger.; cran., ×2 (461, mod.).

Liobolina RICHTER & RICHTER, 1951 [**L. nebulosa*]. Glabella subparallel-sided; ends of occipital ring slightly narrowed, not vaulted, without lobes; palpebral lobes very indistinct, nearly at mid-length of cranidium, with anterior ends nearest to glabella; anterior sections of facial sutures nearly parallel, posterior sections long, subparallel near palpebral lobes, then strongly divergent toward posterior margin; posterior part of fixigenae narrow, with long prolongation on posterior border. [Relations to Phillipsiinae like *Liobole*.] *L.Carb.*, Eu.——FIG. 299,*3*. **L. nebulosa*, Ger. (Sauerland); cran., ×2.7 (461, mod.).

Drevermannia Rud. Richter, 1909 [**Drevermannia schmidti* Rud. Richter, 1913]. Glabella tapering, anterior part in some species finger-shaped; occipital ring narrowing laterally, without lobes; facial sutures distant from glabella, nearly straight; without palpebral lobes (except indicated in some *Palpebralia*), no visual area; librigenae moderately vaulted, pointed or spine-bearing. Thorax (as far

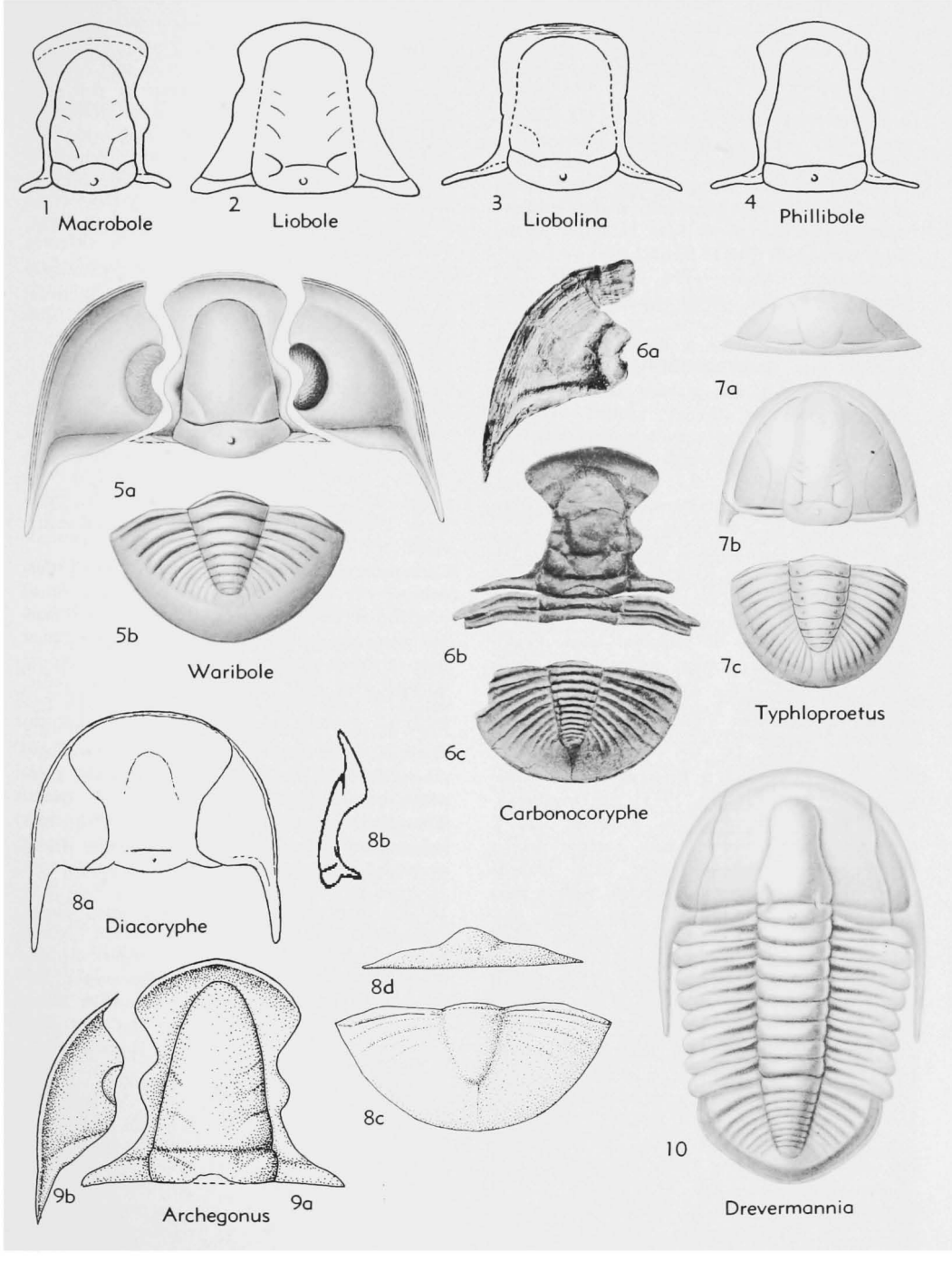


Fig. 299. Proetidae (Cyrtosymbolinae) (p. O392-O395).

as known) with 8 segments, ends pointed. Pygidium semicircular; axis with 5 to 11 rings; pleural fields with 6 to 10 ribs, pleural and interpleural furrows distinct. *Up.L.Dev.-L.Carb.*, Eu.

D. (Drevermannia). Preglabellar field minute. Pygidium with narrow convex border. *Up.U.Dev.-L.Carb.*, Eu.——FIG. 299,*10*. *D. (D.) pruvosti* RICHTER & RICHTER, L.Carb., Menorca; exoskel., ×4 (461).

D. (Eodrevermannia) PŘIBYL, 1946 [**D. (Eodrevermannia) bouškai*]. Cephalon with distinct narrow anterior border; preglabellar field broad, moderately convex; fixigenae very broad; genal angles pointed. Pygidium with slightly concave margin; axis short, with 6 to 11 rings; pleural fields wide, with 6 to 10 distinct ribs. *Up.L.Dev.-Low.M.Dev.*, Czech.——FIG. 298,*8*. **D. (E.) bouskai; 8a,b,* cran., thorax and pyg., ×7 (445a, mod.).

D. (Formonia) RICHTER & RICHTER, 1927 [**D. formosa* RUD. RICHTER, 1913]. Cephalon with distinct convex border; glabella narrow, appearing plunged into strongly vaulted fixigenae. Pygidium with narrow convex border; axis with 5 or 6 rings; pleural fields with 4 to 6 ribs. *U.Dev.*, Eu.——FIG. 298,*7*. **D. (F.) formosa,* (RUD. RICHTER), Ger.(Oberscheld); *7a-c,* librigena, cran., pyg., ×8 (461n).

D. (Palpebralia) RICHTER & RICHTER, 1927 [**D. palpebralis* RICHTER & RICHTER, 1926]. Cephalon without distinct border; glabella rather stout; mostly with vestiges of eye ridges, some also showing indications of palpebral lobes. Pygidium with convex border, segmentation indistinct. *M.Dev.-U.Dev.*, Eu.-Afr.——FIG. 298,*3*. **D. (P.) palpebralis* RICHTER & RICHTER, Low. U.Dev., Ger.(Langenaubach); *3a,b,* cran. with librigenae, dorsal, side, ×5 (461).

Chaunoproetus RICHTER & RICHTER, 1919 [**Proetus palensis* RUD. RICHTER, 1913]. [=*Drevermannia (Carnicia)* RICHTER & RICHTER, 1927]. Cephalon highly vaulted, with anterior border concave, erect; no preglabellar field; glabella stout, anterior end broadly rounded, with 4 pairs of lateral furrows; occipital ring broad, narrowing laterally, no lobes; facial sutures nearly straight, coalesced, crossing posterior border furrow on ridge; no palpebral lobes or eyes; genal angles rounded. Pygidium vaulted, laterally and posteriorly down curved steeply to margin, without border or border furrow; axis short, no axial ridge; segmentation fading on posterior region; doublure parallel to very convex upper test. *U. Dev.*, Eu.——FIG. 298,*4*. **C. palensis* (RUD. RICHTER), Ger.(Ebersdorf); *4a,b,* pyg., ×6 (461).——FIG. 300,*2*. *C. carnicus* (RUD. RICHTER), Austr. (Carnic Alps); *2a,b,* ceph., ×4 (460).

Skemmatopyge RICHTER & RICHTER, 1919 [**S. tietzei*]. Pygidium triangular, prolonged backward into point, very convex, without border or border furrow; axis short; with few rings; pleural fields with few broad low ribs. *U.Dev.*, C.Eu.——FIG. 298,*6*. **S. tietzei,* Ger.(Ebersdorf); *6a,b,* pyg., ×6 (461).

Skemmatocare RICHTER & RICHTER, 1927 [**Otarion elegans* MÜNSTER, 1842]. Cephalon (possibly belonging to pygidium named *Skemmatopyge*) narrow, with flat border bearing frontal spine; preglabellar field broad *(sag.)*, anterior part concave, sharply defined from convex posterior part; glabella slender triangular, with pair of ovoid separated *1p* lateral lobes; occipital ring with narrowed ends, without lobes; posterior sections of facial sutures long, directed outward, forming sharp angle with anterior sections. *U.Dev.*, C.Eu. ——FIG. 298,*9*. **S. elegans* (MÜNSTER), Ger. (Wildungen); cran., ×6.5 (461n).

Cystispina RICHTER & RICHTER, 1939 [**Phillibole? (Cystispina) cystispina* RICHTER & RICHTER, 1939]. Cephalon with narrow preglabellar field; glabella tapering with broad front; no occipital lobes; palpebral lobes slightly curved or absent; facial sutures curved, anterior sections divergent; eyes very narrow or visual area missing; fixigenae with broad posterior areas; inflated genal spines. Pygidium with narrow, slightly tapering axis, distant from posterior margin; border not separated. *L.Carb.*, Eu.——FIG. 298,*5*. **C. cystispina* (RICHTER & RICHTER), Ger.(Frankenau); ceph., ×5 (461).

?Carbonocoryphe RICHTER & RICHTER, 1950 [**Carbonocoryphe bindemanni*]. Cephalon with broad preglabellar field, concave, without border, margin sharp; glabella tapering gently, with rather long glabellar region in front of *3p* furrows; occipital ring not narrowed laterally, no lobes; palpebral lobes distant from posterior border furrow; anterior sections of facial sutures strongly divergent, posterior sections long, increasingly divergent; librigenae broad, flat, continuing gradually into broad, sickle-shaped genal spines. Thoracic segments (number unknown) with sickle-shaped ends. Pygidium large, without border or border furrow; axis rather long, narrow, with 12 rings and axial ridge; pleural fields with 9 or 10 ribs that (unlike Tropidocoryphinae) consist predominantly of posterior segmental bands, higher than anterior; interpleural furrows distinct. Doublure extremely broad. [*Carbonocoryphe* possesses some characters of genera assigned to Tropidocoryphinae and Phillipsiinae.] *L.Carb.*, Ger. ——FIG. 299,*6*. **C. bindemanni,* Herborn; *6a-c,* librigena, cran., pyg., ×2 (461).

?Diacoryphe RICHTER & RICHTER, 1951 [**Diacoryphe pfeifferi*]. Cephalon with very broad slightly concave preglabellar field, no border; glabella tapering, glabellar region in front of (only indicated) pair of *3p* furrows long; axial furrows obsolete; occipital ring narrowed laterally, confluent with glabella and fixigenae; anterior sections of facial sutures strongly divergent, palpebral lobes and eyes minute or lacking; genal

spines long. Pygidium shorter than semicircle; axis narrow, short, with 8 barely discernible rings, axial ridge present; pleural fields with 3 faint ribs (in space for 7), broadening outward, anterior segmental bands somewhat broader than posterior. [Some features correspond to *Pteroparia.*] *Low.L. Carb.*, Ger.——FIG. 299,*8*. **D. pfeifferi*, Saalfeld; *8a*, ceph.; *8b*, cran., side; *8c,d*, pyg., dorsal, post.; all ×4 (461n).

?**Typhloproetus** RUD. RICHTER, 1913 [**T. microdiscus*] [=*Helioproetus* RICHTER & RICHTER, 1918]. Cephalon forming high uniform vault that includes glabella and genae; border furrow incised; glabella reaching border, long, slender; glabellar region in front of *3p* furrows long; axial furrows generally obsolete; occipital ring narrowed laterally, no lobes; facial sutures coalesced, anterior sections divergent, supramarginal nearly throughout; palpebral lobes and eyes vestigial or entirely vanished; with genal spines. Pygidium elongate semicircular, vaulted, without distinct border; axis short, slender, with about 8 rings, axial ridge present; pleural fields with 6 to 10 radiating ribs, anterior segmental bands broader than posterior, pleural and interpleural furrows equally distinct. *Up.U.Dev.-L.Carb.*, Eu.——FIG. 300,*1*. **T. microdiscus*, U.Dev., Austr.(Carn.Alps); *1a-c*, ceph., ×4 (460).——FIG. 299,*7*. *T. subcarintiacus* (RUD. RICHTER), U.Dev., Ger.(Sauerland);*7a-c*, ceph., pyg., ×4 (461).

Subfamily PROETIDELLINAE Hupé, 1953

Exoskeleton depressed, 8 to 20 mm. in length. Cephalon with broad *(sag.)* preglabellar field; glabella tapering forward, suboval or trapezoidal, *1p* lateral furrows distinct; anterior sections of facial sutures long, strongly divergent; eyes large, restricted to posterior half-length of cephalon, tending to be strongly crescentic; librigenae broad, slightly vaulted uniformly, extended into broad genal spines. Thorax with 9 or 10 segments. Pygidium rather long, nearly semicircular, entire; axis narrow, long, with 6 to 11 rings; pleural fields with 4 to 7 ribs, radiating, broadening outward, segmental bands and furrows diverging. *M.Ord.-M. Dev.*

Proetidella BANCROFT, 1949 [**Proetidella fearnsidesi*]. Cephalon with moderately broad preglabellar field, anterior part ascending; glabella short, with subangular front; occipital ring broad, lobes indicated. Thorax with 10 segments (20 mm. long.), ends sharply pointed. Pygidium with axis having 10 rings; pleural fields with about 6 ribs curved backward. *M.Ord.(Caradoc.)*, Eng. ——FIG. 301,*1*. *P. fearnsidesi*, Shrops.; exoskel., ×2 (2).

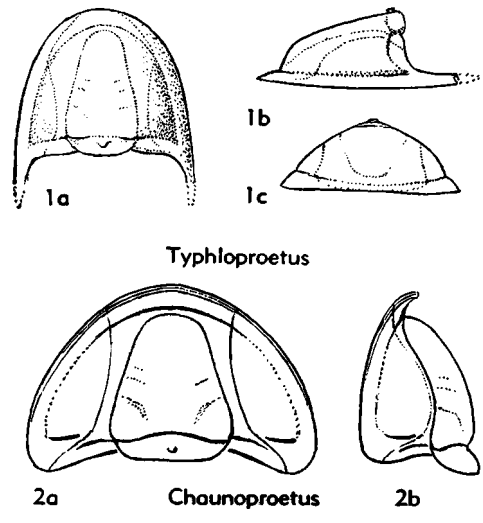


FIG. 300. Proetidae (Cyrtosymbolinae) (p. O394-O395).

Astroproetus BEGG, 1939 [**Astroproetus reedi*]. Cephalon with preglabellar field scarcely 0.7 of length of glabella; glabella trapezoidal, gently tapering; eyes long, strongly arcuate. Thorax with 10 segments (length 16 mm.). *U.Ord.(Ashgill.)*, G.Brit.——FIG. 301,*4*. **A. reedi*, Scot.(Girvan); exoskel., ×1.5 (375).

Clypoproetus BEGG, 1939 [**Clypoproetus asteroideus*]. Cephalon with preglabellar field nearly 0.7 of length of broadly subtriangular glabella, which has *1p* lobes separated. Thorax with 9 segments (length 8 mm.). Pygidium with axis containing 6 rings; pleural fields with 6 ribs. *U.Ord. (Ashgill.)*, G.Brit.——FIG. 301,*5*. **C. asteroideus*, Scot.(Girvan); exoskel., ×2.2 (375).

Paryfenus HADDING, 1913 [*pro Colymbus* HADDING, 1913 (*non* LINNÉ, 1758, *nec* PAETEL, 1875] [**Colymbus lovisae* HADDING, 1913]. Glabella finger-shaped, reaching close to broad anterior border; *1p* lateral glabellar lobes egg-shaped, detached, about 0.125 of glabellar length *(exsag.)*; palpebral lobes semicircular, 0.2 of glabellar length, close to glabella and posterior border furrow; anterior sections of facial sutures strongly divergent. *Low.M.Ord.*, Swed.

Prantlia PŘIBYL, 1946 [**Proetus longulus* HAWLE & CORDA, 1847]. Cephalon and thorax like those of *Clypoproetus;* lobes of occipital ring distinct, long *(tr.)*. Pygidium very large, considerably longer than semicircle; tapered axis long and narrow, with 11 distinct rings, axial ridge short; pleural fields with 6 or 7 ribs with narrow low anterior segmental bands and high posterior ones, broadening outward. *U.Sil.*, Eu.——FIG. 301,*6*.

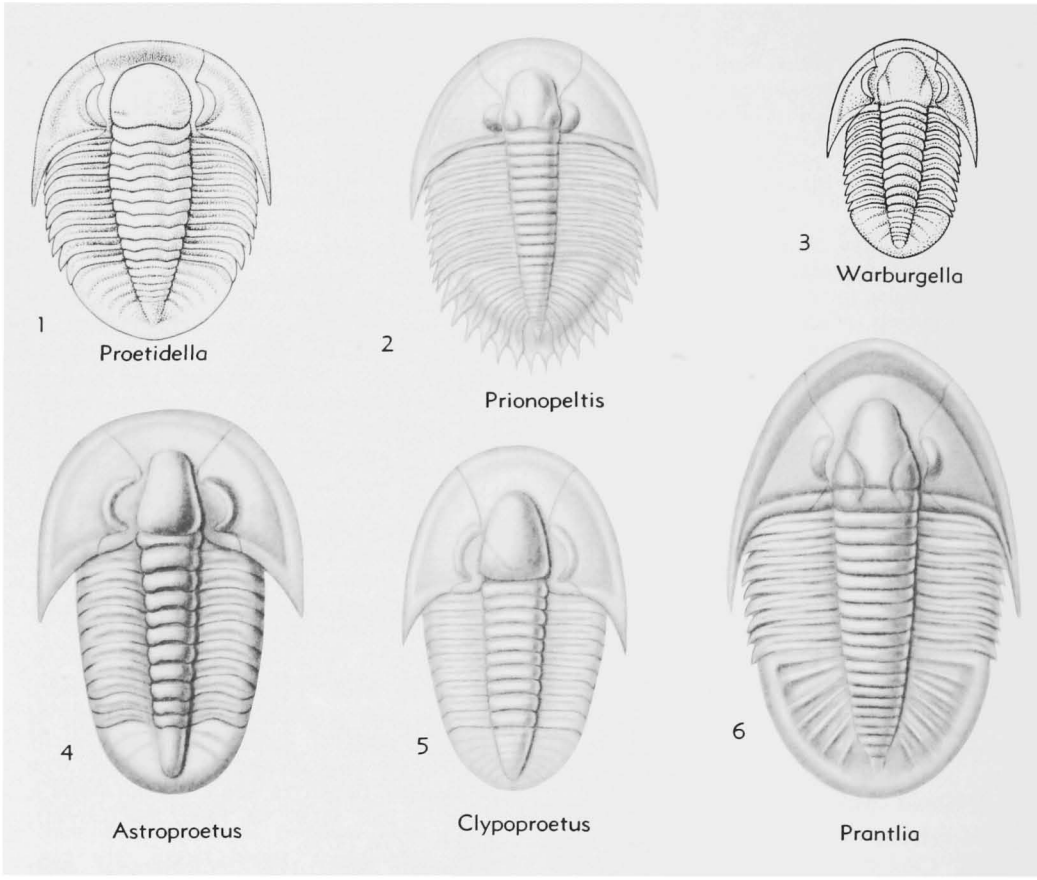


FIG. 301. Proetidae (Proetidellinae) (p. *O*395-*O*396).

**P. longula* (HAWLE & CORDA), Czech.; exoskel., ×2.7 (445a).

?**Prionopeltis** HAWLE & CORDA, 1847 [*pro Phaeton* BARRANDE, 1846 (*non* LINNÉ, 1758] [**Phaeton archiaci* BARRANDE, 1846; SD VOGDES, 1925] [=*Prionurus* HAWLE & CORDA, 1847, p. 288 (*non* LACÉPÈDE, 1804; *non* RAFINESQUE, 1815; *non* HEMPRICH & EHRENBERG, 1829); *Phaetonides* ANGELIN, 1854]. Cephalon with outer border rather narrow, border furrow distinct and preglabellar field conspicuous; glabella short, scarcely tapering, with broad rounded front, *1p* lateral lobes separated; anterior sections of facial sutures long, strongly divergent; librigenae broad, continuing into long furrowed genal spines; visual surface of eyes large but short. Thorax with 10 segments, pleurae with pointed ends. Pygidium large; axis long and narrow, with 9 or 10 rings; pleural fields with 4 to 7 pleurae that continue into marginal spines; no border or border furrow. *Sil.-M.Dev.*, Eu.——FIG. 301,*2*. **P. archiaci* (BARRANDE), Sil. (e beta Zone), Czech.; exoskel., ×1.5 (3).

?**Pseudoproetus** POULSEN, 1934 [**Proetus (Pseudoproetus) regalis*]. Cephalon with narrow border and distinct border furrow, preglabellar field long *(sag.)*; glabella short, semioval, glabellar region in front of *2p* furrows short; occipital ring not narrowed laterally, lobes distinct; palpebral lobes short, eye ridges distinct; anterior sections of facial sutures almost straight and subparallel; librigenae moderately convex, genal spines furrowed. Pygidium longer than semicircle; axis narrow, touching narrow convex border, with 12 or 13 rings; pleural fields with 10 faint furrowed ribs. *Sil.(Llandov.)*, Greenl.——FIG. 302,*2*. **P. regalis* (POULSEN); *2a-c*, cran., librigena, pyg., ×2 (445).

?**Warburgaspis** PŘIBYL, 1946 [**Proetus modestus* TÖRNQUIST, 1884]. Cephalon as in *Proetus (Proetus)*, but librigenae and pygidium as in *Proetidella*. Thorax with 10 segments (total length 14 mm.). *Ord.(Ashgill.)*, Swed.

?**Warburgella** REED, 1931 [**Asaphus stokesii* MURCHISON, 1839]. Cephalon as in *Proetus (Cyphoproetus)* but with narrow convex preglabellar

field. Thorax with 10 segments (length 13 mm.). Pygidium like that of *Proetidella. Sil.(Wenlock.)*, Eng.——Fig. 301,*3*. **W. stokesii* (Murchison), Dudley; exoskel., ×2 (495).

Subfamily TROPIDOCORYPHINAE Přibyl, 1946

Cephalon with large preglabellar field marked by narrow ridge (tropidia) concentric to border; glabella short (0.5 to 0.7 length of cephalon), narrow, tapering, front rounded to truncate; glabellar region in front of *3p* furrows very short, *1p* lateral lobes not separated; occipital ring not narrowed laterally, without lobes; genal spines furrowed. Thorax with 9 or 10 segments, ends sickle-shaped. Pygidium entire; slender tapering axis with 6 to 9 rings, axial ridge present; pleural fields with 5 to 7 ribs developed as sharp, wide-spaced ridges consisting only of anterior segmental bands, pleural furrows broad, interpleural furrows faint. Shell thin, doublure broad. *Sil.-Low. U.Dev.*

Tropidocoryphe Novák, 1890 [**T. filicostata;* SD Vogdes, 1925]. Cephalon depressed, margin sharp, without border or rim; glabella about 0.5 of length of cephalon; anterior sections of facial su-

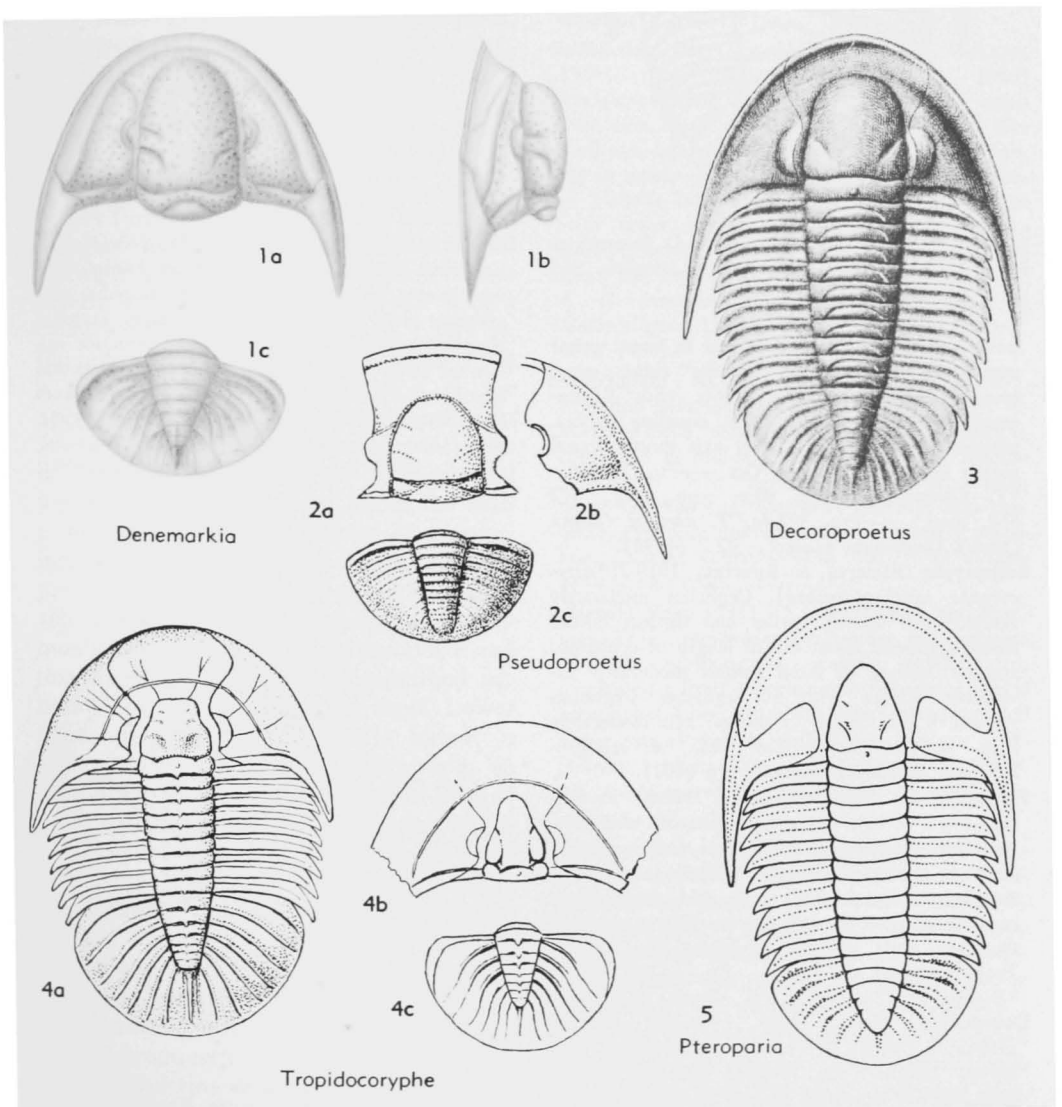


Fig. 302. Proetidae (Proetidellinae, Tropidocoryphinae) (p. *O396-O398*).

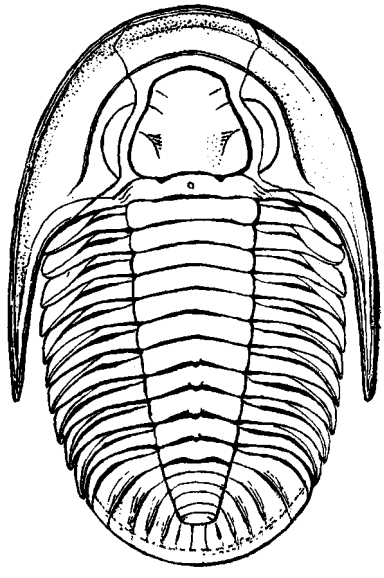


FIG. 303. *Astycoryphe senckenbergiana* RICHTER & RICHTER (Proetidae), M.Dev., Ger.; exoskel., ×4 (461, 1919).

tures strongly divergent, marginal in front; genae commonly with radiating "vascular" ridges, genal spines prominent, stout. Thorax with 9 segments. Pygidium large, length equaling thorax, margin sharp without border; axis short; pleural region large, flat. *M.Dev.*, Ger.——FIG. 302,*4b,c*. **T. filicostata*, Bicken; *4b,c*, ceph., pyg., ×2 461, mod.).——FIG. 302,*4a*. *T. barroisi* (MAILLIEUX), Gerolstein; exoskel., ×2.7 (474n).

Astycoryphe RICHTER & RICHTER, 1919 [**Astycoryphe senckenbergiana*]. Cephalon moderately vaulted with convex border and distinct border furrow; glabella about 0.7 of length of cephalon; anterior sections of facial sutures moderately divergent. Thorax with 10 segments. Pygidium vaulted, 0.5 of length of thorax; axis moderately long. *M.Dev.*, Ger.——FIG. 303. **A. senckenbergiana*, Gerolstein; exoskel., ×6 (461).

?**Decoroproetus** PŘIBYL, 1946 [**Proetus decorus* BARRANDE, 1846]. Cephalon depressed, with narrow rim; preglabellar field broad *(sag.)*, distally concave, proximally convex; glabella nearly rectangular; occipital ring, genae and genal spines resembling those of *Astycoryphe*. Thorax with 10 segments, ends pointed. Pygidium like that of *Tropidocoryphe*. *Sil.-M.Dev.*, Eu.——FIG. 302,*3*. **D. decorus* (BARRANDE), Sil., Czech.; ×2.4 (3).

Denemarkia PŘIBYL, 1946 [**Proetus frontalis* HAWLE & CORDA, 1847]. Cephalon vaulted, with narrow anterior rim, tropidia present; glabella long, scarcely tapering; *1p* and *2p* lateral furrows distinct; occipital ring narrowing laterally, no lobes; anterior sections of facial sutures strongly divergent, posterior sections long, parallel to axial furrows; eyes small; librigenae continuing gradually into broad genal horns. Thorax with 10 segments, ends pointed. Pygidium similar to that of *Tropidocoryphe* but with broader and longer axis bearing 7 rings; pleural fields with 5 ribs. *L.Dev.*, Czech. —— FIG. 302,*1*. **D. frontalis* (HAWLE & CORDA) Koněprusy Ls., *1a,b*, ceph., ×7; *1c*, pyg., ×10 (445a).

?**Phyllaspis** REINH. RICHTER, 1863 [**P. raniceps*]. Cephalon ogival, flat; genal regions and preglabellar field very large; marginal part of cephalic border bent slightly upward, accompanied inward by 2 faint, flat, parallel swellings; glabella small, slender, flat, axial furrows distinct; lateral furrows faint, directed obliquely backward. [Poorly known genus established on a single, fragmentary cranidium that shows similarities to *Pteroparia* and *Astycoryphe*. Whether outline of posterolateral margin of figured fragment represents a facial suture or merely a fracture is uncertain.] *M.Dev.*, Ger.——FIG. 304. **P. raniceps*, Tentaculiten-Schiefer, Thuringia; cephalon(incompl.), ×2 (459).

Pteroparia RUD. RICHTER, 1913 [**P. columbella*]. Cephalon moderately vaulted; outer border convex, border furrow incised, without tropidia, preglabellar field broad; glabella tapering; occipital ring not narrowed laterally, no lobes; anterior section of facial sutures curved backward; palpebral lobes and eyes minute or missing; genal spines long. Pygidium resembling that of *Astycoryphe*. *Low.U.Dev.*, Eu.-Austral.——FIG. 302,*5*. **P. columbella*, Ger.(Oberscheld); exoskel., ×6 (460n).

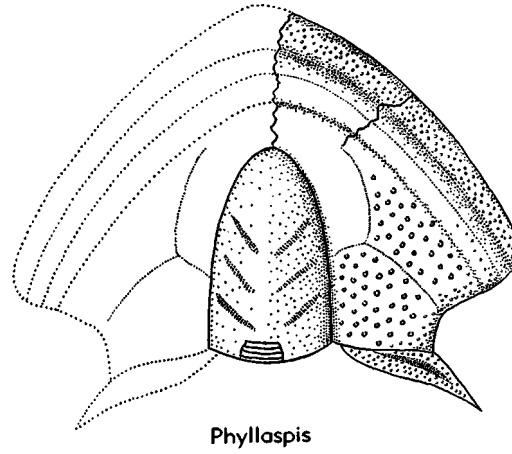


FIG. 304. **Phyllaspis raniceps* REINH. RICHTER (Proetidae), M.Dev., Ger.; incompl. cran., ×2 (461, 1919).

Family PHILLIPSIIDAE Oehlert, 1886

[*emend.* Hupé, 1953]

Small (2 cm. maximum width); isopygous. Glabella long, generally expanded in front, generally reaching to or beyond anterior border furrow; lateral preoccipital lobes invariably present, lateral glabellar furrows 3 or 4, *1p* distinct, others commonly indistinct; occipital ring normally without lobes. Thorax with 9 segments. Pygidium generally long, multisegmented (7 to 33 axial rings, 6 to 14 pleural ribs). Surface generally bearing granules, tubercles, or very short spines. *L.Carb.(Miss.)-M.Perm.*

Most phillipsiids are small trilobites (width 15 mm. or less). A few from Lower Mississippian strata have 10 thoracic segments, but all others, so far as known, have 9. All are distinguished by a comparatively large glabella that reaches to the anterior border furrow or even overhangs the frontal margin; none has a preglabellar field. Strength of the glabellar furrows varies greatly and their number seems not to be a character of generic significance. Likewise, the presence or length of genal spines is not a generic character. Segmentation of the pygidium varies between wide limits. In several phyletic lines segmentation increases in stratigraphically younger forms. Axial segments usually are more numerous than pleural segments and numerical discrepancy increases upward stratigraphically. Intrapleural furrows generally are distinguishable at least on anterior segments but commonly they have not been described and they are not visible in most published figures. The pygidial axis of most Lower Carboniferous (Mississippian) forms is rather uniformly arched transversely, in later ones sides of the axis tend to become flattened and more and more steeply inclined posteriorly. The pygidial border is not well defined in some Lower Mississippian forms, but in later ones it is generally demarked clearly and tends to be flattened, particularly anteriorly. In some Permian genera it becomes steeper behind and may be overturned behind the axis. Most forms have a prominent tubercle at the center of the occipital ring and most are ornamented with granules that are coarsest on the central and posterior parts of the glabella and occipital ring. Segments of the thorax and pygidium commonly bear a row of granules along the posterior borders. A few Lower Mississippian forms have granules accentuated as short spines.

Phillipsia Portlock, 1843 [*emend.* J. M. Weller, 1936] [**P. kellii* (?=**Asaphus gemmuliferus* Phillips, 1836); SD Vogdes, 1890]. Glabella parallel-sided or slightly tapering forward, ending at anterior border furrow. Pygidium slightly wider than long, with axis uniformly arched transversely without sharply demarked border. *L.Miss.-M.Miss.*, N.Am.; *L.Carb.*, Eu.——Fig. 305,*3*. *P. gemmulifera* (Phillips), L.Carb., Eng.; exoskel. (reconstr.), ×3.5 (498).

Griffithides Portlock, 1843 [*emend.* Weller, 1936] [**G. longiceps;* SD Vogdes, 1890] [=*Metaphillipsia* Reed, 1943]. Cephalon semioval, eyes small, central or slightly posterior; like *Phillipsia* but glabella expanding forward, reaching or nearly reaching anterior margin, basal lobes of glabella long. Pygidium as in *Phillipsia* but with fewer segments. *L.Miss.-M.Miss.*, N.Am.; *L.Carb.*, Eu.——Fig. 306,*1*. **G. longiceps*, L.Carb., Eng.; *a,b*, ceph., pyg., ×3.5 (498).——Fig. 306, *4*. *G. seminiferus* (Phillips), type species of *Metaphillipsia*, L.Carb., Eng.; exoskel. (reconstr.), ×1.7 (498).

Eocyphinium Reed, 1942 [**E. clitheroense*]. Cephalon subtriangular in outline, rounded in front, glabella nearly reaching anterior margin, contracted at mid-length, with indistinct median preoccipital lobe between lateral preoccipital lobes; occipital ring narrowed laterally; eyes posterior. Pygidium unknown. Surface coarsely pustulose. *L.Carb.*; G.Brit.——Fig. 305,*7*. **E. clitheroense*, Eng.; ceph., ×2.7 (452).

Bollandia Reed, 1943 [**Asaphus globiceps* Phillips, 1836]. Resembles *Griffithides* but cephalon distinctly subtriangular; glabella parallel-sided, overhanging front margin, with very large lateral preoccipital lobes; palpebral lobes extending well above eyes. Pygidium with broad axis; no well-defined border. *L.Carb.*, G.Brit.——Fig. 305,*4*. **B. globiceps* (Phillips), Eng.; exoskel. (reconstr.), ×2 (498).

Exochops Weller, 1936 [**Phillipsia (Griffithides) portlocki* Meek & Worthen, 1873]. Resembles *Bollandia* but relatively small eyes not covered by palpebral lobes. Pygidium with high, strongly tapering axis; without distinct border. *Low.M. Miss.*, C.USA.——Fig. 306,*5*. **E. portlocki* (Meek & Worthen), Ill.; *5a,b*, ceph., pyg., ×2 (491).

Kaskia Weller, 1936 [**K. chesterensis* Weller & Weller in J. M. Weller, 1936]. Glabella nearly parallel-sided, with large lateral preoccipital lobes; eyes medium-sized, central. Resembles *Griffithides* but pygidium has well-defined border and more

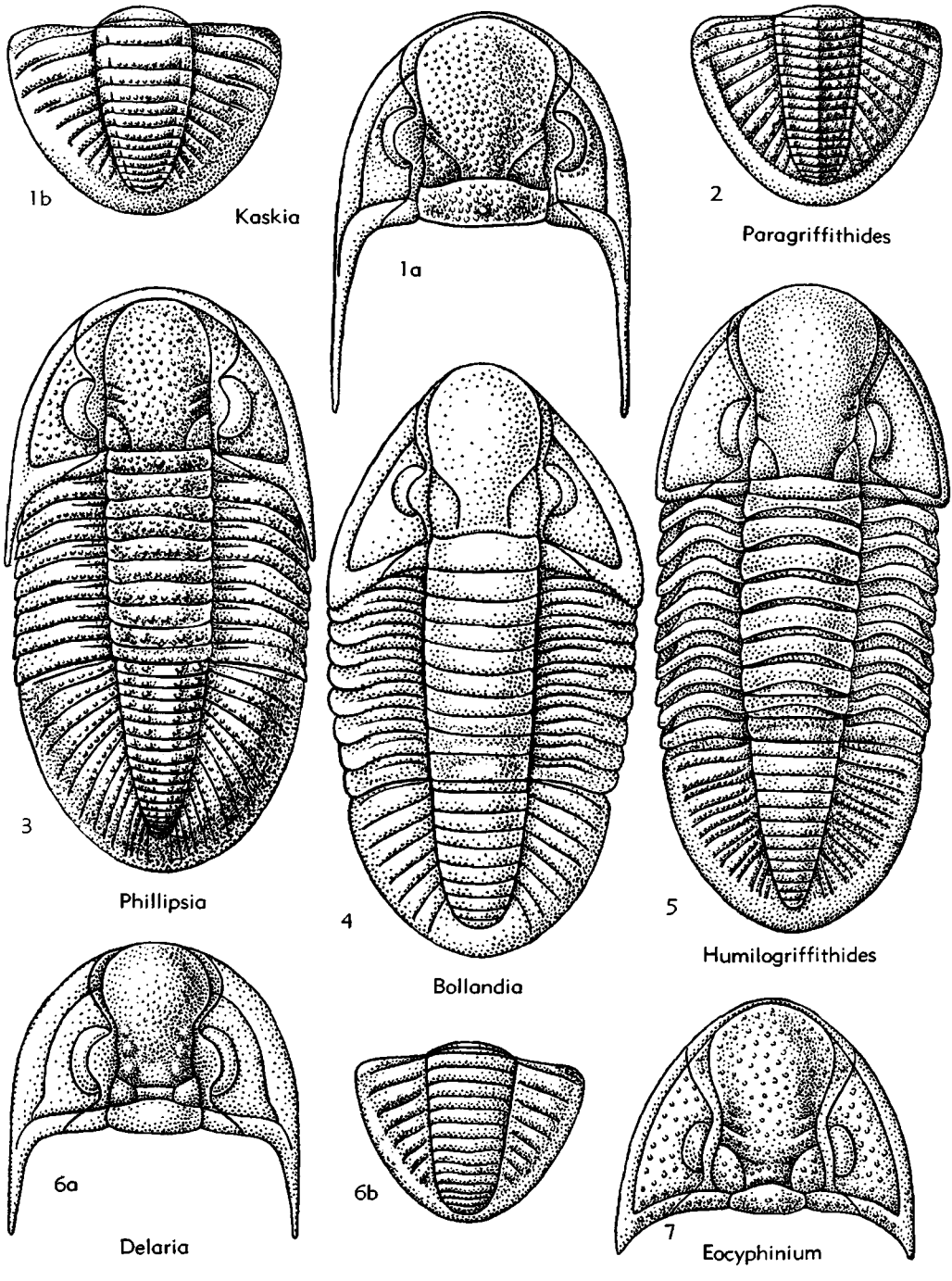


FIG. 305. Phillipsiidae (p. 0399-0401).

prominent axis that tapers less strongly. *M.Miss.-L.Penn.*, USA.; *Low.U.Carb.*, Eu.——Fig. 305,*1*. **K. chesterensis;* U.Miss.(Chester.), Ill.-Ky.; *1a,b*, ceph., pyg., ×3.3 (491).

Humilogriffithides Inai, 1936 [**H. divinopleurus*]. Like *Kaskia* but glabella more expanded in front, eyes farther back, and occipital ring much narrower *(sag.)*. Pygidium with more regularly tapered axis. *U.Carb.*, S.Manch.——Fig. 305,*5*. **H. divinopleurus;* exoskel. (reconstr.), ×3 (412).

Neogriffithides Toumansky, 1935 [**N. gemmellaroi*]. Like *Kaskia* but eyes smaller, farther forward, entirely in front of lateral preoccipital lobes of glabella. Pygidium with longer, more regularly tapered axis, and more numerous axial rings. *M.Perm.*, Crimea-Sicily.——Fig. 306,*6*. **N. gemmellaroi,* Crimea; exoskel. (reconstr.), ×2.6 (485).

Paragriffithides Reed, 1943 [**Phillipsia carinata* Salter in Woodward, 1884]. Cephalon unknown. Pygidium like that of *Kaskia* but axis triangular in cross section. *L.Carb.*, G.Brit.——Fig. 305,*2*. **P. carinatus* (Salter); pyg., ×3 (498).

Paladin Weller, 1936 [**Griffithides morrowensis* Mather, 1915]. Like *Kaskia* but glabella only slightly expanded in front, encroaching on anterior border but not reaching anterior margin, slightly contracted opposite eyes, which are large and posterior in location. Pygidium with well-defined border. *M.Miss.-L.Perm.*, USA.; *Low.L. Carb.* Eu.——Fig. 306,*3*. **P. morrowensis* (Mather), L.Penn., Ark.; *3a,b*, ceph., pyg., ×3.8 (491).

Weberides Reed, 1942 [**Phillipsia mucronata* M'Coy, 1844]. Like *Paladin* but glabella strongly expanded in front; eyes large, posterior. Pygidium with distinct border and commonly bearing terminal spine. Surface smooth except for rows of tubercles on occipital ring and axial rings of thorax and pygidium. *L.Carb.-Low.U.Carb.*, Eu.-E.N.Am.——Fig. 306,*2*. **W. mucronatus* (M'Coy), Eng.; exoskel. (reconstr.), ×2.8 (498).

Ditomopyge Newell, 1931 [**D. lansingensis*] [=*Cyphinium* Weber, 1933, **Phillipsia (Griffithides) scitula* Meek & Worthen, 1865; *Neophillipsia* Gheyselinck, 1937, **Phillipsia (N.) decurtata* Gheyselinck]. Like *Kaskia* but glabella broad, with median and lateral preoccipital lobes. Pygidium with broad axis flattened on top and strongly geniculate pleural fields; young stages with posterior pair of spines. *Penn.-L.Perm.*, cosmop.——Fig. 307,*5a,b*. *D. scitula* (Meek & Worthen), Penn., Ill.; *5a,b*, ceph., pyg., ×4 (491).——Fig. 307,*5c*. **D. lansingensis,* U.Penn., Kans.; juvenile pyg., ×22 (436).

Delaria Weller, 1944 [**Anisopyge? antiqua* Girty, 1908]. Like *Ditomopyge* but glabella narrower, expanded in front, reaching anterior margin, distinctly contracted opposite eyes with smaller median and lateral preoccipital lobes and with lateral glabellar lobes appearing as small rounded protuberances. Pygidial axis narrowly arched to subtriangular in cross section. *L.Perm.-M.Perm.*, SW.USA.——Fig. 305,*6*. **D. antiqua* (Girty), Tex.; *6a,b*, ceph., pyg., ×3.5 (491).

Cyphinioides Reed, 1942 [**C. ashfellensis*]. Like *Ditomopyge* but glabella greatly expanded in front, reaching anterior margin; occipital ring wide *(sag.)* but much less than 0.3 of cephalic width; eyes posterior. Pygidial axis narrow, tapering; border distinct. *L.Carb.*, Eng.——Fig. 308, *1*. **C. ashfellensis; 1a,b,* ceph., pyg., ×3 (452).

Permoproetus Toumansky, 1935 [**P. teschi;* SD J. M. Weller, 1944]. Cephalon poorly known, probably similar to *Ditomopyge* but eyes smaller, more posterior; preoccipital glabellar lobes well defined. Pygidium very broad. *M.Perm.*, Crimea. ——Fig. 308,*6*. **P. teschi;* exoskel. (reconstr.), ×3 (485).

Ameura Weller, 1936 [**Phillipsia (Griffithides) sangamonensis* Meek & Worthen, 1865]. Glabella not reaching anterior margin, widest between the large strongly crescentic eyes; lateral preoccipital lobes large but no median lobe. Pygidium elongate subtriangular; axis with flattened sides and gently arched crest; border progressively wider and flatter toward rear. Surface smooth. *Penn.-L. Perm.*, USA.——Fig. 308,*3*. **A. sangamonensis* (Meek & Worthen), Penn., Ill.; *3a,b*, ceph., pyg., ×2 (404).

Sevillia Weller, 1936 [**S. sevillensis*]. Like *Ameura* but glabella narrower, with median preoccipital lobe; eyes large, semicircular. Pygidium with prominent axis characterized by flat sides and gently arched crest; border distinct. Surface finely granulose. *L.Penn.*, USA.——Fig. 308,*5*. **S. sevillensis,* Ill.; *5a,b*, ceph., pyg., ×2.5 (491).

Cummingella Reed, 1942 [**Phillipsia jonesii* Portlock, 1843; ICZN Opinion 352]. Glabella broad, reaching anterior margin, narrowest between front ends of large, reniform eyes; fixigenae extremely narrow *(tr.)*. Pygidium with intrapleural furrows that cross onto border anteriorly. Surface smooth or with small pits. *L.Carb.*, Eu.——Fig. 308,*4*. **C. jonesii* (Portlock), Eng.; exoskel. (reconstr.), ×3.5 (498).

Linguaphillipsia Stubblefield, 1948 [**L. terapaiensis*]. Like *Cummingella* but glabella narrower anteriorly, not reaching front border; eyes long, relatively narrow *(tr.)*. Pygidium with border. *L. Carb.*, Malaya.——Fig. 307,*1*. **L. terapaiensis; 1a,b,* ceph., pyg., ×3.2 (475).

Paraphillipsia Toumansky, 1935 [**P. karpinskyi*]. Like *Kaskia* but glabella very wide, eyes central. Pygidium short, wide. *M.Perm.*, Crimea-C.Himalaya.——Fig. 308,*2*. **P. karpinskyi,* Crimea; exoskel. (reconstr.), ×6 (485).

Neoproetus Tesch, 1923 [**N. indicus*]. Cephalon subtriangular, anterior part of glabella swollen;

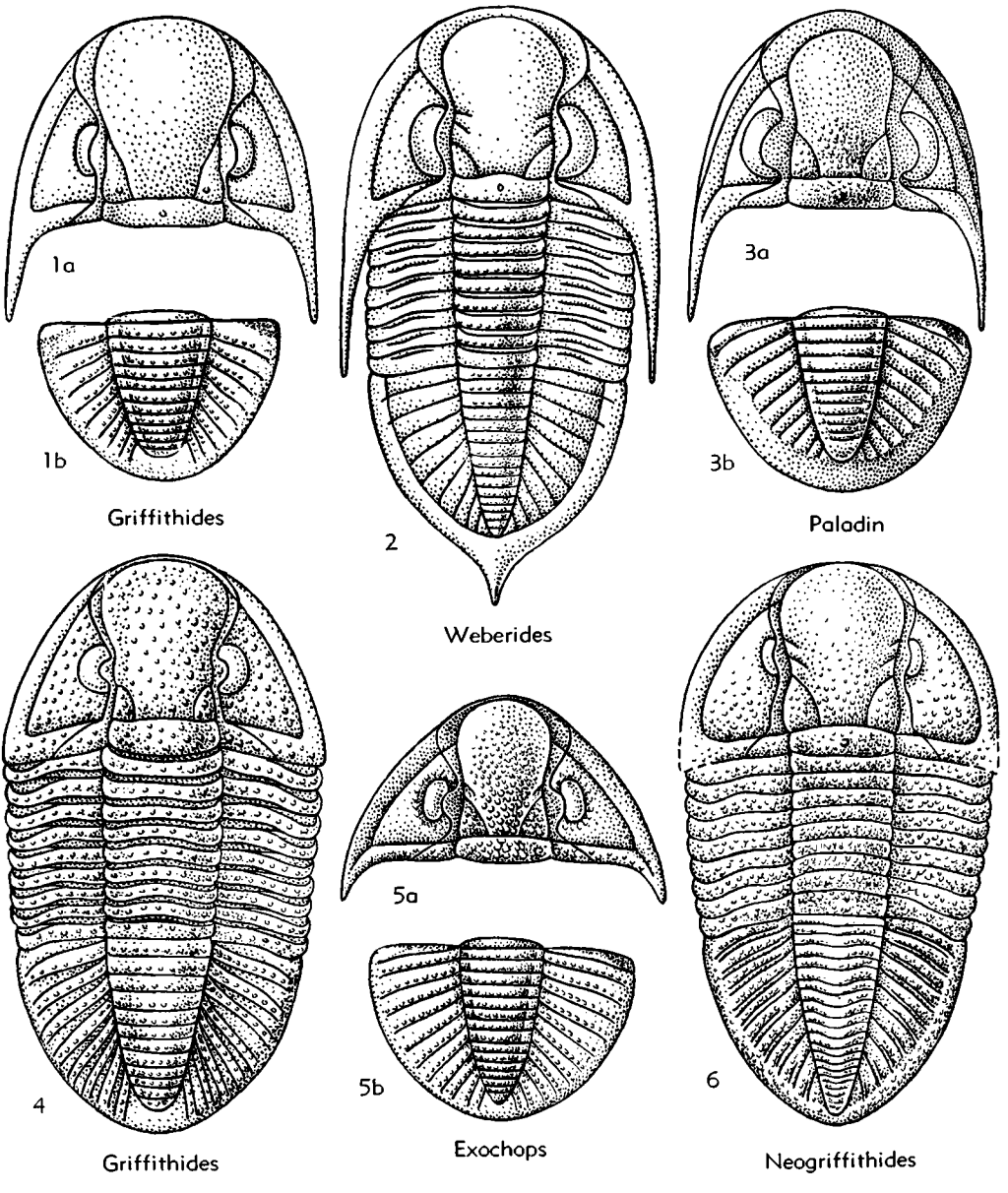


FIG. 306. Phillipsiidae (p. O399-O401).

tending to overhand anterior margin. Pygidium short, with few segments. *M.Perm.*, E.Indies-SE. Asia-Crimea-Sicily.——FIG. 307,*3*. **N. indicus*, Timor; *3a,b*, ceph., pyg., ×2.5 (480).

Anisopyge GIRTY, 1908 [**Phillipsia perannulata* SHUMARD, 1858]. Resembles *Ditomopyge* but pygidium subtriangular, with strongly elevated axis extending to rear margin, axial rings very numerous; posterior border vertical or overturned, pleural segments equal in width. Eyes long; median preoccipital lobe of glabella large, lateral preoccipital lobes very small. *M.Perm.*, SW.USA. ——FIG. 307,*6*. **A. perannulata* (SHUMARD), Tex.; *6a,b*, ceph., pyg., ×3.5 (491).

Vidria WELLER, 1944 [**V. vespa*]. Pygidium semioval, with terminal spine in young stages. Cephalon unknown. *M.Perm.*, SW.USA.——FIG. 307,*2*. **V. vespa*, Tex.; pyg., ×2 (491).

Pseudophillipsia GEMMELLARO, 1892 [**Phillipsia sumatrensis* ROEMER, 1880]. Like *Paladin* but

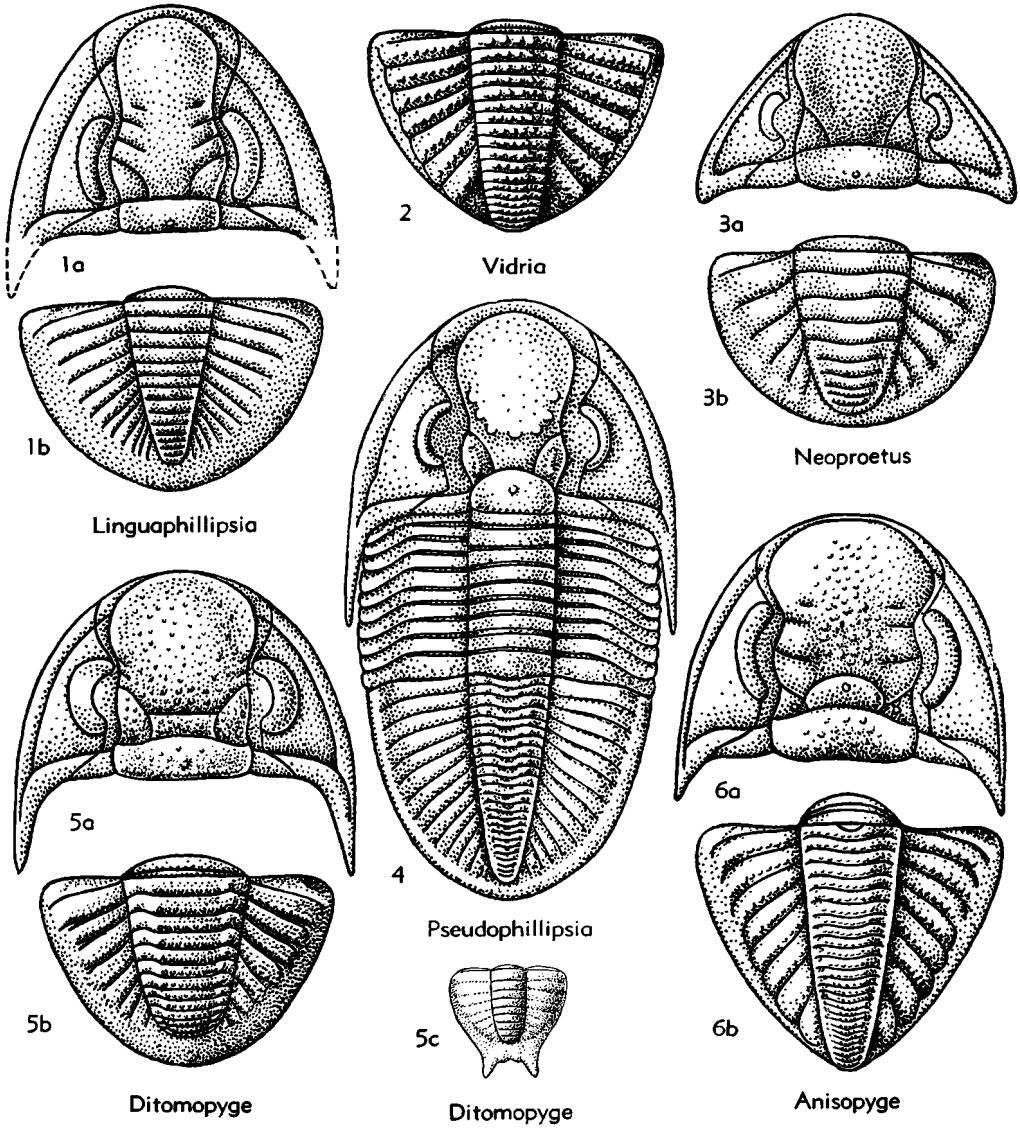


FIG. 307. Phillipsiidae (p. O401-O402).

with depressed area between lateral preoccipital glabellar lobes, glabella expanded in front, not reaching anterior margin. Pygidium longer and more segmented; border distinct. *M.Perm.*, Sicily-Crimea-SE.Asia-E.Indies-Calif.——FIG. 307,*4*. **P. sumatrensis* (ROEMER), Sumatra; exoskel. (reconstr.), ×2 (462).

Family OTARIONIDAE Richter & Richter, 1926

[=Cyphaspidae SALTER, 1864]

Exoskeleton opisthoparian, of small to medium in size. Cephalon conspicuously vaulted, with genal spines; preglabellar field narrow to moderately broad or absent, convex; glabella more or less inflated, with single pair of distinct glabellar furrows *(1p)* reaching occipital furrow and separating a pair of basal lobes; 1 or 2 other pairs of glabellar furrows may be present; glabella surrounded by deep axial and preglabellar furrows; genae convex to inflated or even conical; eyes small to medium in size, subcircular in outline; anterior sections of facial sutures divergent forward, subparallel,

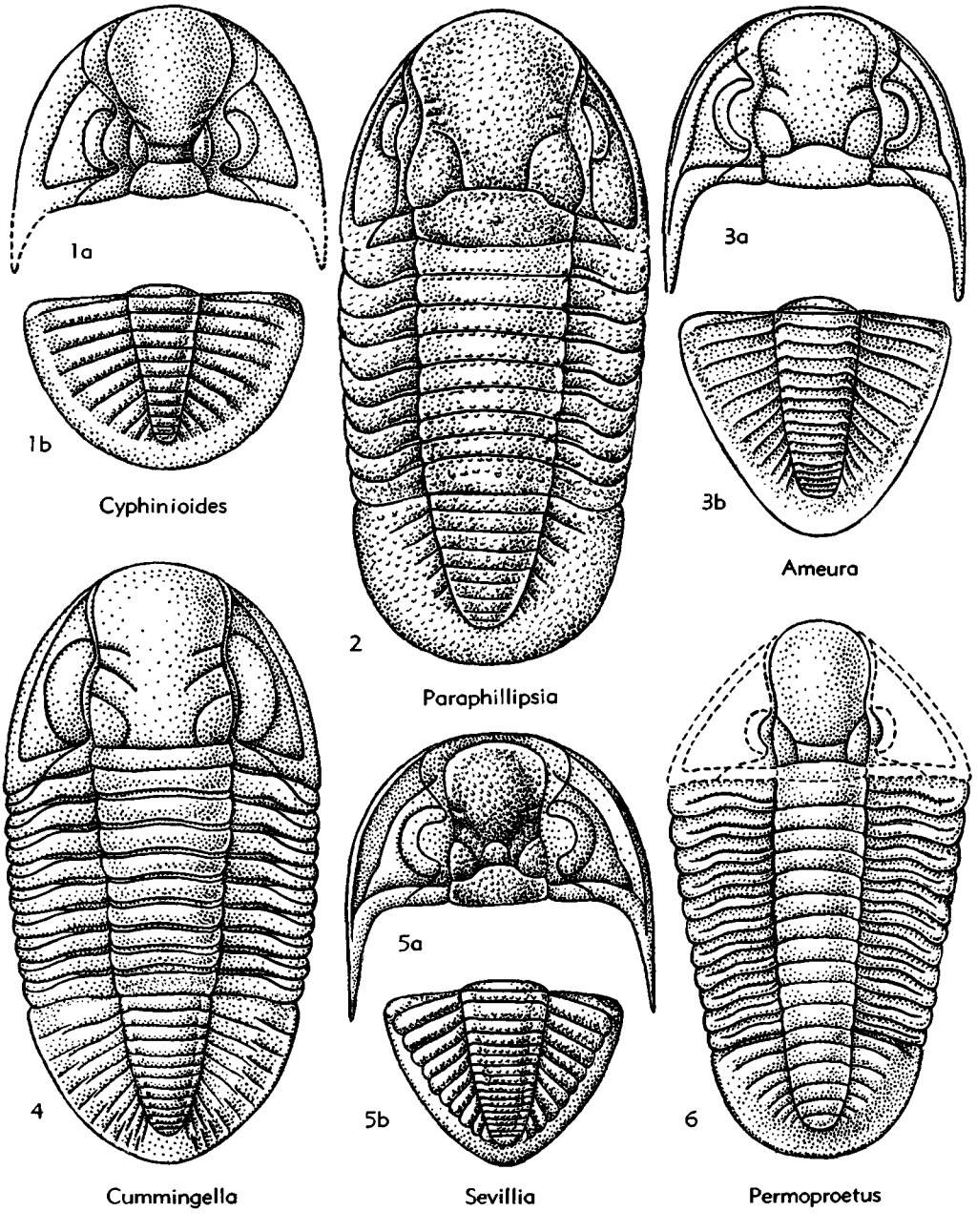


FIG. 308. Phillipsiidae (p. O401).

or somewhat convergent; posterior sections strongly divergent, reaching posterior margin near genal angles. Thorax with 11 to 17 segments. Pygidium small, with few segments (247). *M.Ord.-U.Carb.*

Subfamily OTARIONINAE Richter & Richter, 1926

[*nom. transl.* PŘIBYL, 1947 (*ex* Otarionidae RICHTER & RICHTER, 1926)]

Cephalon semicircular, with narrow to moderately broad preglabellar field; gla-

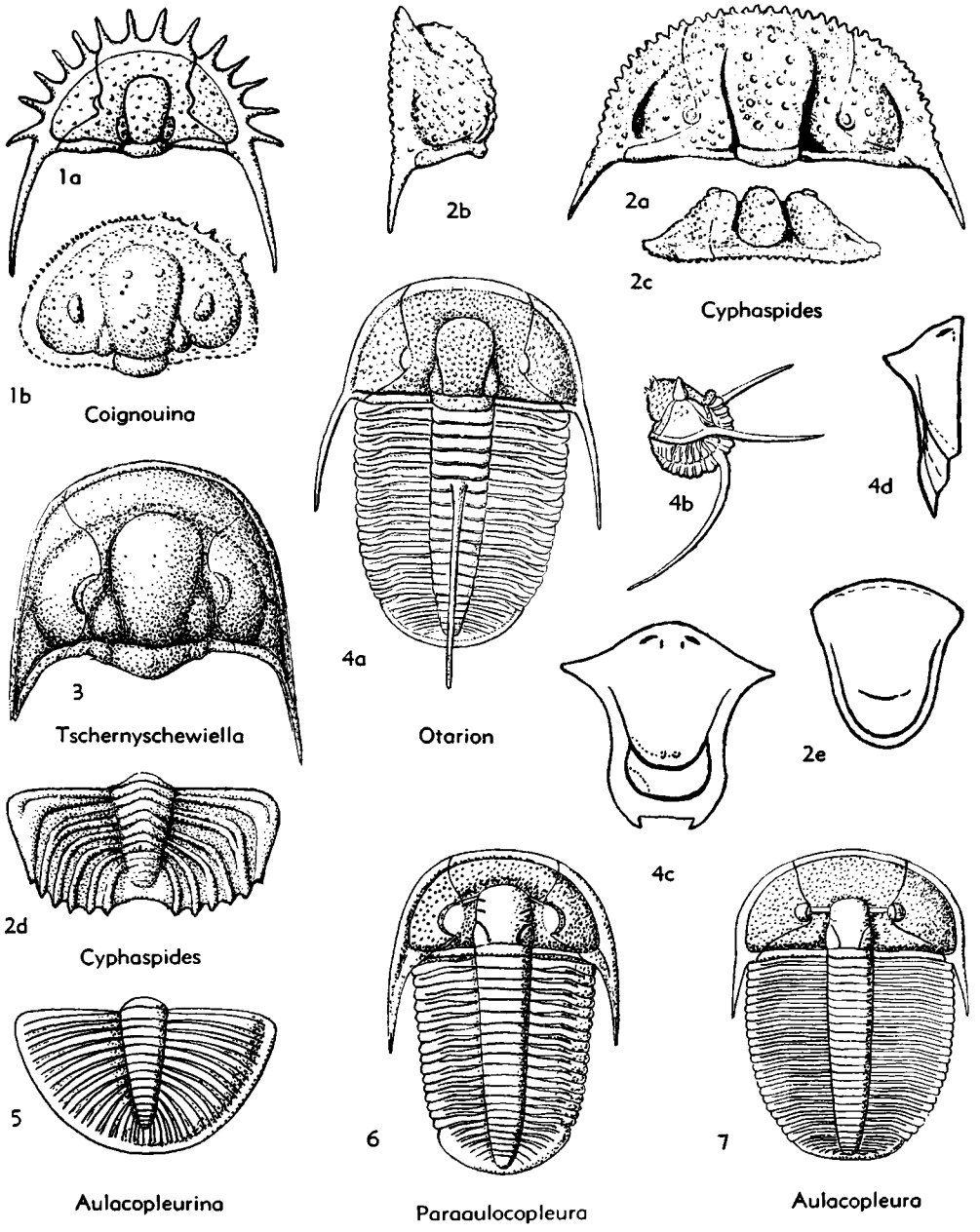


FIG. 309. Otarionidae, Aulacopleuridae (p. O405-O406).

bella with pair of broad, deep lateral furrows *(1p)* completely separating strongly developed basal lobes; no eye ridges. Thorax with 11 to 17 segments, outer ends rounded. Pygidium small, short, with even margin. *M.Ord.-U.Carb.*

Otarion ZENKER, 1833 [**O. diffractum*] [=*Cyphaspis* BURMEISTER, 1846 (*non* BURMEISTER, 1843); *Conoparia* HAWLE & CORDA, 1847; *?Goniopleura* HAWLE & CORDA, 1847 (*non* WESTWOOD, 1832); *?Harpidella* M'COY, 1849; *Novákaspis* PŘIBYL, 1946]. Cephalon with narrow border and distinct border furrow; genal spines long; anterior and

lateral margins even. Sixth ring of thoracic axis in almost all species stronger than others bearing long backward-curved spine. Pygidial axis with 5 to 7 rings. Hypostoma resembling that of Proetidae but with complete median furrow separating anterior and posterior lobes; anterior border furrow reduced. Surface granulose. *M.Ord.-U.Dev.*, cosmop.——Fig. 309,*4a*. **O. diffractum*, Sil. (e Zone), Czech.; exoskel., ×2 (3).——Fig. 309, *4b-d*. *O. ceratophthalmus* (Goldfuss), M.Dev., Ger.(Eifel); *4b*, exoskel. (reconstr.), ×1.7; *4c,d*, hypostoma, ventral, lateral, ×8 (460*).

Coignouina Reed, 1943 [**Cyphaspis acanthina* Coignou, 1890]. Cephalon as in *Otarion;* anterior and lateral margins with row of radiating spines; 2nd pair of glabellar furrows weakly developed (type species); anterior and lateral borders flat, without distinct border furrow. *L.Dev.-M.Dev.* (Czech.-Ger.) - *U.Dev.*(N.Am.) - *U.Carb.*(Eng.).——Fig. 309,*1b*. **C. acanthina* (Coignou), Eng. (Yorks.); ceph., ×6 (389).——Fig. 309,*1a*. *C. coronata* (Barrande), M.Dev., Czech.; ceph., ×3 (445a*).

Tschernyschewiella Toll, 1899 [*nom. subst. pro Schmidtella* Chernyshev, 1893 (*non* Ulrich, 1892)] [**Schmidtella uralica* Chernyshev, 1893]. Cephalon resembling *Otarion,* strongly convex transversely; genae divided into 3 parts by furrows originating at axial furrows near anterior part of glabella, curving backward and running nearly parallel to lateral border, then bifurcating, with branches running to posterior and lateral borders. *L.Dev.,* USSR(Urals).——Fig. 309,*3*. **T. uralica* (Chernyshev), cephalon, ×3 (383).

Subfamily CYPHASPIDINAE Přibyl, 1947

[=Cyphaspidedinae Prantl & Přibyl, 1950 (invalid *nom. correct. pro* Cyphaspidinae Přibyl, 1947)]

Cephalon low-arched, with 1 to 3 rows of short spines on anterior and lateral margins; preglabellar field narrow or absent; glabella with small basal lobes; eye ridges present. Thorax with 11 or 12 segments; pleurae bent downward in knee shape, prolonged into spines. Pygidium nearly trapezoidal; axis roof-shaped, with rings strongly curved forward; pleural fields with ribs bent backward-downward in knee shape, and produced marginally into short spines, outer (1st) pair of ribs forming acute angles, others obtuse angles. Hypostoma rounded-triangular; with anterior border furrow faint or absent, posterior and especially lateral border furrows deep, posterior lobe lower than anterior, with pair of maculae, separated from anterior lobe by shallow furrow. *L.Dev.-M.Dev.*

Cyphaspides Novák, 1890 [**C. scuticauda;* SD Vogdes, 1925]. Characters of subfamily, *L.Dev.-M.Dev.*——Fig. 309,*2d*. **C. scuticauda,* M.Dev., Ger.(Greifenstein); pyg., ×4 (437).——Fig. 309, *2a-c*. *C. cerberus* (Barrande), L.Dev., Vinařice (Czech.); ceph., dorsal, lateral, frontal, ×? (*3).——Fig. 309,*2e*. *C. holinensis* Růžička, M.Dev., Czech.; hypostoma, ×5 (445a).

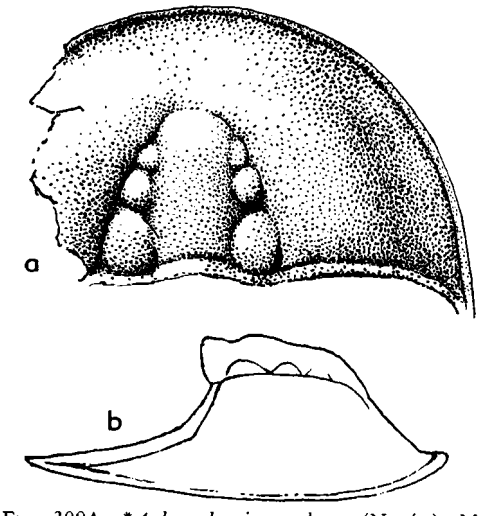


Fig. 309A. **Aulacopleurina peltata* (Novák), M. Dev., Ger.; *a,b,* ceph., dorsal, profile, ×9 (Schmidt, n).

Family AULACOPLEURIDAE Angelin, 1854

Cephalon slightly to moderately convex and with relatively long *(sag.)* preglabellar field; glabella with 2 or 3 pairs of lateral furrows, posterior pair curved to reach occipital furrow; axial furrows with or without pits; eyes sessile; distinct eye ridges present. Thorax with 12 to 22 segments, pleural ends rounded. Pygidium small, without spines. Surface of genae and preglabellar field pitted. *M.Ord.-M.Dev.*

Aulacopleura Hawle & Corda, 1847 [**Arethusa konincki* Barrande, 1846] [*pro Arethusa* Barrande, 1846 (*non* de Montfort, 1808; *nec* Oken, 1815; *nec* Bonaparte, 1838; *nec* Dumeril & Bibron, 1841)] [=*Arethusina* Barrande, 1852, obj. (*pro Arethusa* Barrande, 1846)]. Pygidium with 6 or 7 axial rings. *M.Ord.-M.Dev.,* Eu.-Morocco-Greenl.

A. (Aulacopleura). Eyes opposite anterior part of glabella. *Sil.-M.Dev.,* Eu.-Moroc.-Greenl.——Fig. 309,*7*. **A. konincki konincki* (Barrande), Sil., Czech.; exoskel., ×2 (370).

A. (Paraaulacopleura) Chaubet, 1937 [**A. (P.) roquemaillerensis*]. Like *A. (Aulacopleura)* but with eyes opposite middle part of glabella, shorter preglabellar field, and relatively fewer thoracic

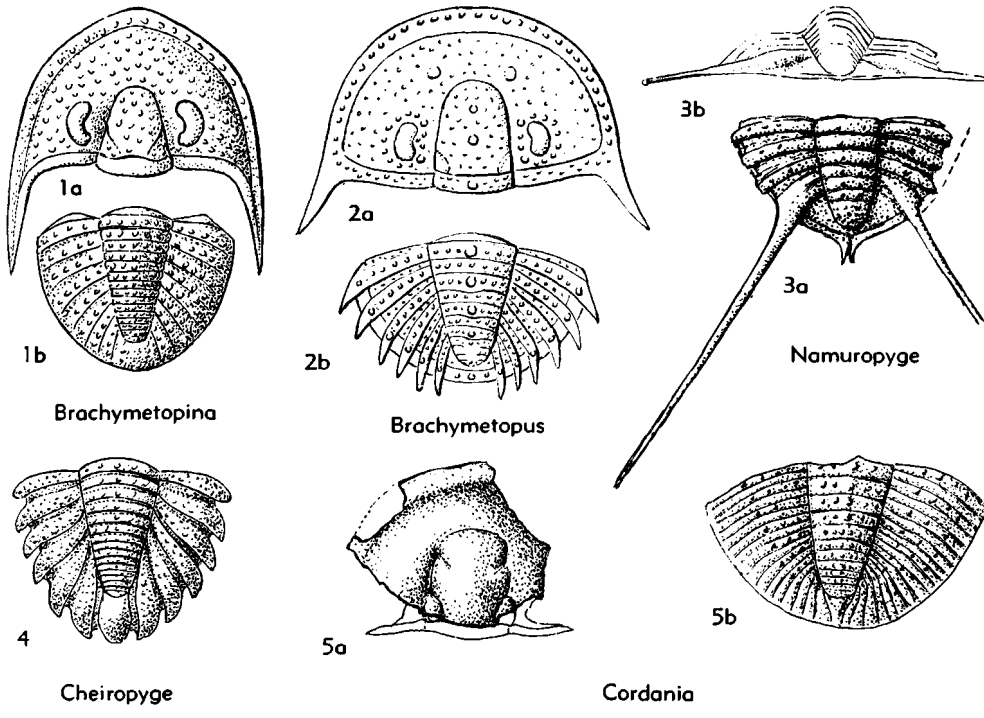


FIG. 310. Brachymetopidae (p. O407-O408).

and more pygidial segments. *M.Ord.-M.Dev.*, Eu. ——FIG. 309,*6*. *A. (P.) beyrichi* NOVÁK, M.Dev., Ger.; exoskel., ×2 (184).

?**Aulacopleurina** PŘIBYL, 1949 [**Arethusina peltata* NOVÁK, 1890]. Cephalon semicircular, high; preglabellar field long *(sag.)*; inner parts of genae vaulted, outer parts sloping steeply, flattened near border; glabella rounded-triangular, bounded by deep axial furrows without pits, preglabellar furrow nearly obsolete, 3 pairs of lateral glabellar furrows and lobes present, all lobes moderately well separated from central area of glabella; eyes, eye ridges, and facial sutures lacking. Thorax with 8 segments. Pygidium with 14 to 16 axial rings. *M.Dev.*, Eu.——FIGS. 309,*5*, 309*A*. **A. peltata* (NOVÁK); 309,*5*, pyg., Czech., ×4 (181); 309*A*, ceph., dorsal and profile views, Ger. (Ballersbach), ×9 (SCHMIDT, n).

Family BRACHYMETOPIDAE Prantl & Přibyl, 1950

[*nom. transl.* HUPÉ, 1955 (*ex* Brachymetopinae PRANTL & PŘIBYL, 1950)]

Exoskeleton opisthoparian. Cephalon semicircular or semielliptical, convex border distinct, posterolaterally produced into genal spines; glabella short, moderately convex, tapering forward, with 1 or 2 pairs of lateral furrows, basal glabellar lobes almost completely isolated by glabellar furrow *1p*; eyes medium-sized; facial sutures not discernible; preglabellar field broad. Thorax with ?10 segments. Pygidium parabolic to semicircular, abundantly segmented (up to 17 axial rings); margin even or spined. Surface with tubercles of various size. *L.Dev.-U.Carb.*

Brachymetopus M'COY, 1847 [**B. strzeleckii*; SD REED, 1903]. Cephalon with raised border and distinct border furrow; genal spines not longer than 0.5 of length of cephalon; glabella parallel-sided or subtriangular, with single pair of lateral furrows; eyes reniform, situated far backward. Pygidium half-circle or longer; axis about 0.3 of width of pygidium, with 9 to 17 rings; pleurae gently curved backward, divided by longitudinal furrows into a narrow anterior strip and a raised, broader posterior ridge. *U.Dev.*(Eu.)-*L.Carb.*(N. Am.-Asia-Austral.).

[According to GOLDRING & STUBBLEFIELD (Geol. Mag., v. 94, p. 421-424, 1957) no type species was indicated for *Brachymetopus* by M'COY and this became established when VOGDES (1890) validly named *Phillipsia maccoyi* PORTLOCK (1843) as type species of this genus. It would then follow that *Brachymetopina* REED is an objective junior synonym of *Brachymetopus*, because RICHTER & RICHTER in 1926 designated *Phillipsia maccoyi* as type species of *Brachymetopina*. In the opinion of SCHMIDT (Senckenbergiana, v. 39, p. 153-156, 1958) M'COY did adequately indicate *Brachymetopus strzeleckii* M'COY, 1847, as type species and proposes application to ICZN for decision.—HERTA SCHMIDT.]

B. (Brachymetopus). Axis of pygidium with 9 to 10 segments; posterior ridges of pygidial pleurae prolonged beyond thickened border into spines curved backward and bearing large tubercle where they cross border. *U.Dev.*(Eu.)-*L.Carb.*(N. Am.- Austral.-Eu.-Kazakhstan).——FIG. 310,*2*. **B. (B.) strzeleckii,* Carb., (Dunvegan) N.S. W.; *2a,b,* ceph., pyg., ×8 (452).

B. (Brachymetopina) REED, 1903 [**Phillipsia maccoyi* PORTLOCK, 1843; SD RICHTER & RICHTER, 1926]. Pygidium with larger number (up to 17) of segments than in *B. (Brachymetopus);* margin even, no distinct border nor spines. *L. Carb.,* N.Am.-Asia-Eu.——FIG. 310,*1*. **B. (B.) maccoyi* (PORTLOCK), Ire. (Limerick); *1a,b,* ceph., pyg., ×3 (498).

Cordania CLARKE, 1892 [**Phaetonides cyclurus* HALL, 1888]. Cephalon with elevated margin and short genal spines; preglabellar field and sides of cephalon concave; glabella short, ovoid, with 2 pairs of lateral furrows and lobes, basal lobes conspicuous and completely separated from glabella. Thorax with not more than 10 segments. Pygidium relatively large; axis with 6 to 12 rings; 6 to 8 pleural fields with ribs divided into subequal bands. Surface with tubercles irregularly scattered on cephalon, in regular rows on pygidium; in some species tubercles prolonged into spines extending beyond margin of pygidium. *L.Dev.-M.Dev.,* N.Am.——FIG. 310,*5*. **C. cyclurus* (HALL), L.Helderberg, N.Y. (Clarksville); *5a,b,* ceph., pyg., ×3 (404).

?**Cheiropyge** DIENER, 1897 [**C. himalayensis*]. Pygidium nearly as long as broad, moderately vaulted; axis with 15 segments; lateral lobes abruptly bent down toward margin; 6 pleurae, defined by deep depressions; originate as sharp ridges and broaden towards margin, tapered ends extending beyond margin; posterior pleurae broader than anterior ones, not distinctly carinate; posterior termination of axis surrounded by axial lappet exceeding pleurae in width. Surface granulose. *Permocarboniferous,* Himalaya.——FIG. 310, *4*. **C. himalayensis,* Chitichun; pyg., ?×1 (316).

?**Namuropyge** RICHTER & RICHTER, 1939 [**N. demaneti*]. Pygidium short, semicircular; border narrow, convex; axis reaching nearly to border, with 9 rings (6 distinct, 3 faint); pleural fields with 4 (4.5) segments, anterior band of segments low, posterior much higher; posterior band of 4th segment by far largest and highest, prolonged beyond border into long spine; 2 small spines at posterior end of pygidium. Surface with granules distributed in longitudinal and transverse rows. *U.Carb,* Belg.——FIG. 310,*3*. **N. demaneti,* Belg.(Bioul); *3a,b,* pyg., dorsal, posterior, ×8 (461).

?**Panarchaegonus** ÖPIK, 1937 [**P. parvus*]. Cephalon subsemicircular; glabella acute-ovoid, with 3 pairs of lateral furrows, *1p* very shallow, reaching to occipital furrow, separating pair of triangular basal furrows, anterior 2 pairs only slightly indicated; axial furrows shallow; palpebral lobes long, crescentic, eye ridges may be present; anterior sections of facial sutures sigmoid, posterior sections strongly divergent, crossing middle of posterior border; preglabellar field gently sloping; occipital ring widest at mid-line. *M.Ord., ?L.Sil.,* Eu.(Est.-?Swed.).——FIG. 311,*1*. **P. parvus,* Kukruse (Kuckers) Shale (C2), Est.; *1a,* ceph., *1b,* cran., lateral; ×? (439).

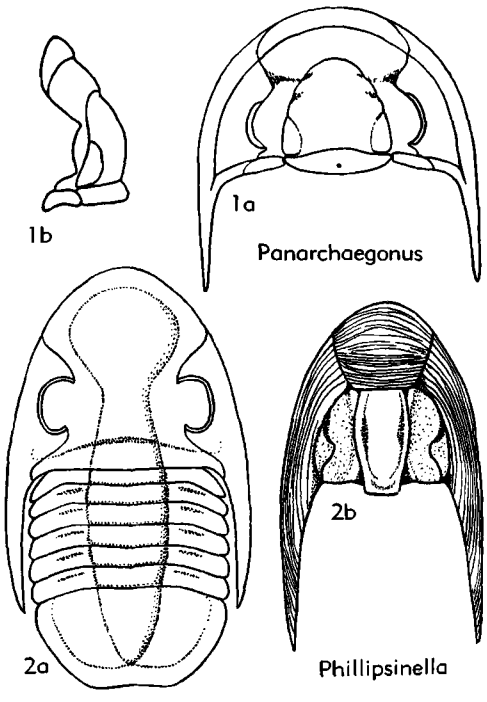


FIG. 311. Brachymetopidae, Phillipsinellidae (p. O408-O409).

[NOTE.—According to present view of HERTA SCHMIDT, *Panarchaegonus* should be classed as *incertae sedis,* rather than included doubtfully in the Brachymetopidae—Ed.]

Family PHILLIPSINELLIDAE Whittington, 1950

Cephalon as long *(sag.)* as wide, moderately convex; glabella defined by broad, shallow furrows, narrowest between eye lobes, widest across frontal lobe, no glabellar furrows; eye lobes large; facial sutures opisthoparian, anterior sections diverging forward, curving to meet along anterior margin; genal spines long; rostral plate and hypostoma elongate *(sag.)*. Thorax of 6 segments, pleural furrows shallow. Pygidium with axial and pleural furrows faint or absent. Surface of dorsal exoskeleton smooth, doublure with anastomosing raised lines (350). *U.Ord.*

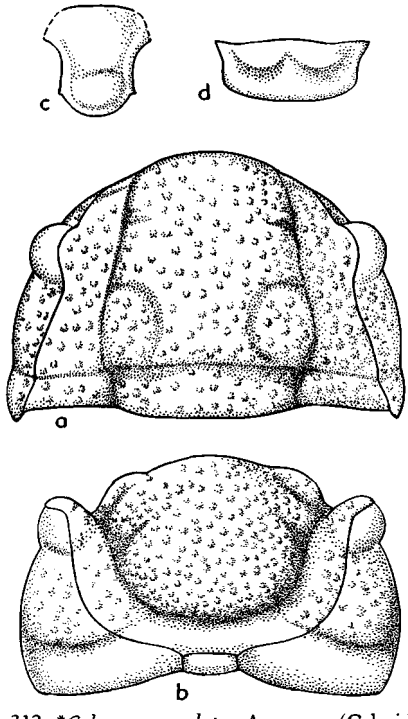


FIG. 312. **Celmus granulatus* ANGELIN (Celmidae), L.Ord.(Llanvirn.), Baltoscandia; *a,b,* hypostoma, pyg., ×5.3; *c,d,* ceph., dorsal, front, ×4 (414n).

Phillipsinella NOVÁK, 1886 [**Phacops parabola* BARRANDE, 1846] [=*Phillipsella* OEHLERT, 1886, suppressed, ICZN opinion 476]. Characters of family. *U.Ord.*, Br.I.-Swed.-Czech.——FIG. 311,*2*. **P. parabola* (BARRANDE); *2a,b,* exoskel., ceph. (ventral, showing rostral plate, hypostoma, and cephalic doublure), both reconstr., ×3.3 (496n).

Family CELMIDAE Jaanusson, 1956

Exoskeleton small, opisthoparian. Cephalon surrounded by distinct border; glabella slightly narrowing forward, with 2 or 3 pairs of lateral glabellar furrows, lateral preoccipital glabellar lobe comparatively long; occipital furrow present. Rostral plate narrow *(tr.)*, short, trapezoidal; hypostoma with comparatively strong lateral furrows, posterior lobe rather convex, anterior wings apparently narrow *(tr.)*, triangular. Thorax with 12 segments (type genus); pleurae of ridged type, without pleural furrows or facets. Pygidium very small, trapezoidal, apparently consisting of single tergite only; no axis, 2 crescent-shaped elevations near the anterior margin. *L.Ord.*

Celmus ANGELIN, 1854 [**C. granulatus*] [=*Crotalurus* VOLBORTH, 1858]. *L.Ord.(Llanvirn.)*, Baltoscandia.——FIG. 312. **C. granulatus; a,b,* ceph., dorsal, anterior, ×4; *c,d,* hypostoma, pyg., ×5.3 (414n).

Family PLETHOPELTIDAE Raymond, 1925

Exoskeleton opisthoparian, micropygous. Glabella tapering to rectangular, with convex frontal area, all furrows faint or obsolete on exterior and interior, occipital and posterior border furrows most persistent, occipital spine or node may occur; eyes of medium size or absent, placed near anterior 3rd of glabella; fixigenae with narrow palpebral areas, posterior areas triangular; librigenae unfurrowed, with genal spines or rounded genal angles. Thorax with up to 10 segments; axis tending to be wider than pleurae; pleural furrows faint to obsolete, pleural ends blunt. Pygidium narrow-transverse; axis long, bluntly rounded, about same in width as pleural regions, with up to 6 axial rings, furrows variable in strength. Surface smooth, with transverse ridges on borders, rarely pitted. Derived from Ptychopariidae. *U.Cam.-L. Ord.*

Plethopeltis RAYMOND, 1913 [**Agraulos saratogensis* WALCOTT, 1890]. Cranidium elongate, with convex glabella having subparallel sides, and rounded front, lateral furrows faint to obsolete on exterior, faint on interior; frontal area 0.25 to 0.3 of glabellar length, axial furrows on exterior, with occipital spine or node; fixigenae upsloping slightly; librigenae broad, with short genal spines. Thorax unknown. Pygidium with convex axis and 3 axial rings; pleural regions narrower, 3 pleurae with short pleural furrows, no border furrow (303). *U.Cam.(Trempeal.)*, Sib.-N.Am.-?S.Am.——FIG. 313,*1*. **P. saratogensis* (WALCOTT), N.Y.; *1a-c,* cran., dorsal, side, front, ×2; *1d,e,* pyg., dorsal, rear; ×2 (16).

Arapahoia B. M. MILLER, 1936 [**A. typa*] [=*Hesperaspis* STOYANOW, 1936]. Cranidium narrow-elongate; glabella low, tapering, front rounded, all furrows except posterior border furrow very faint or obsolete on exterior, faint on interior, occipital spine usually present; fixigenae horizontal or upsloping; librigenae elongate, with short genal spine. Thorax unknown. Pygidium with convex axis and 2 to 4 poorly defined axial rings; pleural regions about equal to axis in width, with 2 to 4 broad pleurae; faint border furrow, narrow border (132). *U.Cam.(Dresbach.)*, N.Am.——FIG. 313,*2*. **A. typa*, Wyo.; *2a-c,* cran., pyg., librigena, ×1, ×2, ×1 (472).

Leiocoryphe T. H. CLARK, 1924 [**L. gemma*]. Cephalon hemispherical, glabella seemingly broad

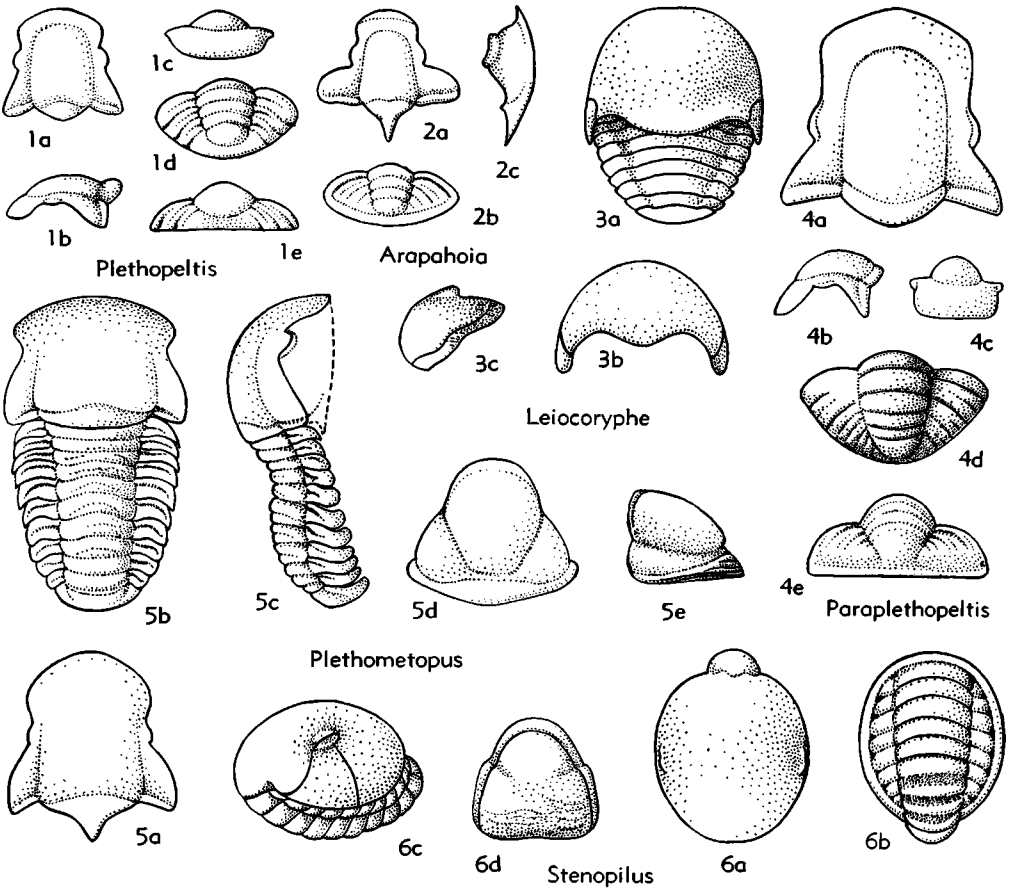


FIG. 313. Plethopeltidae (p. O409-O412).

but shape unknown, without lateral, axial, or border furrows, faint occipital furrow may occur; frontal area continuous with glabella; eyes absent; facial sutures faint; fixigenae downsloping; librigenae with blunt genal spines. Thorax with 8 segments; axis very wide, low; axial furrows shallow; pleurae much narrower than axis, unfurrowed. Pygidium very narrow, unfurrowed, or with very faint axial furrows. Outer surface may be pitted (190). *U.Cam.(Trempeal.)*, N.Am. ——FIG. 313,*3a*. **L. gemma*, Que.; exoskel., ×4 (385).——FIG. 313,*3b,c*. *L. transversa* RASETTI, Que.; *3b,c*, ceph., ×3 (190).

Paraplethopeltis BRIDGE & CLOUD, 1947 [**P. obesa*]. Cranidium elongate, with convex, tapering glabella, no lateral furrows; frontal area 0.5 of glabellar length, axial furrows distinct, occipital and posterior border furrows faint on exterior, anterior border furrow visible on interior only; fixigenae downsloping, with posterior areas shorter than usual; librigenae unknown. Thorax unknown. Pygidium with wide convex axis with end merging into posterior margin, with 5 axial rings; pleural regions convex, with 3 or 4 broad pleurae; faint border furrow, very narrow border (16). *L.Ord. (Gasconad.)*, N.Am.——FIG. 313,*4*. **P. obesa*, Tex.; *4a-c*, cran., dorsal, side, front, ×2, ×1, ×1; *4d,e*, pyg., dorsal, rear, ×2 (16).

Plethometopus ULRICH in BRIDGE, 1930 [**Bathyurus armatus* BILLINGS, 1860] [=*Enontioura* RESSER, 1942]. Cranidium with low subrectangular glabella, no lateral furrows; frontal area continuous with glabella, axial and anterior border furrows obsolete on exterior, very faint on interior; with short occipital spine or node; eyes below medium size; fixigenae horizontal; librigenae unfurrowed, with rounded genal angles or short genal spines. Thorax with 10 segments; axis convex, twice width of pleurae, which bear distinct pleural furrows. Pygidium with strongly convex axis, up to 3 axial rings, axial furrows faint, all other furrows faint to obsolete; narrow rimlike border (239, 303). *U.Cam.(Francon.-Trempeal.)*, N.Am.-S.Am.——FIG. 315,*5a*. **P. armatus* (BILLINGS), Que.; cran., ×1 (207).——FIG. 313,*5b,c*. *P.* sp., Mo.; *5b,c*, exoskel., ×3

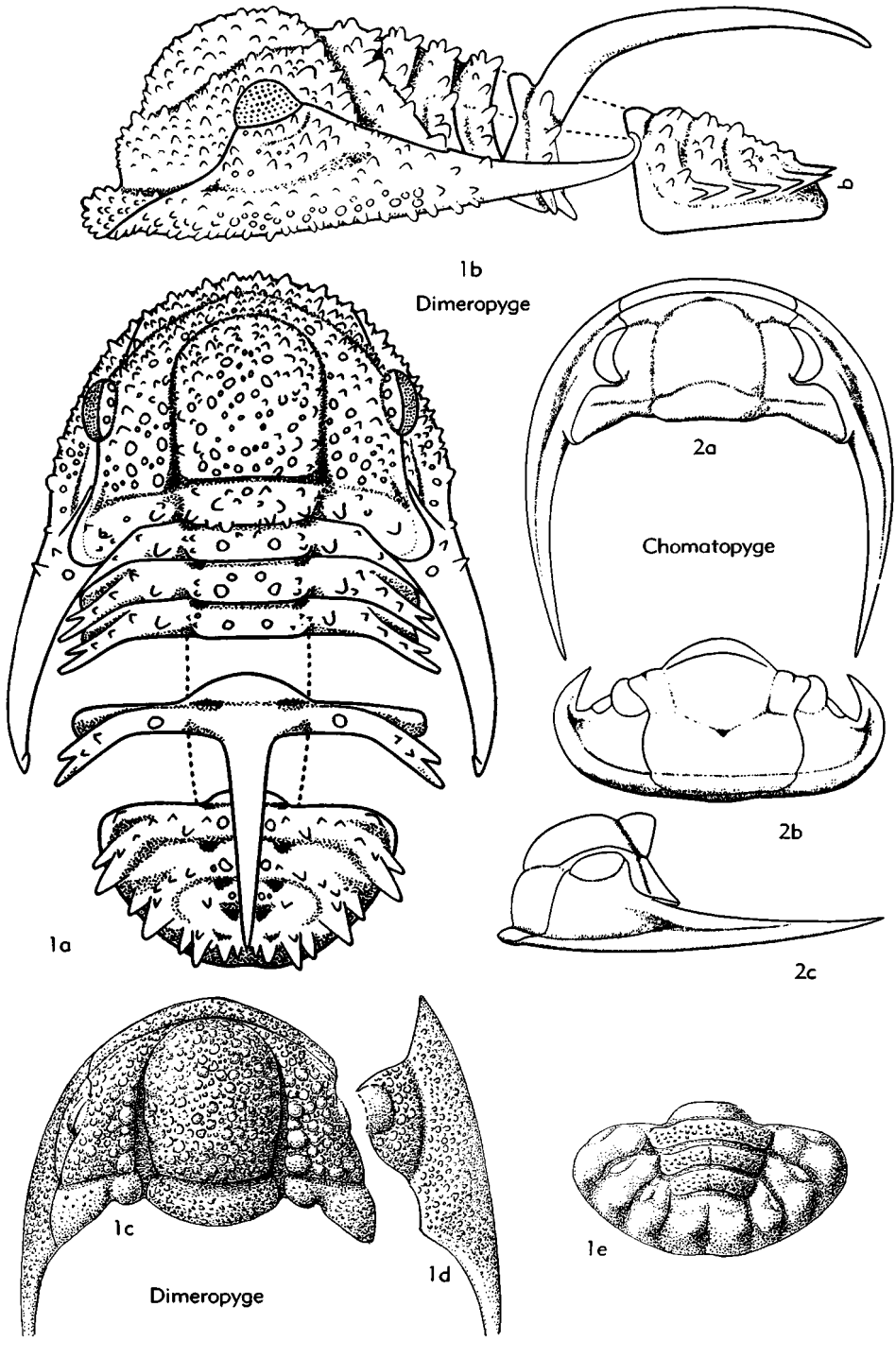


FIG. 314. Dimeropygidae (p. O412).

(425).——Fig. 313,*5d,e*. *P. dubius* (Rasetti), Que.; *5d,e*, pyg., ×5 (189).

Stenopilus Raymond, 1924 [**S. pronus*]. Cephalon ovate, strongly convex with low, apparently subquadrate glabella; frontal area continuous with glabella, all furrows obsolete on exterior, faint posterior half of axial furrow visible on interior; eyes small; fixigenae downsloping; librigenae with blunt genal angles. Thorax with 10 segments; axis convex, twice width of unfurrowed pleurae. Pygidium spade-shaped, inclined at 90° to thorax, axial furrows appearing only as pair of short depressions at anterior margin, no other furrows. Surface covered with irregular narrow ridges (190). *U.Cam.(Trempeal.)*, N.Am.-NE. Asia.——Fig. 313,*6*. *S. elongatus* Rasetti, Que.; *6a-c*, exoskel., dorsal, thorax, side, *6d*, pyg., and last thoracic segment; all ×6 (190).

Strotocephala Raymond, 1937 [**S. howelli*]. *U. Cam.(Trempeal.)*, Vt.

Family DIMEROPYGIDAE Hupé, 1953

[*emend.* Whittington & Evitt, 1954]

Exoskeleton about 1 cm. or less in length. Cephalon gently to strongly convex, cephalic border convex; glabella ovate convex, subparallel-sided or narrowing forward, with 3 or fewer pairs of lateral glabellar furrows, never deeply impressed; preglabellar field short to long *(sag.)*, steeply sloping; median pit may occur in preglabellar furrow; facial sutures opisthoparian, with anterior sections running directly forward to anterior border, then inward along edge of border; connective sutures may isolate narrow rostral plate or be absent. Thorax of few segments (8 in *Dimeropyge*); V-shaped panderian openings in pleural doublure. Pygidium moderately convex, 3 to 6 segments, axis characteristically with median longitudinal depression (360). *L.Ord.-U.Ord.*

Dimeropyge Öpik, 1937 [**Sphaerexochus minutus* Nieszkowski, 1857] [=*Haploconus* Raymond, 1913 (*non* Cope, 1882)]. Cephalon subsemicircular, with long genal spines hooked slightly at tips; with narrow, steeply sloping preglabellar field and broad convex border; glabella parallel-sided, rounded anteriorly, with 2 or 3 pairs of lateral glabellar furrows represented by ovate smooth areas adjacent to axial furrows; eye lobes small, far out on genae. Rostral plate T-shaped, hypostoma subquadrate in outline, with gently convex middle body. Thorax with shallow axial furrows; one segment (probably 5th) bears stout backwardly directed median spine; outer parts of pleurae bent strongly downward. Pygidium with 3 or 4 segments, longitudinal depression in posterior part of axis, steeply sloping border beneath pleural spines. External surface of exoskeleton with numerous short spines, groups on pleural terminations characteristically arranged. *M.Ord.-U.Ord.*, N.Am.-Swed.-Est.——Fig. 314,*1a,b*. *D. virginiensis* Whittington & Evitt, M.Ord., Va.; *1a,b*, incompl. exoskel. (reconstr.), dorsal, side, ×20 (360*).——Fig. 314,*1c-e*. **D. minuta* (Nieszkowski), M.Ord. (Kuckers Sh.), Est.; *1c*, ceph. (incompl.), ×11; *1d*, librigena, ×11; *1e*, pyg., ×13 (*c,d*, 439; *e*, 461n).

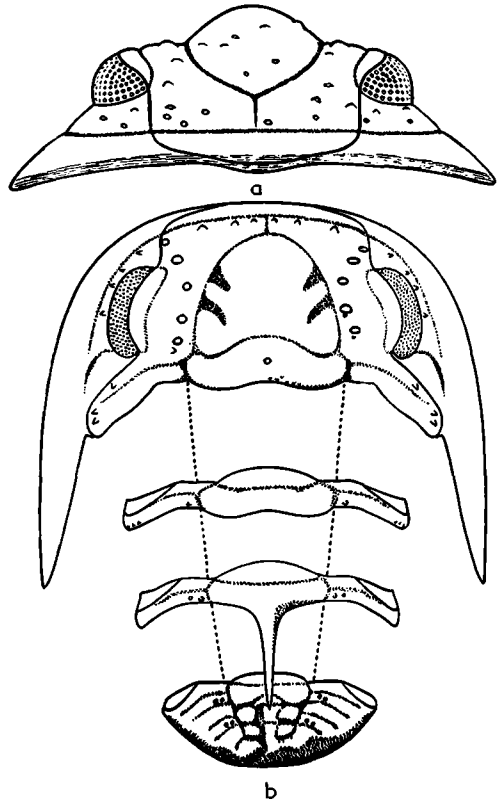
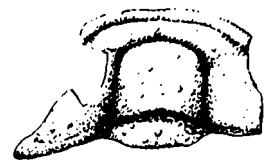


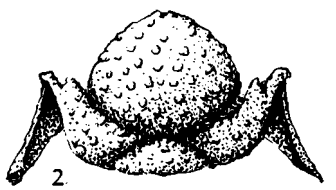
Fig. 315. **Mesotaphraspis parva* Whittington & Evitt (Dimeropygidae), M.Ord., Va.; *a,b*, incompl. exoskel. (reconstr.), ceph., front, ×10 (360).

Chomatopyge Whittington & Evitt, 1953 [**C. falcata*]. Like *Mesotaphraspis* but without lateral glabellar furrows, with longer, steeper preglabellar field lacking sagittal furrow, deep median pit in preglabellar furrow. Pygidium with short axis, indistinct axial rings, less prominent sagittal depression, and pleural fields with outer parts steeply sloping. *M.Ord.*, Va.——Fig. 314,*2*. **C. falcata; 2a-c*, ceph., dorsal, front, side (reconstr.), ×8 (360*).

Dimeropygiella Ross, 1951 [**D. caudanodosa*]. Like *Dimeropyge* but cephalon nasute; glabella suboval, preglabellar field short or absent at mid-line; genal spines represented by tubercle or absent. Pygidium with 3 to 5 axial rings, pair of pustules behind axis; pleural fields strongly ribbed. Sur-



1 Toernquistia



2

Dimeropygiella

FIG. 316. Dimeropygidae (p. O412-O413).

face coarsely to finely tuberculate or smooth, no groups of spines on pleural terminations (258). *L. Ord.*, Utah-Nev.——FIG. 316,*2*. **D. caudanodosa*; ceph., front, ×14 (258).

Mesotaphraspis WHITTINGTON & EVITT, 1953 [**M. parva*]. Glabella narrowing forward, with 1 or 2 pairs of shallow, lateral glabellar furrows; preglabellar field with sagittal furrow; eye lobes long, curved; anterior sections of facial sutures united along anterior margin, no median or connective sutures; genal spines long. One thoracic segment with median spine. Pygidium with sagittal depression in axis, pleural regions furrowed. Surface smooth or finely granulose, lines of paired tubercles on cephalon. *M.Ord.*, Va.——FIG. 315. **M. parva*; *a*, incompl. exoskel. (reconstr.); *b*, ceph., front; both ×10 (360*).

Toernquistia REED, 1896 [*pro Törnquistia* (ICZN Op. 367)] [**Cyphaspis (Törnquistia) nicholsoni*] Like *Dimeropyge* but less completely known, with glabella narrowing forward, deep median pit in preglabellar furrow, pair of faint furrows running from anterolateral margins of glabella outward and forward to anterior corners of large ?eye lobes; rostral plate may be wider *(tr.)*. *M. Ord.-L.Sil.*, Eng.-Scot.-Swed. —— FIG. 361,*1*. **T. nicholsoni* (REED), Keisley Ls., Eng.; cran., ×9 (360*).

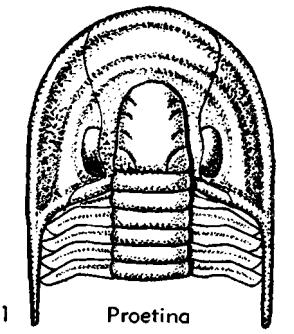
Family UNCERTAIN

[*Authorship.*—Diagnoses by RICHTER & RICHTER with additions by W. STRUVE, except *Cyrtoproetus* and *Palaeophillipsia* by J. M. WELLER]

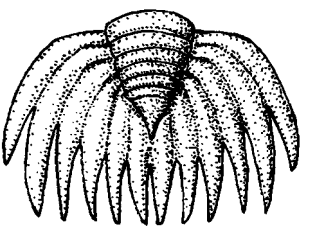
Cyrtoproetus REED, 1943 [**Phillipsia cracoensis* REED, 1899]. Glabella tapering slightly forward; lateral occipital lobes present behind basal lobes; eyes long, median; pygidium with poorly defined border. *L.Carb.*, G.Brit.——FIG. 318,*1*. **C. cracoensis* (REED); *1a,b*, ceph., pyg., ×3.3 (452).

Palaeophillipsia SUGIYAMA & OKANO, 1944 [**P. japonica*]. Cephalon subtriangular; glabella narrower than genae, widest at basal lobes; preglabellar field present; eyes long, posterior; pygidium of uncertain character. *Up.U.Dev.*, Japan.——FIG. 318,*3*. **P. japonica; 3a,b*, ceph., pyg., ×2.8 (477).

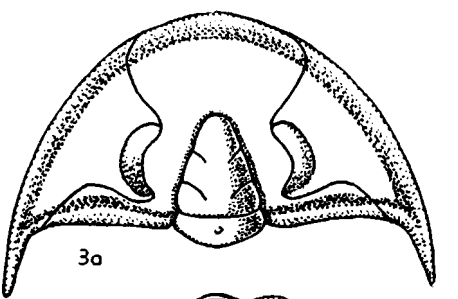
Perunaspis PŘIBYL, 1949 [**Perunaspis longispinus*]. Cephalon and thorax unknown. Pygidium small, moderately convex; axis strongly tapering, with



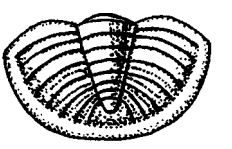
1 Proetina



2 Perunaspis



3a



3b Scharyia

FIG. 317. Proetacea (Family Uncertain) (p. O413, O415).

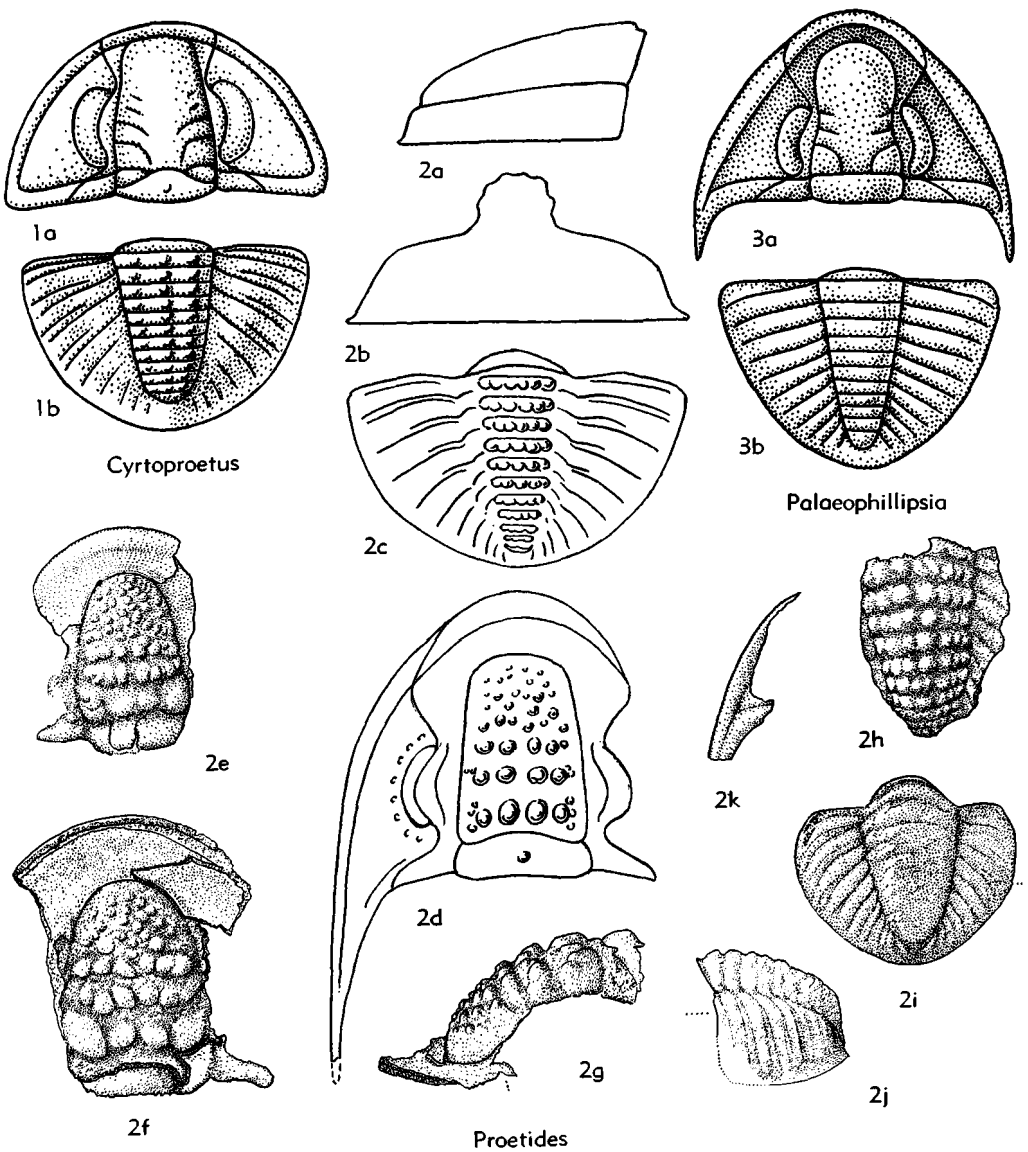


FIG. 318. Proetacea (Family Uncertain) (p. O413-O414).

6 or 7 rings, postaxial ridge present; pleural fields with 6 pairs of long, ensiform ribs that become free spines in their distal halves, posterior 4 or 5 pairs ending in nearly straight transverse line. *M. Dev.*, Czech.——FIG. 317,2. **P. longispinus;* pyg., ×12 (445a).

Proetides O. T. WALTER, 1924 [**Phillipsia insignis* WINCHELL, 1863]. Cephalon elongate *(sag.)* semi-elliptical; cephalic border distinct; preglabellar field large, deeply concave; glabella tapering, lateral furrows fairly distinct, connected by transglabellar depressions that divide posterior part of glabella in 3 transverse stripes, each with row of very coarse nodes; anterior part of glabella coarsely granulose; *1p* lobes ("basal lobes") detached; eyes close to glabella and posterior border furrows; anterior sections of facial sutures distinctly divergent; long genal spines. Pygidium short, strongly vaulted; axis broad, elevated, not reaching posterior border; about 11 rings, each with single row of tubercles; 10 pairs of broad ribs, last pair converging behind axis; anterior pleural bands progressively reduced adaxially, none in posterior ribs; border narrow, indistinctly de-

tached. *L.Miss.*, USA.——FIG. 318,*2*. **P. insignis* (WINCHELL), U.Kinderhookian, Iowa; *2a-d*, specimens "better-preserved than types," drawn by J. M. WELLER, ×2.7 (*2a,b*, long. and transv. profiles, pyg.; *2c*, dorsal, pyg.; *2d*, dorsal, ceph.); *2e-k*, syntype specimens, courtesy of G. M. EHLERS, drawn by W. STRUVE (*2e*, cran., ×2.7; *2f,g*, lectotype cran., ×2.7—here designated by STRUVE; *2h*, pyg., axis ×2.7; *2i,j*, pyg., ×2.7; *2k*, librigena, ×1.4).

Proetina PŘIBYL, 1946 [**Proetina latimargo*]. Cephalon an elongate paraboloid; preglabellar field broad *(sag.)*, with anterior concavity; slightly convex rounded ridge parallel to cephalic border surrounding glabella and eyes; glabella narrow, gently tapering, with broad rounded front, glabellar region in front of *3p* furrows short, *1p* with separate adaxial branch, *1p* lateral lobes not separated; occipital ring broad, not narrowed laterally, without lobes; anterior sections of facial sutures long, gently curved sigmoidally; eyes large; genal spines long. Thorax with unknown number of segments, ends rounded. Pygidium unknown. [Cephalon combines features of several proetid subfamilies.] *L.Dev.*, Czech.——FIG. 317,*1*. **P. latimargo*, Koněprusy Ls.; ×3 (445a).

Scharyia PŘIBYL, 1946 [**Proetus micropygus* HAWLE & CORDA, 1847]. Small (5 mm. long). Cephalon semicircular, with slightly convex border, preglabellar field rather broad *(sag.)*; glabella tapering; no occipital lobes; palpebral lobe strongly curved, moderately distant from axial furrows; anterior sections of facial sutures divergent, posterior sections running laterally considerably in front of posterior border furrow, describing arc that ends close to genal spines. Thorax with 6 segments having pointed ends. Pygidium semicircular, relatively large, slightly convex, with distinctly separated broad border; axis rapidly tapering, not reaching border, with 6 to 9 rings; pleural fields with 5 ribs. [Shape of posterior section of facial sutures and small number of thoracic segments are unique in Proetacea. *Scharyia* may represent larval stages of one or more other proetid genera.] *Sil.-M.Dev.*, Czech.-Pol.——FIG. 317,*3*. **S. micropyga* (HAWLE & CORDA), Sil., Loděnice; *3a*, ceph., ×12; *3b*, pyg., ×10 (445a).

Suborder HARPINA Whittington, nov.

[=Superfamily Harpedacea KOBAYASHI, 1935; Harpoidae HUPÉ, 1953 (*nom. transl., ex* Harpedacea KOBAYASHI, 1935)] [Type—*Harpes* GOLDFUSS, 1839]

Cephalon subsemicircular to ovate in outline, with long genal prolongations or spines. Glabella convex, narrowing forward, with 1 to 3 pairs of lateral glabellar furrows, preoccipital pair isolating triangular lateral lobes; occipital ring convex; genae convex; preglabellar field sloping outward and downward to flat or upwardly concave fringe or bilaminar border; alae may be present; prominent eye lobes or tubercles centrally located on genae, with strong eye ridges and in some forms with genal ridges also; sutures marginal except on dorsal side at genal angles, and (in genera with eye lobes) where sections of sutures run inward close together. Thorax with 12 or more segments; axis convex; pleurae flat, with broad pleural furrows. Pygidium short, subtriangular or elongate, with convex axis. Radiating, anastomosing genal caecae commonly present on genae and preglabellar field, and extending onto fringe; external surface of cephalon may be tuberculate or granulose (78, 79, 355). *U.Cam.-U.Dev.*

Family HARPIDAE Hawle & Corda, 1847

[*nom. correct.* MILLER, 1889 (*ex* Harpides HAWLE & CORDA, 1847)] [emend. WHITTINGTON, 1950] [=Arraphidae ANGELIN, 1854; Harpedidae (HAWLE & CORDA, 1847) RAYMOND, 1913]

Eye tubercles each with 2 lenses; semicircular alae adjacent to posterior glabellar lobes; bilaminar fringe with opposed pits in outer surfaces, genal rolls steeply sloping, brim gently sloping, with stout girder on lower lamella separating these 2 parts, prolongations of fringe varying in length; cephalic suture traverses marginal band of fringe. Hypostoma pear-shaped in outline, with ovate middle body, large anterior, small posterior, and wings. Thorax with 12 to 29 segments, pleurae bent down at tips. Pygidium small, short *(sag.)*, triangular, with few segments. External surface of glabella and genae with raised ridges in reticulate pattern, tuberculate, or smooth; minute tubercles on fringe between pits and marginal band, on internal rim, and elsewhere (183, 348). *L.Ord.-U.Dev.*

Harpes GOLDFUSS, 1839 [**H. macrocephalus*]. Cephalic outline inverted U-shape, length of prolongations equaling length of cephalon along mid-line; height of cephalon about 0.5 of median length; glabella with ovate anterior lateral lobes larger than posterior; alae extending across genae, each subdivided into 2 crescentic portions; genal roll broad, with inner margin lying against anterior margin of glabella and eye tubercles; girder meeting internal rim; rows of large pits in front of glabella, on each side of girder, on genal roll prolongations, and adjacent to margin of fringe, with quincunxially arranged small pits between these rows. Thorax with 29 segments. External surface of glabella and genae tuberculate (242).

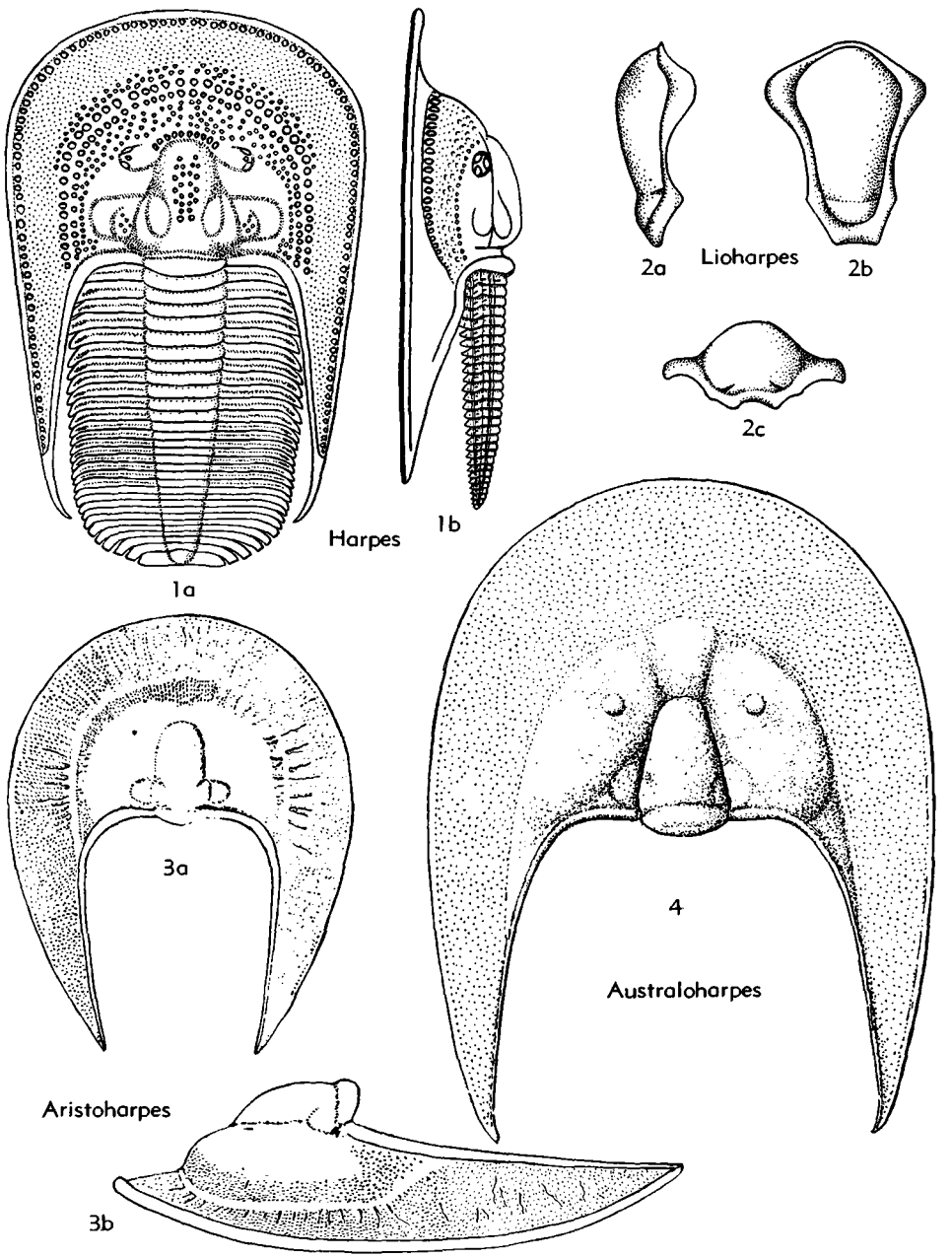


FIG. 319. Harpidae (p. O415-O418).

M.Dev., Eu.-N.Afr.-?Asia-?Austral.——FIG. 319,*1*. **H. macrocephalus*, Ger.; *1a*, exoskel. (reconstr.), ×1.1 (496n); *1b*, same, lateral, ×1 (242*).

Aristoharpes WHITTINGTON, 1950 [**A. willsi*] [?=*Scotoharpes* LAMONT, 1948]. Like *Selenoharpes* but cephalon oval in outline; alae small; fringe with external surfaces of upper and lower lamellae traversed by narrow, ramifying, raised ridges, small pits between the ridges. Thorax with at least 16 segments. Pygidium with strongly curved rib furrows. *L.Sil.*, Eng.——FIG. 319,*3*. **A. willsi*; *3a,b*, ceph., dorsal, lateral, ×2 (348*).

Arraphus ANGELIN, 1854 [**A. corniculatus*]. Nature and affinities uncertain. Brim unknown. *U. Ord.*, Swed. (HE).

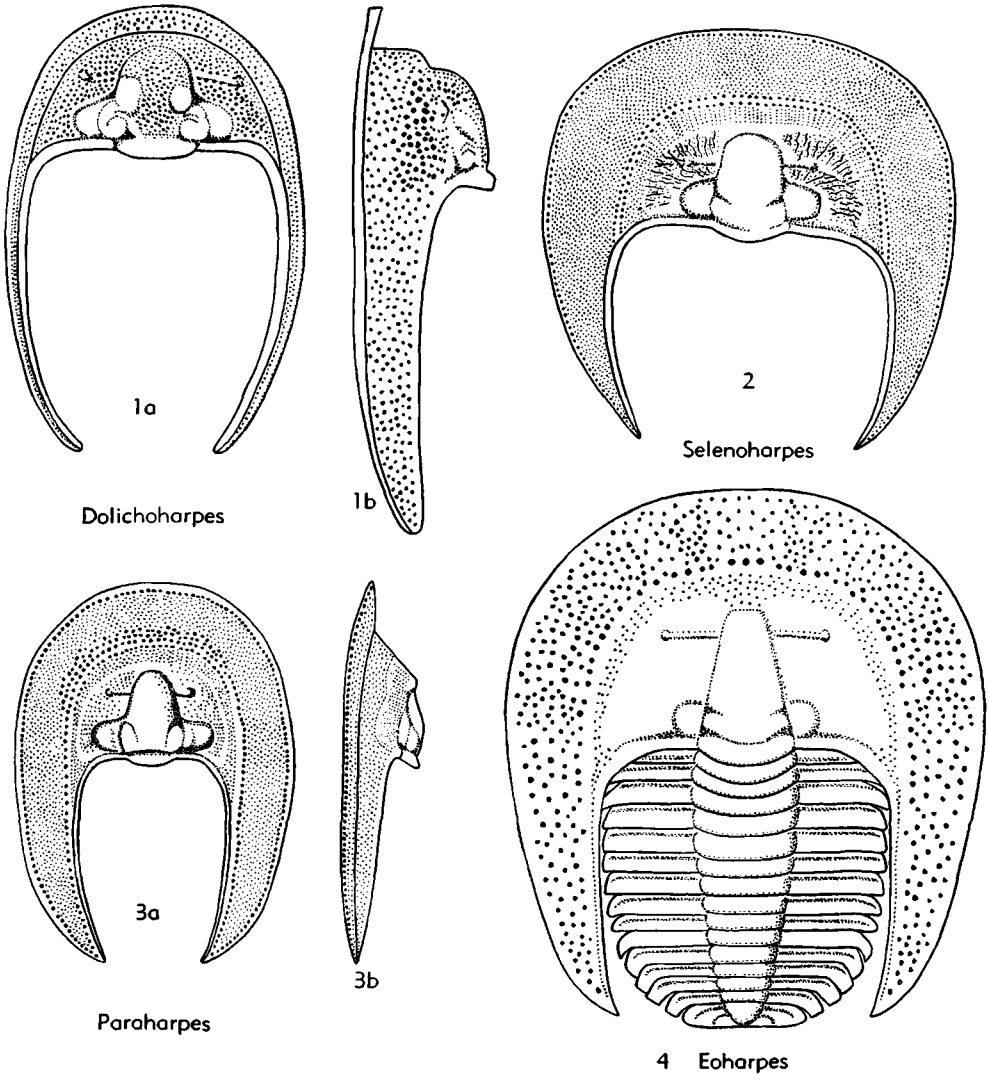


FIG. 320. Harpidae (p. 0417-0418).

Australoharpes HARRINGTON & LEANZA, 1957 [**A. depressus*] Cephalon oval in outline, of low convexity. Small posterior lateral glabellar lobes. Alae faint, eye tubercles opposite preglabellar furrow, preglabellar field elevated, laterally outlined by furrows which diverge forward. Fringe with girder extending to tips of prolongations, genal roll narrow, brim broad, flattened; pits small, closely and irregularly distributed. *L.Ord.(Tremadoc.)*, S. Am.——FIG. 319,*4*. **A. depressus*, Arg.; ceph., ×3.5 (59*).

Dolichoharpes WHITTINGTON, 1949 [**Eoharpes uniserialis* RAYMOND, 1925]. Cephalon ovate in outline, strongly convex; glabella strongly convex, with short median and anterior lateral glabellar furrows; alae depressed below rest of genae; fringe with deep girder extending to tips of prolongations, genal roll and prolongation broad and vertical, brim narrow, with flat lower and concave upper lamellae; pits large, irregularly and closely spaced, with tendency to radial arrangement in brim; coarse reticulate ornament on external surface of glabella and genae (except posterior lobes and alae), merging into fringe; curved ridge on posterior glabellar lobes, smooth paired oval area between posterior and median lateral glabella furrows. Hypostoma as in *Lioharpes* but with deeper and more oblique middle furrow and more pointed posterior ring. Pygidium short, wide *(tr.)*, with 3 or 4 distinct segments (42). *M.Ord.*,

N.Am.-Ire.——Fig. 320,*1*. **D. uniserialis* (Raymond), Mo.; *1a,b*, ceph., dorsal, lateral, ×2 (348*).

Dubhglasina Lamont, 1948 [**D. aldonensis*]. Nature and affinities uncertain. *M.Ord.*, Scot.

Eoharpes Raymond, 1905 [*pro Harpina* Novák, 1885 (*non Harpina* Boeck, 1871; *nec* Dejean in Burmeister, 1844] [**Harpes primus* Barrande, 1872; SD Bassler, 1915]. Cephalon subcircular in outline, convex; anterior part of glabella depressed below genae, posterior lateral glabellar lobes small; alae small, faint, depressed; genal roll prolongation broad *(tr.)*, with bluntly rounded tip, girder extending to tips of prolongations, brim flat with low anterior fold, pits of medium size, irregularly spaced. Thorax with 12 to 15 segments. External surface of glabella and genae apparently smooth but inner surface of genae impressed with pattern of radiating, anastomosing ridges and lines of pits between them. *M.Ord.*, Boh.——Fig. 320,*4*. *E. benignensis* (Barrande); exoskel. (reconstr.), ×2.7 (496n).

Hibbertia Jones & Woodward, 1898 [**Harpes flanagani* Portlock, 1843 (=*Hibbertia orbicularis* Jones & Woodward, 1898)] [=*Platyharpes* Whittington, 1950 (obj.)]. Like *Paraharpes* but outline of cephalon subcircular, fringe with narrower genal roll and broader brim, pits smaller, thorax with few more than 10 segments. *M.Ord.*, Scot.-Ire.

Lioharpes Whittington, 1950 [**Harpes venulosus* Hawle & Corda, 1847]. Like *Harpes* but alae narrower *(tr.)*, no conspicuous rows of large pits flanking girder or at external margin; radiating ridges prominent on inner part of brim, faint on genal roll. *M.Dev.*, Boh.-?Fr.-?Sp.——Fig. 319,*2*. **L. venulosus* (Hawle & Corda), Boh.; *2a-c*, hypostoma, left side, ventral (exterior), posterior, ×2.5 (348*).

Metaharpes Lamont, 1948 [**M. amibouei*]. Only brim known. *L.Sil.*, Scot.

Paraharpes Whittington, 1950 [**Harpes (Eoharpes) hornei* Reed, 1914]. Outline of cephalon oval; glabella convex, carinate; alae large, not depressed; fringe with girder extending to tips of prolongations, brim flat, large pits in rows flanking the girder, along external margin, and on prolongations. Thorax with 23 to 25 segments. External surface of genae (not alae) with raised, radiating, reticulate pattern of ridges. *M.Ord.-U. Ord.*, Eng.-Scot.-?Ala.——Fig. 320,*3*. **P. hornei* (Reed), U.Ord., Scot.; *3a,b*, ceph., dorsal, side, ×1.5 (348*).

Selenoharpes Whittington, 1950 [**Harpes (Eoharpes) youngi* Reed, 1914]. Cephalon subcircular in outline; genal ridges faint, alae large, depressed below level of genae; fringe with girder curving in behind genal angles to meet internal rim, broad genal roll and brim, latter with outward-sloping prolongation, pits tiny and close-spaced, larger ones flanking girder and at external margin. External surface of genae with radiating ridges that continue inward to genal roll only. Hypostoma, thorax, and pygidium unknown. *L.Ord.-M.Ord.*, Eu.——Fig. 320,*2*. **S. youngi* (Reed), M.Ord., Scot.; ceph., ×9 (348*).

Family HARPIDIDAE Whittington, 1950

[=Loganopeltidae Hupé, 1955]

Cephalic border not sharply set off from convex genae and preglabellar field; alae small, semicircular; facial sutures marginal, or with parallel anterior and posterior sections running close to each other and directed anterolaterally from eye tubercles to margin; genal caeca radiating over cheek lobes and in some extending onto cephalic border. Hypostoma subrectangular *(Harpides)*, length *(sag.)* equal to that of glabella. Thorax with 20 or more segments; axis narrow; long *(tr.)* pleurae curving back at outer part may be extended into spines, with deep pleural furrows and convex posterior bands. *U.Cam.-L.Ord.*, Vt.-Que.-Newf.-S. Am.-Eu.-C. Asia (105, 117, 194, 249, 348, 349).

Harpides Beyrich, 1846 [**H. hospes*] [=*?Dictyocephalites* Bergeron, 1895]. Glabella 0.3 of length *(sag.)* of cephalon, with prominent posterior lateral lobes; eye tubercles opposite anterior margin of glabella, eye ridges directed slightly backward; alae depressed below level of genae; genal caeca strong, anastomosing, extending to narrow, convex, marginal rim, irregularly spaced tiny pits between caeca on concave cephalic border. Probably cephalic doublure of same width as border (without opposing pits?), with genal spines borne by such doublure. Pygidium unknown (348). *L.Ord.*, Vt.-Que.-Eu.-Arg.-C.Asia.——Fig. 321,*3a*. *H. rugosus* (Sars & Boeck), Norway-Swed.; cran., ×1 (444).——Fig. 321,*3b*. *H. grimmi* (Barrande), Czech.; incomplete cran. and thorax, ×0.7 (370*).

Fissocephalus Lermontova, 1951 [**F. expansus*]. Resembles *Loganopeltoides*. *U.Cam.*, NE.Kazakhstan (HE).

Loganopeltis Rasetti, 1943 [**L. depressa*]. Glabella short, subconical, elevated above fixed cheeks, not sunk in depression; eyes disconnected from facial sutures, which are marginal. Thorax of 20 or more segments. Pygidium elongate, with short axis, pleurae converging backward and terminating in pair of flat spines. *L.Ord.*, N.Am.——Fig. 321,*2*. **L. depressa*, Que.; *2a*, incompl. exoskel. (holotype), ×3; *2b*, cran., oblique lateral, ×3; *2c*, pyg., ×4 (448n).

Loganopeltoides Rasetti, 1945 [**Conocephalites zenkeri* Billings, 1860]. Like *Loganopeltis* but both sections of facial sutures running outward and forward from eyes close together but sep-

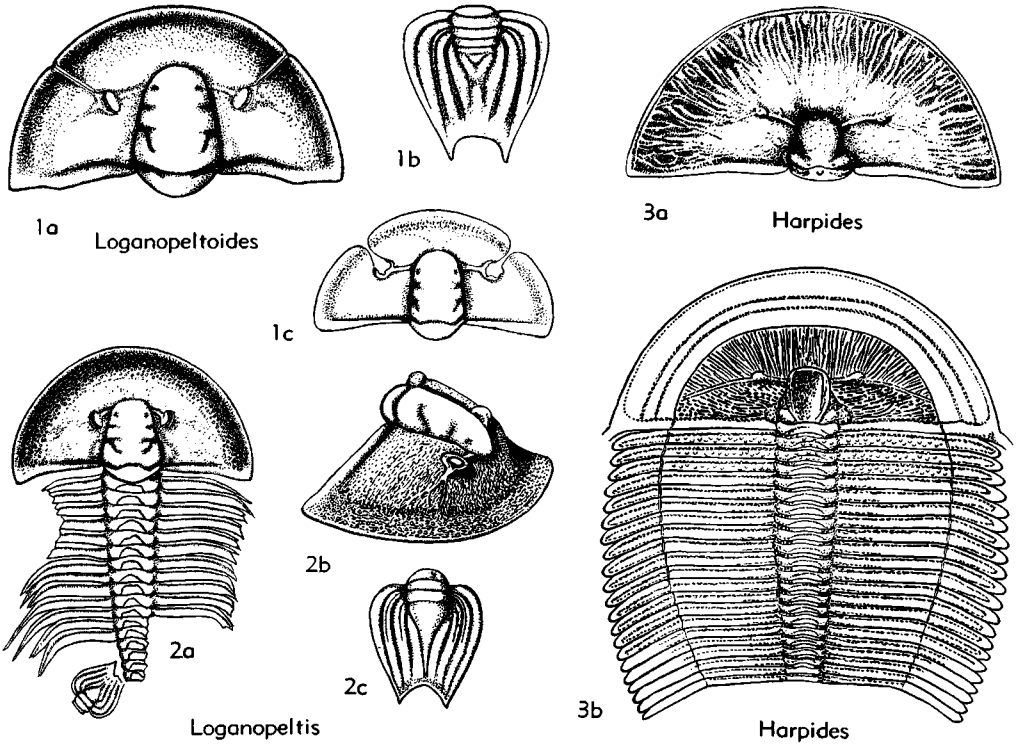


FIG. 321. Harpididae (p. O418).

arately *(L. kindlei)* or merged into one *(L. zenkeri)*. *U.Cam.(Trempeal.)*, N.Am.——FIG. 321,*1a,b*. **L. zenkeri* (BILLINGS), Que.; *1a*, cran., ×1.5; *1b*, pyg., ×3 (448n).——FIG. 321,*1c*. *L. kindlei* RASETTI, Newf.; cran., ×4 (448n).

Family ENTOMASPIDIDAE Ulrich in Bridge, 1930

[*nom. correct.* HENNINGSMOEN, 1951 (*pro* Entomaspidae ULRICH in BRIDGE, 1930)]

Exoskeleton small. Cephalon semicircular, characterized by anterior and posterior sections of facial sutures close to each other, both directed outward-backward; librigenae fused together through doublure, dorsally consisting of narrow strips connecting eyes to margin and genal spines. *U.Cam.-L.Ord.*

Entomaspis ULRICH in BRIDGE, 1930 [**E. radiatus*]. Glabella tapering, truncate, less than 0.5 of length of cephalon; fixigenae convex; border wide, radially striated; eyes small, at level of glabellar midpoint; eye ridges strong, oblique; posterior areas slender, curving backward. Pygidium widely triangular; axis prominent, with several segments; pleural fields flat, with downturned margin. *U.Cam.(Trempeal.)*, N.Am.——FIG. 322,*2*. **E. radiatus*, Mo.; *2a-c*, cran., pyg., librigenae, ×7.5 (448n).

Hypothetica Ross, 1951 [**H. rawi*]. Cranidium weakly convex; glabella short, subovate; eye ridges thick, directed transversely. *L.Ord.*, N.Am.——FIG. 322,*1*. **H. rawi*, Utah; cran., ×15 (258).

Suborder TRINUCLEINA Swinnerton, 1915

[*nom. correct.* WHITTINGTON herein (*pro* Trinucleida SWINNERTON, 1915)] [=Ampycini SALTER, 1864; superfamily *Cryptolithidea* RICHTER, 1933; Trinucleacea KOBAYASHI, 1935, Raphiophoracea HENNINGSMOEN, 1951; Trinucleoidae HUPÉ, 1953] [Type—*Trinucleus* MURCHISON, 1839]

Cephalon subsemicircular to triangular in outline; glabella convex, subquadrate to clavate, with 3 or fewer pairs of lateral furrows and oval lateral lobes in some, median tubercle or glabellar spine in some genera; occipital ring short, narrow; alae characteristic of young stages, retained in some adults; genae convex, eye lobes absent or represented by tubercles, genal ridges present in some genera; cephalic border narrow, rolled, or comprising broad, bilaminar fringe with opposed pits; long genal spines; facial sutures opisthoparian, submarginal or marginal anteriorly and anterolaterally, becoming dorsal posterolaterally near or at genal angles. Thorax generally with

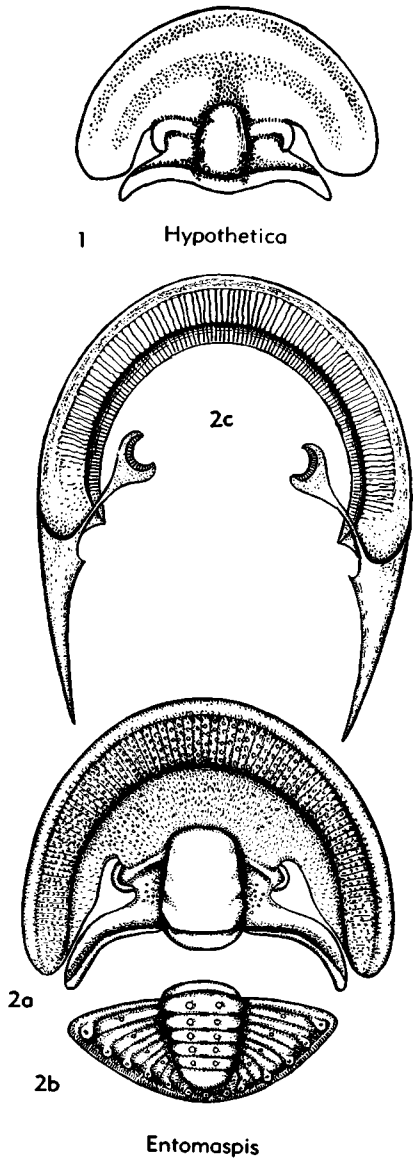


FIG. 322. Entomaspididae (p. O419).

5 to 7 segments (but as many as 30 in *Selenecceme*); axis narrow; pleurae broad *(tr.)*, flat, with deep pleural furrows. Pygidium subsemicircular or subtriangular in outline; narrow axis reaching posterior margin; commonly with many rings and furrows or double rows of muscle scars; pleural fields flat, margin broad. Surface smooth or with raised ridges generally in reticulate pattern but tending to anastomosed radial arrangement on genae. *L.Ord.-M.Sil.*

Family TRINUCLEIDAE Hawle & Corda, 1847

[*nom. correct.* (*ex* Trinucleides HAWLE & CORDA, 1847; ICZN Opinion 505)] [=Trinucleen EMMRICH, 1844 (invalid vernacular name)]

Cephalic fringe broad, sloping outward, bilaminar, with numerous opposed pits on external surfaces, extending posterolaterally somewhat behind rest of cephalon; convex occipital ring commonly with backward-directed spine, occipital furrow with deep apodemal pit; glabella expanding forward, reaching to inner margin of fringe, deep anterior pits at extremities of axial furrows; genae subtriangular in outline, with or without eye tubercles and faint eye ridges; lower lamellae of fringe bearing genal spines. Thorax with 6 segments; convex axial rings, with deep apodemal pits in articulating furrows; pleurae with broad diagonal pleural furrows, pleural tips bent down. Pygidium triangular, length *(sag.)* 0.25 to 0.5 of width *(tr.)*; axis with many rings; pleural fields with shallow pleural furrows. Surface of glabella and genae may bear reticulate pattern of raised ridges, margin of fringe and pygidial border with terraced lines (2, 78, 79, 344, 346). *L.Ord.-U. Ord.*

Subfamily TRINUCLEINAE Hawle & Corda, 1847

[*nom. transl. & correct.* WHITTINGTON, 1941 (*ex* Trinucleides HAWLE & CORDA, 1847)]

Glabella with convex frontal lobe, 3 pairs of short, deep, lateral glabellar furrows; pits in upper lamella of fringe deeply sunk in radial sulci anteriorly and laterally. *L.Ord.-M.Ord.*

Trinucleus MURCHISON, 1839 [*non* LINK, 1807 (ICZN Op. 505)] [**T. fimbriatus*; SD VOGDES, 1890] [=*Edgellia* SHAW, 1950 (obj.); *Botrioides* STETSON, 1927]. Median and posterior glabellar furrows deepest and longest. Pygidium strongly transverse, with breadth 3 or 4 times length *(sag.)*. *L.Ord.-M.Ord.*, Br.I.-Norway-Swed.—— FIG. 323,5. **T. fimbriatus*, M.Ord., Wales; exoskel., ×2.7 (496n).

Paratrinucleus WHITTINGTON, 1941 [**Trinucleus acervulosus* RAYMOND, 1920]. Like *Trinucleus* but median and posterior glabellar furrows isolating pair of triangular lateral lobes. Pygidium with width about twice length *(sag.)*, many segments. *M.Ord.*, Va.

Subfamily TRETASPIDINAE Whittington, 1941

[*nom. correct.* Whittington, herein (*pro* Tretaspinae Whittington, 1941)]

Glabella with prominent frontal lobe, 3 pairs of lateral glabellar furrows; fringe divided into convex genal roll and concave brim, former commonly with concentric ridges between pits, latter with pits in deep radial sulci anteriorly. *M.Ord.-U.Ord.*

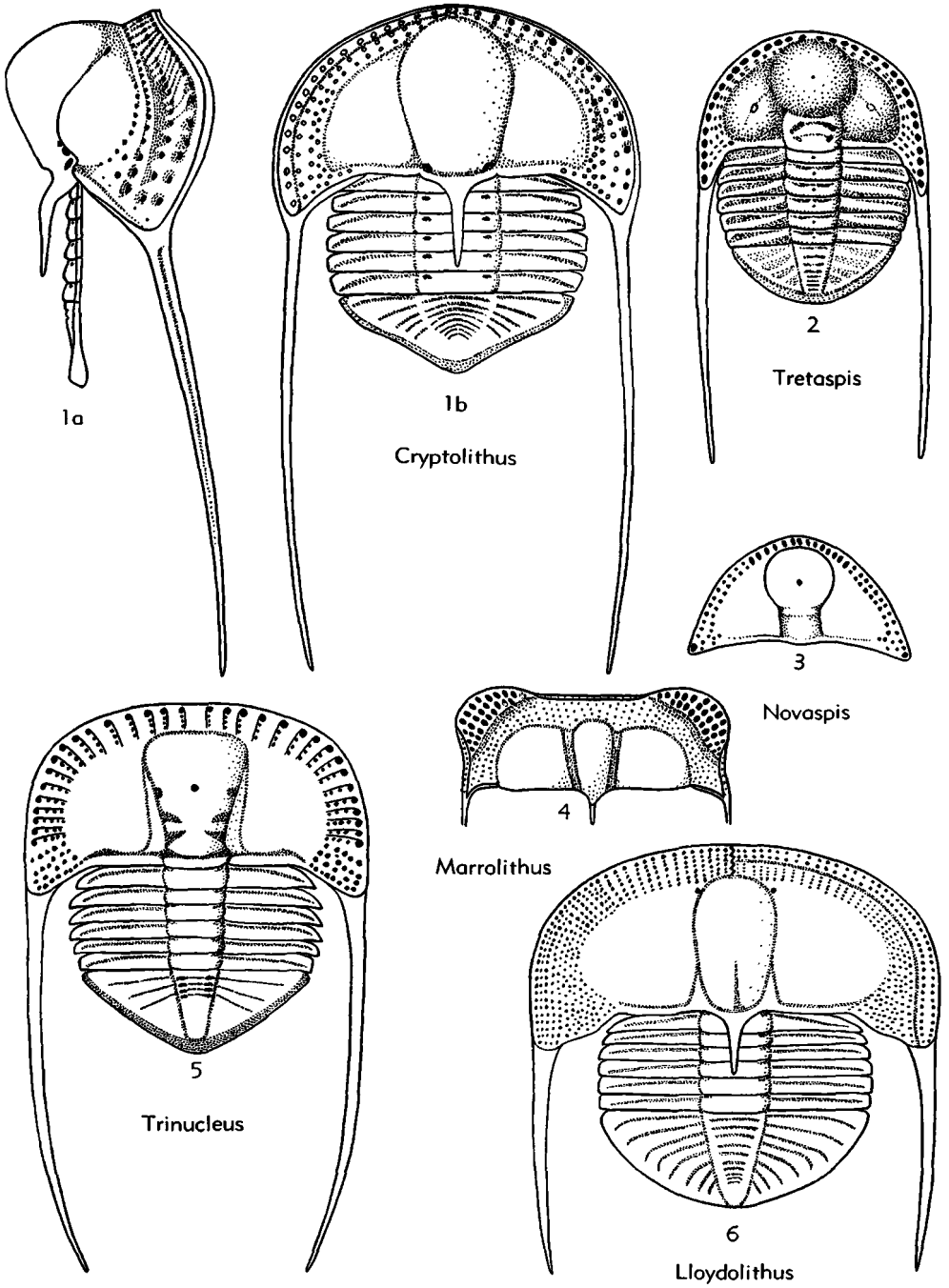


Fig. 323. Trinucleidae (Trinucleinae, Cryptolithinae, Novaspidinae) (p. O420-O424).

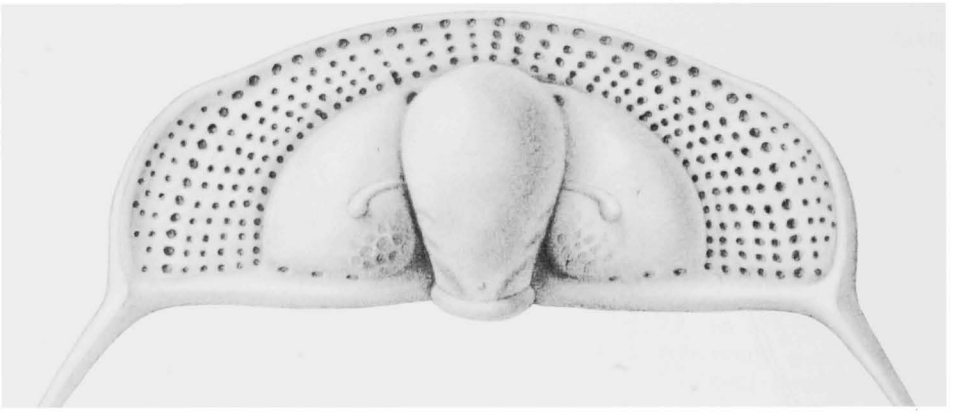


FIG. 324. **Guandacolithus furquei* HARRINGTON & LEANZA (Trinucleidae), *U.Ord.*, NW.Arg.; ceph., ×5 (59*).

Tretaspis M'COY, 1849 [*non Tretaspis* MURCHISON, 1839 (ICZN Op. 505)] [**Asaphus seticornis* HISINGER, 1840; SD BASSLER, 1915]. Frontal glabellar lobe subcircular in outline, posterior part of glabella with median posterior glabellar furrows converging inward; 2 rows of pits external to girder, in some species fusing anteriorly into single row; no median occipital spine. *M.Ord.-U. Ord.*, E. N. Am.-Br. I.-Norway-Swed.-Boh.——FIG 323,*2*. **T. seticornis* (HISINGER), Up.M.Ord.-U.Ord., Br.I.-N.Eu.; exoskel., ×2 (473*).

Reedolithus BANCROFT, 1929 [**Trinucleus subradiatus* REED, 1903]. Glabella carinate, lateral glabellar furrows short; with median occipital spine; eye tubercles and eye ridges present; fringe with single row of large external pits, 5 or more rows of smaller pits internally, arranged concentrically and radially. *M.Ord.*, Scot.-Norway-Swed.-Que.

?Guandacolithus HARRINGTON & LEANZA, 1957 [**G. furquei*]. Glabella pyriform, with 3 pairs of lateral glabellar furrows; eye tubercles and eye ridges present; fringe broad laterally, narrow anteriorly, position of girder unknown; 4 complete rows of pits, outermost of which are large, with 21 or 22 pits on each side in concentric and curved-radial arrangement, also inside innermost complete row, 2 additional rows bordering genae and laterally 3 incomplete rows outside outermost complete row of large pits, incomplete rows being arranged concentrically and radially with respect to complete rows. *M.Ord.(Caradoc.)*, S. Am.——FIG. 324. **G. furquei*, NW.Arg.; ceph., ×10 (59*).

Subfamily CRYPTOLITHINAE Angelin, 1854

[*nom. transl.* BANCROFT, 1933 (*ex* Cryptolithidae ANGELIN, 1854)]

Glabella clavate to carinate, with single pair of short lateral glabellar furrows; eye tubercles and eye ridges usually absent. *L. Ord.-U.Ord.*

Cryptolithus GREEN, 1832 [**C. tesselatus*]. Fringe with concentric rows of pits that show radial arrangement also anteriorly, characteristically with raised radial ridges between outer row or rows and concentric ridges between inner rows, one row of pits external to girder. *L.Ord.-U.Ord.*, N. Am.-Br.I.——FIG. 323,*1*. **C. tesselatus*, M.Ord., E.N.Am.; *1a*, exoskel., dorsal, with left half of upper lamella of fringe removed; *1b*, same, lateral; both ×2.7 (496n).

Onnia BANCROFT, 1933 [*non Tetrapsellium* HAWLE & CORDA, 1847, ICZN pend.] [**Cryptolithus superbus* BANCROFT, 1929]. Upper lamella of fringe convex, with 2 complete rows external to girder and 2 internal in concentric arrangement, rows on each side of girder larger, outermost row of many small pits; bordering genae additional rows, depressed or with marked radial arrangement. *M.Ord.-U.Ord.*, Eng.-Boh.-Fr.-Port.-N.Afr.-Venez. ——FIG. 325,*1*. **O. superba* (BANCROFT), U.Ord., Eng.; ceph., ×2 (422*).

Broeggerolithus BANCROFT in LAMONT, 1935 [*pro Broeggeria* BANCROFT, 1933, *non Broeggeria* WALCOTT, 1903] [**Cryptolithus broeggeri* BANCROFT, 1929] [?=*Ulricholithus* BANCROFT, 1949]. Fringe with 4 rows of pits in concentric and radial arrangement, 2 external; additional pits posterolaterally, 1 or 2 pits intercalated in external row in front of glabella. *M.Ord.*, Eng.-Wales.

Cryptolithoides WHITTINGTON, 1941 [**C. ulrichi*]. Anterolateral cephalic margin angulate; fringe with numerous small pits, single regular external row, 1st internal row in radial concentric arrangement with it, inside this row pits irregularly arranged. *M.Ord.*, Okla.-Tex.——FIG. 325,*2*. **C. ulrichi*, Okla.; exoskel. (paratype), ×2.5 (496*).

Reuscholithus BANCROFT, 1929 [**R. reuschi*]. Fringe with 4 continuous rows of pits, 2 of which form narrow zone external to girder, 4 additional rows laterally; pits irregular in size and distribution. *M.Ord.*, Eng.

Salterolithus BANCROFT, 1929 [**Trinucleus caractaci* MURCHISON, 1839]. Fringe with 3 or 4 rows of pits outside girder, 2 complete rows inside, additional rows laterally; arrangement in concentric rows adjacent to girder. *M.Ord.*, Eng.

Marrolithus BANCROFT, 1929 [**Trinucleus ornatus* var. *favus* SALTER, 1848]. Fringe with angulate margin anterolaterally, pits in radial and concentric arrangement, variable area of upper lamella inflated anterolaterally. *M.Ord.*, Wales-Eng.-Fr.-Port.-N.Afr.——FIG. 323,*4*. **M. favus* (SALTER), M.Ord., Wales; ceph., ×1.5 (361*).

Marrolithoides A. WILLIAMS, 1948 [**M. simplex*]. Pits in simple radial arrangement, anterolateral inflation of upper lamella rare or absent. *M.Ord.*, Eng.

Talaeomarrolithus A. WILLIAMS, 1948 [**Trinucleus radiatus* MURCHISON, 1839]. Glabella with poorly developed frontal lobe, fringe with pits in radiating sulci that bifurcate anterolaterally. *M.Ord.*, Eng.-Wales.

Lloydolithus BANCROFT, 1933 [**Trinucleus lloydi* MURCHISON, 1839]. Pygidium with posterolateral margins in smooth arc; outer parts of pleural furrows curving sharply back; small convex alae at base of glabella; fringe with pits in concentric rows, strong radial arrangement anteriorly, irregular posterolaterally, 2 rows external to girder. *M. Ord.*, Eng.-Wales.——FIG. 323,*6*. **L. lloydi* (MURCHISON); exoskel. (reconstr.), with right half of upper lamella of fringe removed, ×2.7 (496n).

Protolloydolithus A. WILLIAMS, 1948 [**Trinucleus ramsayi* HICKS, 1875]. Glabella with 2 pairs of glabellar furrows; fringe with single row of pits external to girder, inside girder numerous small pits, radial arrangement anteriorly, elsewhere irregular; otherwise like *Lloydolithus* (352, 361). *M.Ord.(Llanvirn.)*, Eng.-Wales.

Eirelithus LAMONT, 1941 [**Trinucleus thersites* SALTER, 1853]. Triangular depressed regions bordering posterior part of glabella; fringe narrow, with 2 rows of pits external to girder, some additional pits anterolaterally, 1st internal row complete, few additional pits anterolaterally; eye tubercles and eye ridges present (115). *M.Ord.*, Ire.

Famatinolithus HARRINGTON & LEANZA, 1957 [**F. noticus*]. Fringe narrow, outer surface of upper lamella deeply concave, broad rim and deep girder forming rolled outer edge of fringe; 2 rows of pits, outer large, inner incomplete only in front of glabella, additional pits anterolaterally between these 2 rows. *M.Ord.(Llanvirn.)*, S.Am.——FIG. 326. **F. noticus*, NW.Arg.; exoskel. (reconstr.), ×4.5 (59*).

Myttonia WHITTARD, 1955 [**M. confusa*]. *L.Ord. (Arenig.)*, Eng.

Bergamia WHITTARD, 1955 [**B. rhodesi*]. *L.Ord.-M.Ord.*, Eng.

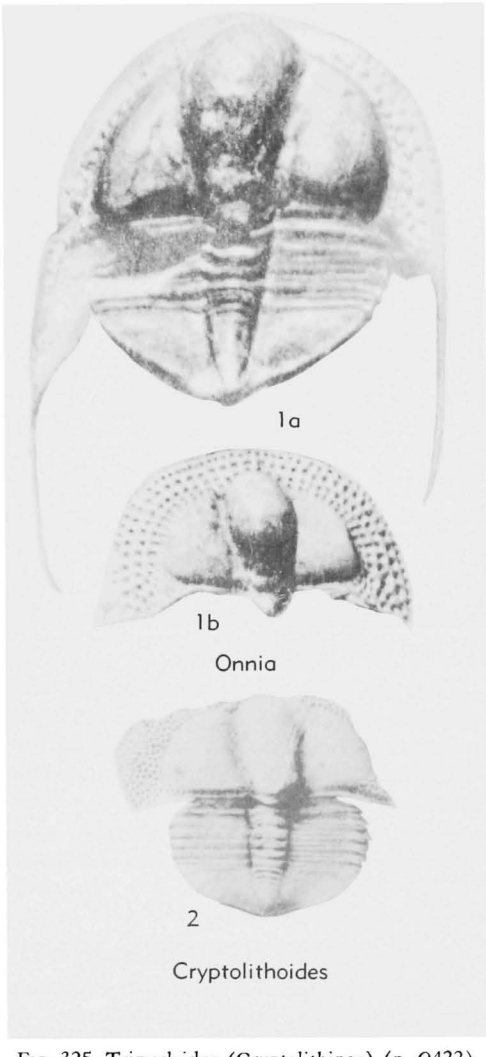


FIG. 325. Trinucleidae (Cryptolithinae) (p. O422).

Incaia WHITTARD, 1955 [**Trinucleus nordenskioldi* BULMAN, 1931]. *M.Ord.(Llanvirn.)*, Peru.

Stapeleyella WHITTARD, 1955 [**S. inconstans*]. *M. Ord.(Llanvirn.)*, Eng.

Bettonia WHITTARD, 1956 [**B. frontalis*]. *M.Ord.*, Eng.

Hangchungolithus LU, 1956 [**Cryptolithus multiseriatus* ENDO, 1932]. Like *Myttonia*. *L.Ord.*, W. Tapashan, China.

Ningkianolithus LU, 1956 [**Cryptolithus welleri* ENDO, 1932]. Like *Protolloydolithus*. *L.Ord.*, W. Tapashan, China.

Nankinolithus LU, 1957 [**N. nankinensis*]. Fringe like *Broeggerolithus*, external pits in deep radial sulci, all pits in such sulci anteriorly; laterally internal pits irregulary arranged. *U.Ord.*, Tangshan, China.

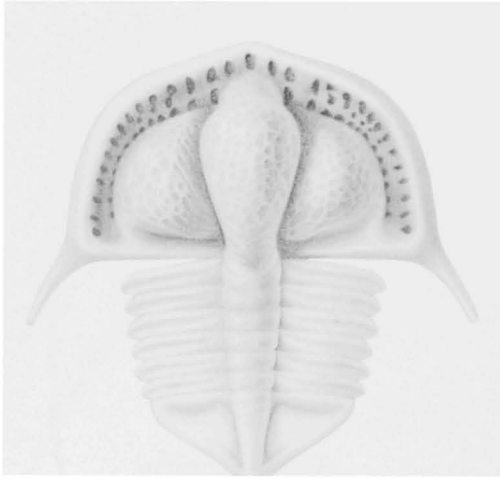


FIG. 326. **Famatinolithus noticus* HARRINGTON & LEANZA (Trinucleidae), M.Ord., NW.Arg.; exoskel. (reconstr.), ×4.5 (59*).

Subfamily NOVASPIDINAE Whittington, 1941

[*nom. correct.* WHITTINGTON, herein (*pro* Novaspinae WHITTINGTON, 1941)]

Glabella with subspherical frontal lobe, posterior portion low, 2 pairs of short lateral glabellar furrows; no eye tubercles; narrow, flat fringe, with 2 rows of pits in radial sulci anteriorly. *U.Ord.*

Novaspis WHITTINGTON, 1941 [**Tretaspis elevata* COOPER & KINDLE, 1936]. Characters of subfamily. *U.Ord.* Que.-?Scot.——FIG. 323,*3*. **N. elevata* (COOPER & KINDLE); ceph., ×1.5 (346*).

Family OROMETOPIDAE Hupé, 1955

Glabella subparallel-sided or expanding forward, convex, basal lateral furrow (if present) short and close to occipital furrow, preoccipital part of glabella extended backward as a spine; occipital ring short *(sag.)*, convex; axial and preglabellar furrows shallow, with anterior pit in some forms; broad *(sag., exsag.)* preglabellar field, narrow anterior and lateral cephalic border; convex triangular genae, with posterior border widening *(exsag.)* laterally, border furrow terminating distally in deep pit; large eye lobes centrally situated on genae, palpebral rims continuous with eye ridges; gently convex alae triangular in outline, not separated from occipital ring by axial furrows; genal spines extended back far beyond pygidium. Doublure narrow, rolled, hypostoma not known in place (associated hypostomas with transversely rectangular outline), with shallow depression at posterolateral corners. Thorax with 7 or 8 segments; axial rings may bear median spine on 3rd and 4th segments; pleurae horizontal; shallow, straight pleural furrow. Pygidium with 6 or fewer axial ring furrows; pleural fields with 1st pleural furrow. External surface of cephalon with raised reticulate pattern, terraced lines on doublure and hypostoma (287). *L. Ord.(Tremadoc.)*.

Orometopus BRØGGER, 1896 [**Holometopus? elatifrons* ANGELIN, 1854]. Characters of family. *L. Ord.(Tremadoc.)*, Eu.-S.Am.——FIG. 327,*3*. **O. elatifrons* (ANGELIN), Swed.; exoskel. (reconstr.), ×7 (496n).

Family DIONIDIDAE Gürich, 1908

[*nom. correct.* RAYMOND, 1920 (*pro* Dionideae GÜRICH, 1908)]

Cephalon, thorax, and pygidium subequal in length *(sag.)*; glabella with anterior part strongly convex, suboval posterolateral lobes, median tubercle, or short glabellar spine; eyes absent; with 2 genal ridges; facial sutures curving across genal angles on dorsal side; cephalic fringe bilaminar with lamellae close together and opposing pits, largest externally, irregularly arranged; girder external. Hypostoma with ovate middle body and broad *(tr.)* lateral areas. Thorax with 6 segments, 1st longest *(sag., exsag.)*, pleural furrows curving forward, concave toward front. Pygidium with narrow axis having about 20 or fewer rings and pleural furrows (352). *M.Ord.-U.Ord.*

Dionide BARRANDE, 1847 [ICZN Opinion 350] [**Dione formosa* BARRANDE, 1846] [=*Polytomurus* HAWLE & CORDA, 1847 (obj.); *Trigrypos* KOBAYASHI, 1940]. Glabella subquadrate, with median tubercle; preglabellar field short *(sag.)* or absent; fringe broad. Axial rings of thorax and pygidium with anterolateral corner isolated by diagonal furrows; sigmoidal course of posterior edge of rings characteristic. Inner part of anterior band of 1st thoracic pleurae inflated. Surface of genae and pleurae pitted, ridges between pits forming reticulate pattern. *M.Ord.-U.Ord.*, Eu.-Va.-Yunnan.——FIG. 327,*2*. **D. formosa* (BARRANDE), *M.Ord.*, Boh.; exoskel. (reconstr.), ×1.25 (496n).

Digrypos KOBAYASHI, 1940 [**Dionide hybrida* REED, 1915]. Cephalon only known, like *Dionide*, fringe narrowing posterolaterally and pits not extending to genal angle. *M.Ord.*, Burma.

Dionidella PRANTL & PŘIBYL, 1948 [**D. incisa*]. Like *Dionide* but relatively longer thorax and shorter pygidium, latter with terminal axial spine. *M.Ord.*, Boh.

Trinucleoides RAYMOND, 1917 [**Trinucleus reussi* BARRANDE, 1856]. Glabella clavate in outline, with upwardly directed glabellar spine and prominent posterolateral lobes; girder stout, pitted portion of fringe narrow. Pygidium short *(sag.)*, triangular, with 8 to 10 axial rings. *M.Ord.*, Boh. ——FIG. 327,*1*. **T. reussi* (BARRANDE); *1a*, exoskel.; *1b*, hypostoma, ventral; both ×1.7 (496n).

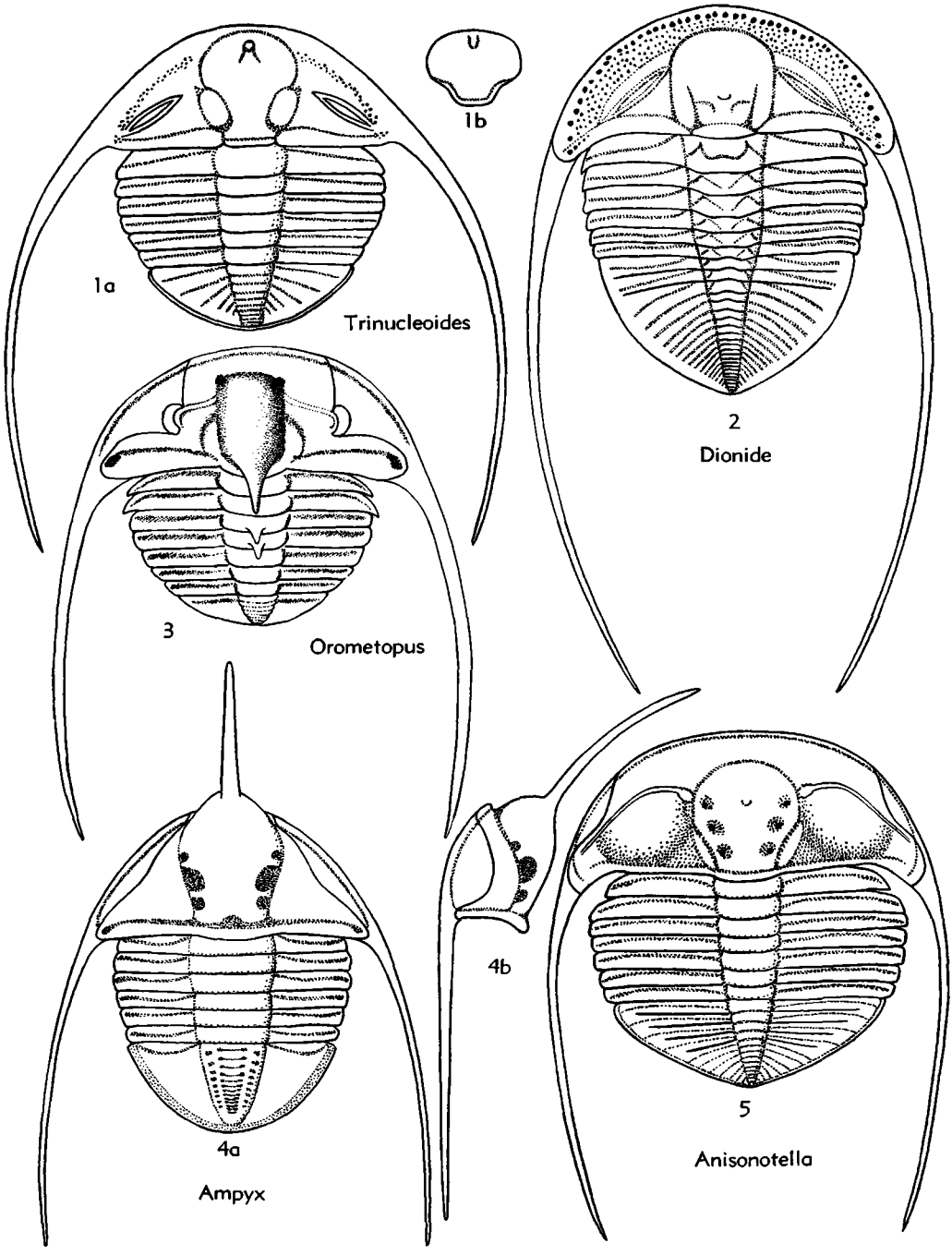


FIG. 327. Orometopidae, Dionididae, Raphiophoridae (p. 0424-0426).

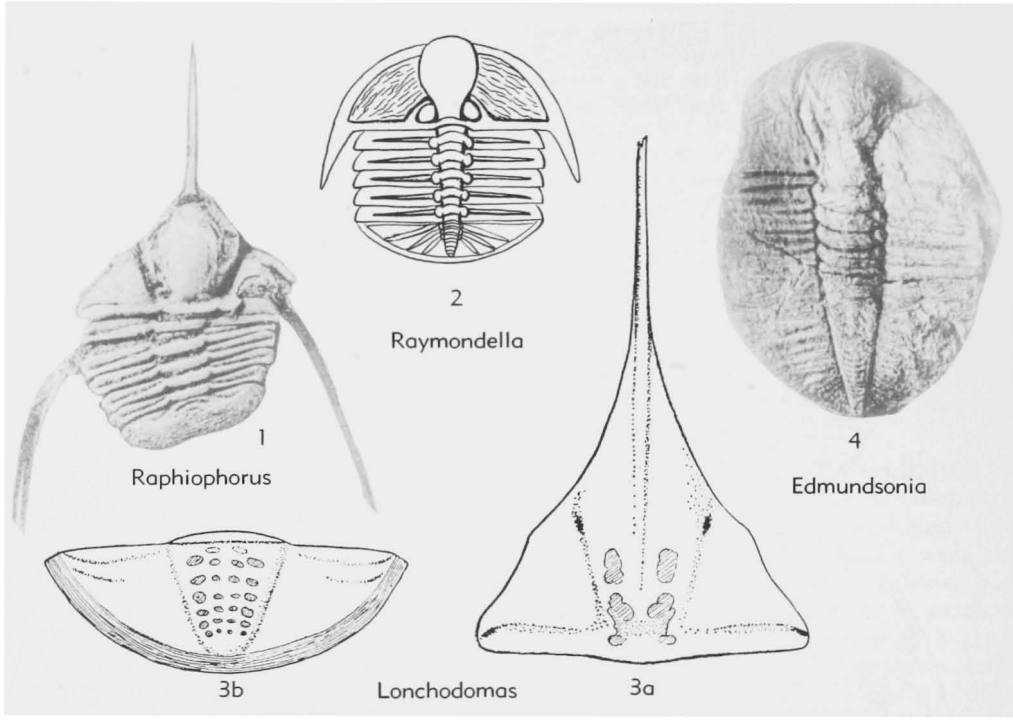


FIG. 328. Raphiophoridae (p. O426-O427).

Family RAPHIOPHORIDAE Angelin, 1854

[=Ampycidae CHAPMAN, 1890]

Cephalon and pygidium subtriangular in outline. Glabella expanding forward, with median glabellar spine directed upward-forward in some genera; occipital ring convex; elongate *(exsag.)* convex alae united with occipital ring present in some adults; eyes absent; facial sutures in curved path along outer part of genae, uniting along anterior margin of cephalon; cephalic border and doublure narrow, latter not crossed by sutures. Hypostoma unknown. Thorax with 5 to 7 segments, 1st commonly longer *(exsag.)* than others. Pygidium with many ring furrows, pleural regions with one or many pleural furrows (350, 352). *L.Ord.-M.Sil.*

Raphiophorus ANGELIN, 1854 [**R. setirostris;* SD RAYMOND, 1925]. Glabellar spine long; alae small. Thorax with 5 segments, 1st longer *(exsag.)* than others. Pygidium short, with broad border. *M.Ord., ?M.Sil.,* Eu.-?USA(Ark.).——FIG. 328,*1*. **R. setirostris,* M.Ord., Swed.; exoskel., ×5 (496*).

Ampyx DALMAN, 1827 [**A. nasutus*] [=*Brachyampyx* FORBES, 1849 (obj.)]. Glabellar spine long, upwardly curved, circular in cross section; with 3 pairs of ovate muscle scars on glabella, 4th pair at extremities of occipital furrow; alae absent; genal spines circular in cross section. Thorax with 6 segments; pleural furrows deepening outward, last 3 pairs curving forward, concave toward front. Pygidium with 2 paired rows of muscle scars on axis; pleural fields with single pair pleural furrows. External surface with fine pits, terraced lines on vertical borders and doublure. *L.Ord.-M.Ord.,* N.Am.-Eu.——FIG. 327,*4*. **A. nasutus,* L.Ord., Swed.-Norway-USSR.; *4a,* exoskel., ×1.5; *4b,* ceph., left lateral, ×1.5 (496n).

Ampyxina ULRICH, 1922 [**A. bassleri* (=**Endymionia bellatula* SAVAGE, 1917)]. No glabellar spine; alae large; rolled cephalic border narrow. Thorax with 5 segments, 1st longer *(sag., exsag.)* than others; pleural furrows curving forward, convex toward front. Pygidium with 6 pairs of pleural furrows curving outward-backward. *M. Ord.-U.Ord.,* Va.-Ala.-Tenn.-Ill.-Mo.——FIG. 329, *1*. **A. bellatula* (SAVAGE), U.Ord., Ill.; exoskel. (reconstr.), ×4.7 (496n).

Anisonotella WHITTINGTON, 1952 [*pro Anisonotus* RAYMOND, 1920 (*non* WHITE, 1847, *nom. nud.: nec* MILNE EDWARDS, 1879)] [**Shumardia glacialis* BILLINGS, 1865]. Glabella clavate, with 3 pairs of lateral furrows as subcircular pits, small median tubercle; narrow *(tr.)* alae extending forward outside axial furrows to opposite median glabellar furrows; genal ridges commencing in axial fur-

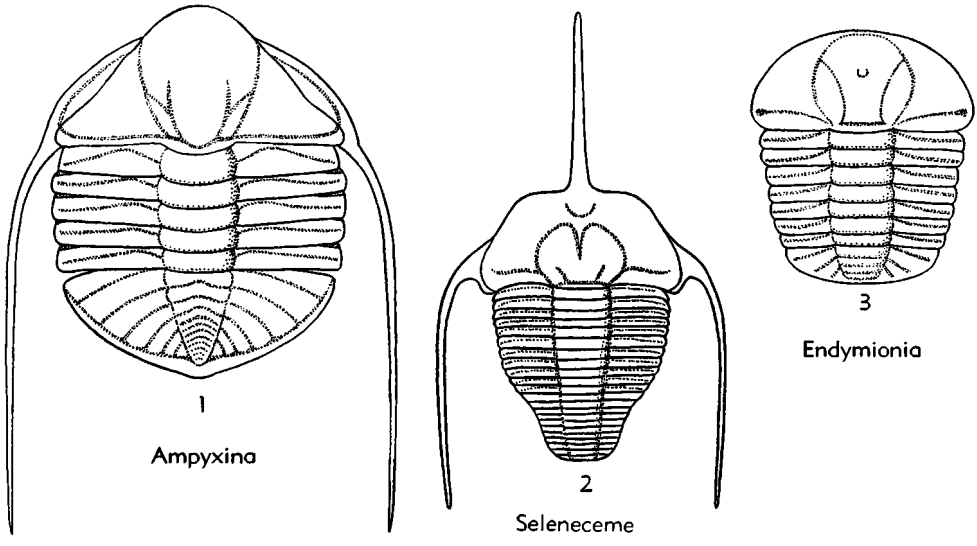


FIG. 329. Raphiophoridae, Endymionidae, Alsataspididae (p. O426-O428).

rows opposite anterior glabellar furrows and curving outward-backward to genal angles; genae behind genal ridges inflated; posterior borders wide *(exsag.)* at genal angles. Thorax with pleural furrows of 1st 3 to 5 segments curving convex forward. Pygidium with 13 axial rings; 7 or 8 pairs of pleural furrows, 4 interpleural grooves. External surface of cephalon inside border with fine raised lines in Bertillon pattern, faint radial ridges peripherally on genae and preglabellar field. *M.Ord.*, Newf.-?Scot.-?Swed.——FIG. 327,*5*. **A. glacialis* (BILLINGS), Newf.; exoskel. (reconstr.), ×4 (496n).

Cnemidopyge WHITTARD, 1955 [**Trinucleus nudus* MURCHISON, 1839]. Like *Ampyx* but distinguished by many axial rings and pleural furrows of pygidium. *M.Ord.*, Eng., Wales.

Edmundsonia B. N. COOPER, 1953 [**E. typa*]. Like *Anisonotella* but glabella with 2 pairs of shallow lateral furrows and ovate lateral lobes; preglabellar field short; genal ridges trifid. Thorax with 6 segments (26). *M.Ord.*, Va.-?Scot.——FIG. 328,*4*. **E. typa;* exoskel., ×1.3 (26*).

Lonchodomas ANGELIN, 1854 [**Ampyx rostratus* SARS, 1835; SD BASSLER, 1915]. Like *Ampyx* but glabella diamond-shaped in outline, carinate, with long median glabellar spine subquadrate in section directed horizontally; glabella with 2 pairs of muscle scars; genal spines subquadrate in section. Thorax with 5 segments. Pleural regions of pygidium with 2 pairs of narrow pleural furrows. *L. Ord.-U.Ord.*, N.Am.-S.Am.-Eu.-Asia.——FIG. 328, *3*. **L. rostratum* (SARS), Up.L.Ord., Norway; *3a*, cran., dorsal, ×2.7; *3b*, pyg., ×4 (496).

Mendolaspis RUSCONI, 1951 [**M. salagastensis*]. Based on pygidium like that of *Ampyx* but with axis tapering more rapidly and lacking muscle scars; glabella of attributed cranidium (*?Asaphus salagastensis* RUSCONI, 1951) does not project over anterior border, lacks glabellar spine, and has short basal lateral glabellar furrows. *M.Ord. (Llanvirn.)*, S.Am.——FIG. 330. **M. salagastensis*, NW.Arg.; *a,b*, ceph., pyg., ×2.4 (59*).

Raymondella REED, 1935 [*non* BANCROFT, 1933 *(nom. nud); nec* WHITTINGTON, 1938] [**Ampyx? macconochiei* NICHOLSON & ETHERIDGE, 1879]. Like *Ampyxina* but glabella flask-shaped, with hemispherical anterior part; alae subcircular in outline. Thorax with broad, shallow pleural furrows. External surface with small, closely spaced tubercles; genae with raised anostomosing ridges subparallel to anterolateral margins, crest of each ridge with single line of tubercles. *M.Ord.*, Scot. ——FIG. 328,*2*. **R. macconochiei* (NICHOLSON & ETHERIDGE); exoskel. (reconstr.), ×4 (452).

Family ENDYMIONIIDAE Raymond, 1920

[*nom. correct.* WHITTINGTON, herein (*pro* Endymionidae RAYMOND, 1920)]

Glabella subcircular in outline, with 3 or fewer pairs of furrows; convex genae continuous with convex preglabellar field; eyes absent; facial sutures marginal anterolaterally, probably curving across posterolateral areas of genae to isolate narrow *(tr.)* librigenae. Thorax with 7 segments; pleural furrows curving concavely forward. Pygidium triangular. *L.Ord.-M.Ord.*

Endymionia BILLINGS, 1865 [*pro Endymion* BILLINGS, 1862 (*non* SWAINSON, 1832)] [**Endymion*

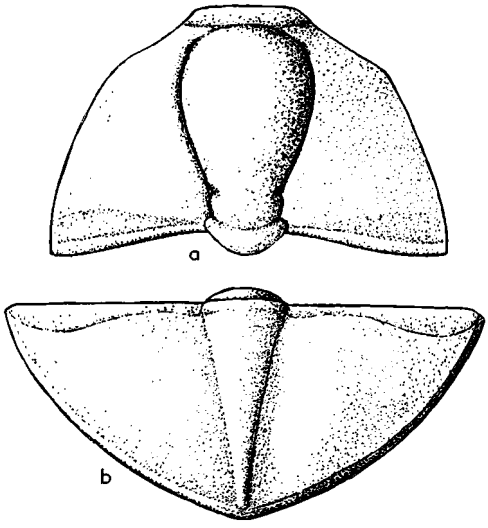


FIG. 330. **Mendolaspis salagastensis* RUSCONI (Raphiophoridae), M.Ord.(Llanvirn.), NW.Arg.; *a,b*, ceph., pyg., ×2.4 (59*).

meeki BILLINGS, 1862]. Frontomedian glabellar lobe convex, with median tubercle, lateral glabellar lobes long, undivided; preglabellar field steeply bent down; posterior border furrows arcuate forward, ending distally in shallow pits; nature of cephalic border, course of sutures, librigenae, and genal spines unknown. Pygidium short, with 4 or 5 axial rings, 3 pairs of pleural furrows, and steep border. External surface of preglabellar field with concentric raised lines. *M.Ord.*, Que.-Newf.—FIG. 329,*3*. **E. meeki* (BILLINGS), Que.; exoskel. (reconstr.), ×4 (496n).

Salteria W. THOMSON, 1864 [*non* WALCOTT, 1884] [**S. primaeva*]. Glabella subcircular with 3 pairs of pits representing lateral furrows, posterior pair connected by shallow longitudinal grooves to occipital furrow, median tubercle between these grooves; preglabellar field short. Pygidium with 10 to 12 axial rings, 6 of 7 pairs of pleural furrows. External surface with radial ridges on preglabellar field; fine anastomosing raised lines running transversely on posterior cephalic border and thoracic pleurae. *M.Ord.*, Scot.-Va.

Family ALSATASPIDIDAE Turner, 1940

[*nom. correct.* WHITTINGTON, herein (*pro* Alsataspidae TURNER, 1940)]

Cephalon with long frontal axial spine distally upcurved, genal spines curving back and reaching beyond pygidium. Glabella subcircular in outline, occipital ring narrow *(tr.)*, short *(sag.)*, anterior median longitudinal glabellar furrow deep, paired lateral longitudinal furrows shallow, extending forward short distance from occipital furrow; long *(sag.)* frontal area with low convexity; genal regions gently convex, without eye lobes, facial sutures curving across genal angles, presumably marginal anterolaterally and anteriorly. Thorax with 30 or fewer segments, widest at about 4th segment; axis narrow, pleurae bent down at extremities, with deep slightly diagonal pleural furrows. Pygidium narrow, with 10 or fewer segments (352). *L.Ord.*

Seleneceme T. H. CLARK, 1924 [**S. propinqua*] [=*Alsataspis* TURNER, 1940]. Characters of family. *L.Ord.*, Newf.-Que.-Tex.—FIG. 329,*2*. *S. evansi* (KINDLE), Newf.; exoskel. (reconstr.), ×2.2 (496n).

Falanaspis TJERNVIK, 1956 [**F. aliena*]. Like *Seleneceme*, but glabella lacks anterior median longitudinal glabellar furrow, and has short, shallow paired lateral longitudinal furrows and a median tubercle. Facial suture marginal and frontal axial spine borne by doublure. *L.Ord.(L. Arenig.)*, Swed.

Family HAPALOPLEURIDAE Harrington & Leanza, 1957

Exoskeleton small, isopygous, opisthoparian. Cephalon semielliptical in outline, transversely elongate; glabella convex, expanded forward, with 3 pairs of short lateral furrows which may be almost obsolete;

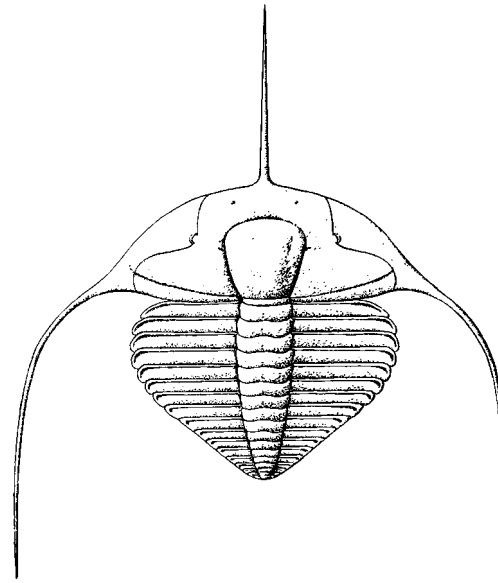


FIG. 331. *Hapalopleura longicornis* HARRINGTON & LEANZA (Hapalopleuridae), L.Ord., Arg.; exoskel. (reconstr.), ×5.5 (59*).

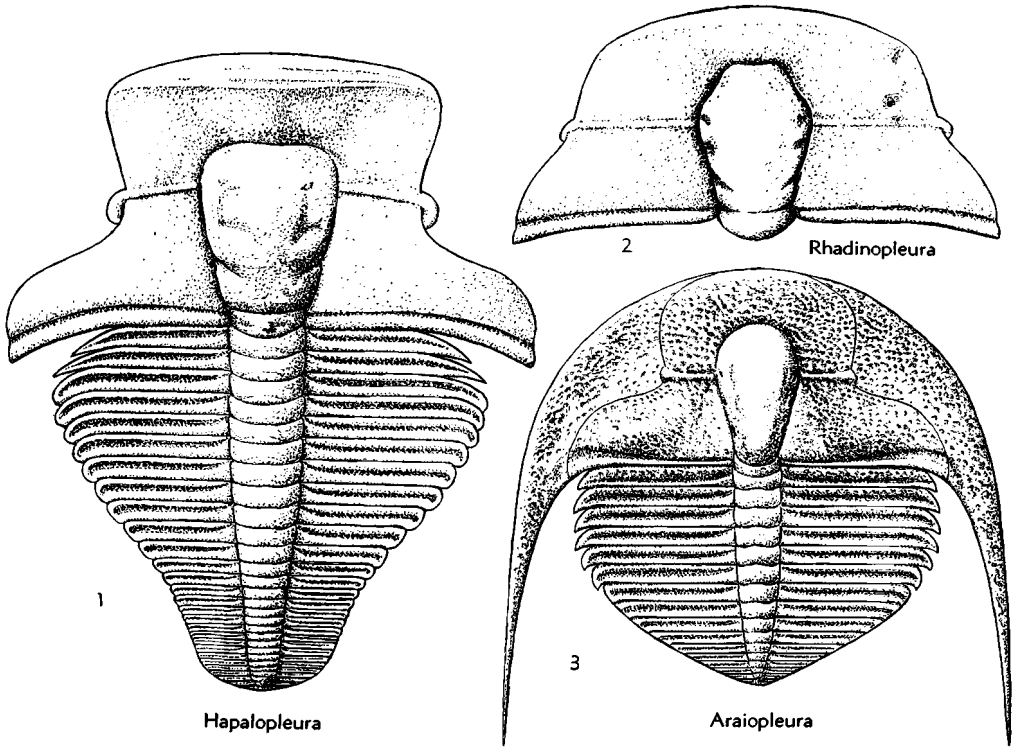


FIG. 332. Hapalopleuridae (p. O429).

preglabellar field wide; anterior border wide, sloping steeply downward, eyes small, submedian, located far from glabella; eye ridges narrow, long, raised, librigenae narrow, with very long curved genal spines. Thorax with 6 segments, not clearly differentiated from pygidium; axis narrow; pleurae narrow *(exsag.)*, ribbon-like, straight, normal to axis, with very distal fulcrum, deep submedian furrow and extremities rounded or ending in short spines. Pygidium very similar to thorax, with 10 to 22 segments, spatulate to rounded-subtriangular in outline; segmentation of pleural regions reaching margin; border absent. *L.Ord.*

Hapalopleura HARRINGTON & LEANZA, 1957 [**H. clavata*]. Exoskeleton ovoid in outline. Cranidium subtrapezoidal; glabella convex, raised above level of fixigenae, clavate, expanded forward, with 3 pairs of lateral furrows that normally are faint; preglabellar field wide, raised forward; anterior border not differentiated by border furrow, steeply sloping downward; posterior areas of fixigenae subtrapezoidal; eyes small, submedian, located far from glabella; eye ridges narrow, long, raised, straight, normal to axis or oblique forward-outward; librigenae subtriangular, narrow, with long curved genal spines. Thorax with 6 segments; axis narrow; pleurae with rounded extremities. Pygidium spatuliform to triangular-subspatulate in outline, with 11 to 22 segments identical to thoracic. *L.Ord.*, Arg.——FIG. 332,*1*. **H. clavata;* incompl. exoskel. (reconstr.), ×9 (59*).——FIG. 331. *H. longicornis* HARRINGTON & LEANZA; exoskel. (reconstr.), ×5.5 (59*).

Araiopleura HARRINGTON & LEANZA, 1957 [**A. reticulata*]. Differs from *Hapalopleura* in having glabella long, narrow, pyriform, expanded forward, with 3 pairs of very faint small lateral depressions; frontal area depressed; posterior areas of fixigenae very wide, subrhomboidal in outline, slightly inflated, with vaguely differentiated triangular areas near glabella; eyes located very far from glabella, eye ridges normal to axis; anterior sections of facial sutures subparallel in front of eyes; surface of cephalon (excluding glabella, eye ridges, and anterior border) with irregularly distributed pits separated by network of raised lines. Thoracic pleurae with extremities ending in very short spines, surface of anterior 4 pleurae bearing sculpture similar to that of cephalon. Pygidium subtriangular in outline, with not less than 10

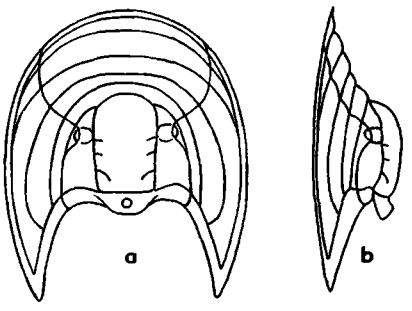


FIG. 333. **Ityophorus undulatus* WARBURG (Ityophoridae), U.Ord., Swed.; *a,b*, ceph., dorsal, lateral, ×9 (489).

segments identical to those of thorax. *L.Ord.*, Arg. ——FIG. 332,*3*. **A. reticulata;* exoskel (reconstr.), ×14.6 (59*).

Clavatellus POLETAEVA, 1955 [**C. globosus*]. Resembles *Hapalopleura*. *L. Ord. (U. Tremadoc.)*, USSR (HE).

Rhadinopleura HARRINGTON & LEANZA, 1957 [**R. eurycephala*]. Differs from *Hapalopleura* in having cranidium semielliptical-subtrapezoidal in outline, glabella pyriform-subhexagonal, with 3 pairs of short deep lateral furrows; frontal area slightly convex; fixigenae very wide; eyes located far from glabella, eye ridges normal to axis, anterior sections of facial sutures convergent in front of eyes. Thoracic pleurae slightly sinuous. Pygidium unknown. *L.Ord.*, Arg.——FIG. 332,*2*. **R. eurycephala;* cran. (holotype), ×10 (59*).

Family ITYOPHORIDAE Warburg, 1925

[In the opinion of H. B. WHITTINGTON, this family is so doubtfully classifiable as belonging in the Trinucleina that it should be segregated under the designation "affinities uncertain."—Ed.]

Cephalon of harpid form; convex glabella reaching to inner margin of bilaminar fringe, expanding slightly forward, with 3 short lateral glabellar furrows; occipital ring prolonged backward, with low median tubercle; genae narrower than glabella, convex, sloping steeply outward, with narrow *(exsag.)* posterior border; eye lobes close to anterolateral margins of genae, broad *(exsag.)* eye ridges extending directly inward to axial furrows; anterior sections of facial sutures running outward-forward in curve to margins, posterior sections curving outward along edge of genae to posterior margins; fringe concave upward, genal roll steeply sloping to gently inclined brim, with prolongations about 0.5 of length *(sag.)* of cephalon; narrow convex external and internal rims; lamellae of fringe bent into 4 folds that are separated by narrow furrows subconcentrical to rim so that 3 inner folds extend back along prolongation, outer fold being placed just outside anterior sections of facial sutures. Thorax with 6 segments; axis convex; pleurae straight, inner part horizontal, outer portion beyond fulcrum bent down and faceted, with deep pleural furrows. Pygidium wider than long, convex axis divided into 5 or 6 rings, narrow postaxial ridge; inner part of pleural fields horizontal, outer part sloping gently to narrow border, 5 pairs pleural furrows extending to border, interpleural grooves shallower. Doublure narrow. External surface smooth (323). *U.Ord.*

Ityophorus WARBURG, 1925 [**I. undulatus*]. Characters of family. *U.Ord.*, Swed.——FIG. 333. **I. undulatus; a,b*, ceph., dorsal, lateral, ×9 (323).

Order PHACOPIDA Salter, 1864

[*nom. transl.* HARRINGTON & LEANZA, 1957, *ex* Phacopini SALTER, 1864] [=order Proparia BEECHER, 1897; order Phacopida HARRINGTON & LEANZA, 1957 (erroneously attributed by them to RICHTER, 1932)] [Type—*Phacops* EMMRICH, 1839]

An order of post-Cambrian trilobites, probably derived from the Ptychopariida. Cephalon with facial sutures typically proparian (most Phacopina and Cheirurina) or gonatoparian (most Calymenina, some Cheirurina), but may be opisthoparian (some Calymenina and Cheirurina) or even lacking (some Cheirurina); glabella variously shaped, commonly expanding forward (Phacopina, most Cheirurina) or tapering forward (Calymenina, some Cheirurina), lateral glabellar furrows (if present) variously developed; preglabellar field short *(sag.)* or lacking; rostral plate present (Calymenina, most Cheirurina) or lacking (Phacopina, some Cheirurina). Thorax with 8 to 19 segments. Pygidium mostly medium to large, but small in some exceptional early representatives. Known protaspides of similar type (496). *L.Ord.-U.Dev.*

Suborder CHEIRURINA Harrington & Leanza, 1957

[Erroneously ascribed to ÖPIK, 1937, by HARRINGTON & LEANZA, 1957] [Superfamily Cheiruracea ÖPIK, 1937; Cheiruroidae HUPÉ, 1953 (attributed to ÖPIK, 1937] [Type—*Cheirurus* BEYRICH, 1845]

Exoskeleton proparian, rarely gonatoparian or exceptionally opisthoparian; cephalon with axis expanding forward or tapering, or oval in outline, with whole or

part more or less strongly inflated; glabella with as many as 4 pairs of lateral or transglabellar furrows; preglabellar field very short *(sag.)* or lacking; fixigenae with or without genal spines; eyes small or absent, and facial sutures may be lacking. Rostral plate present; hypostoma free. Thorax with 8 to 19 segments, with smooth, ridged, or furrowed pleurae. Pygidium with 2 to 16 pairs of ribs. Appendages only of *Ceraurus* described. *L.Ord.-M.Dev.*

Family CHEIRURIDAE Salter, 1864

[=Chirurides Hawle & Corda, 1847; Chiruridae Angelin, 1854, suppression of both pend. ICZN; =Ceraurida e Miller, 1889]

Pleurae with pointed or bluntly rounded spines and oblique or transverse pleural furrows, in some genera represented by row of pits, or effaced. Pygidium with 2 to 4 pairs of pleural ribs and spines; axial rings few. Surface commonly tuberculate, pitted, or both. Appendages only of *Ceraurus* described; antennae uniramous, other appendages biramous, with gill branches bearing filaments only on distal segments (178, 359). *L.Ord.(Tremadoc.)-M.Dev.*

The ancestral stock from which various representatives of this suborder assigned to the Pliomeridae, Cheiruridae, and Encrinuridae are interpreted to have been derived is contained in the subfamily Pilekiinae of the Pliomeridae. Direct descendants of the Pilekiinae presumably are genera of the Cheirurinae and Cyrtometopinae (subfamilies of Cheiruridae), whereas other cheirurids (Acanthoparyphinae, Sphaerexochinae, Deiphoninae, Areiinae), except the Heliomerinae, of uncertain relationships, are derivatives of the Cyrtometopinae.

Subfamily CHEIRURINAE Salter, 1864

[*nom. transl.* Raymond, 1913 (*ex* Cheiruridae Salter, 1864)]

Glabella expanding forward or with subparallel sides; preoccipital lateral glabellar furrow generally curved backward, commonly joining occipital furrow. Hypostoma with elongate middle body. Thorax generally of 11 segments; proximal part of pleurae with distinct oblique pleural furrows. Pygidium with 3 pairs of pleural spines, 2 posterior pairs more or less reduced in some. *L.Ord.-M.Dev.*

Cheirurus Beyrich, 1845 [**C. insignis;* SD Barton, 1913 (*non C. exsul,* SD Reed, 1896, because this species was not originally assigned to *Cheirurus*)]

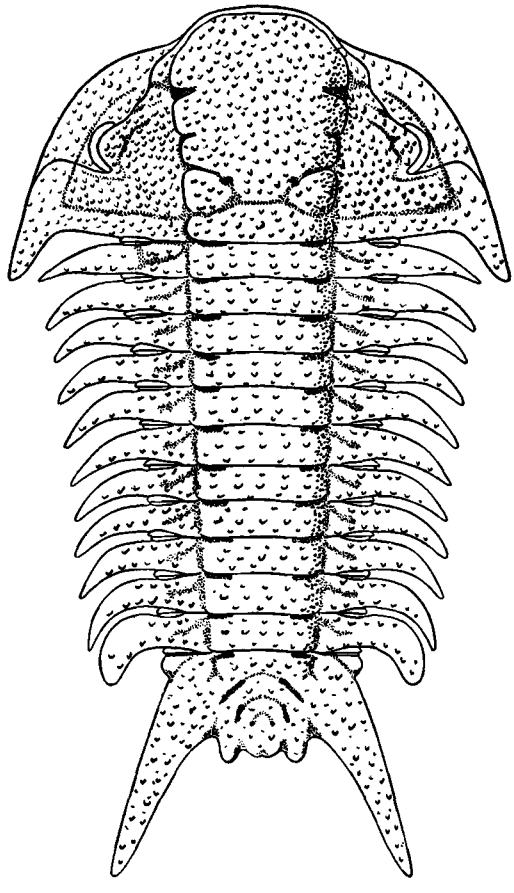


Fig. 334. **Ceraurinella typa* Cooper (Cheiruridae), M.Ord., Va.; exoskel. (reconstr.), ×4.5 (359).

[=*Chirurus* Burmeister, 1846 (obj.)]. Glabella expanding forward, overhanging anterior border, occipital and preoccipital furrows joined at middle. Thorax with 11 segments. Pygidium with 3 pairs of subequal pleural spines and a terminal spine. *U.Ord.-M.Dev.*, cosmop.

C. (Cheirurus). Eyes moderately close to glabella, fixigenae wider *(tr.)* than occipital ring, glabella with 2 pairs of lateral furrows in front of preoccipital furrow. Pygidium with slender pleural spines. *U.Ord.-Sil.*, cosmop.——Fig. 335,9. **C. (C.) insignis,* Sil.(Motel beds), Boh.; *9a,* exoskel.; *9b,* hypostoma; both ×1 (370).

C. (Crotalocephalus) Salter, 1853 [**Calymene articulata* Münster, 1840]. Eyes close to glabella; fixigenae narrower *(tr.)* than occipital ring; 2 pairs of transglabellar furrows in front of preoccipital furrow. Pygidium with broad hooklike pleural spines. *L.Dev.-M.Dev.*, Eu.-AsiaM.——Fig. 335,6. *C. (C.) gibbus* (Beyrich) Bráník beds, Boh.; *6a,* ceph.; *6b,* thoracic segment; *6c,* pyg.; all ×1 (370).

Ceraurinella Cooper, 1953 [**C. typa*]. Like *Ceraurus*, but with eyes farther back (opposite 2*p*) and nearer glabella; with short genal spines. *M.Ord.*, N.Am.——Fig. 334. **C. typa*, Va.; exoskel. (reconstr.), ×4.5 (359).

Ceraurinus Barton, 1913 [**C. marginatus*]. Like *Ceraurus* but with longer lateral glabellar furrows and finer surface ornamentation. *M.Ord.-U.Ord.*, N.Am.-Eu.-Asia.——Fig. 335,*2*. **C. marginatus* Richmond, Manitou I., Lake Huron; incompl. ceph., ×1 (372).

Ceraurioides Prantl & Přibyl, 1947 [**Cheirurus hawlei* Barrande, 1852]. Eyes opposite base of anterior lobe; short genal spines. Pygidium with

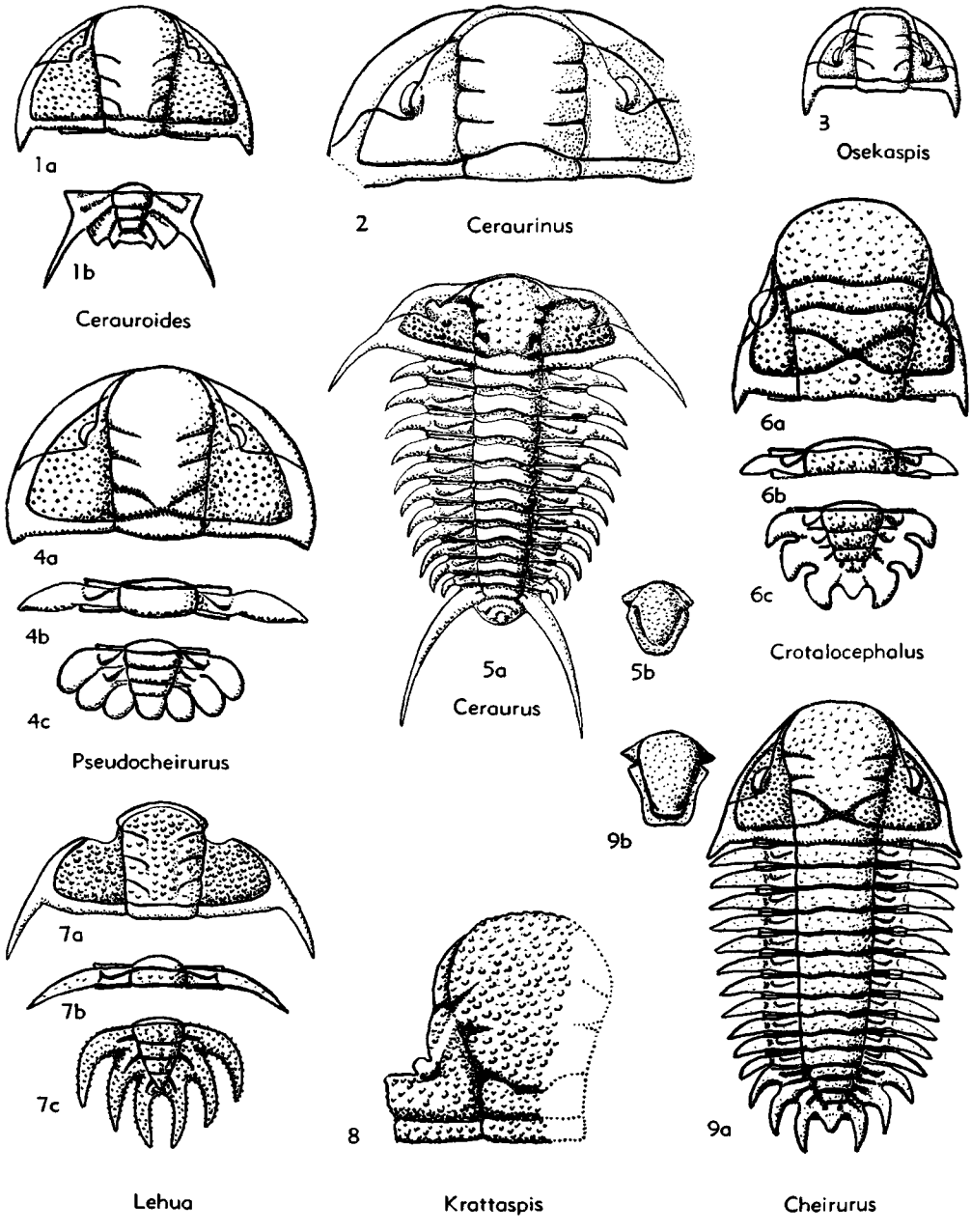


Fig. 335. Cheiruridae (Cheirurinae) (p. O431-O433).

long anterior pair of pleural spines and 2 rudimentary posterior pairs. *U.Sil.*, Eu.——Fig. 335,*1*. **C. hawlei* (Barrande), U.Sil. (Budňany beds), Boh.; *1a,b*, ceph., pyg., both ×0.5 (178, 370).

Ceraurus Green, 1832 [**C. pleurexanthemus*]. Glabella expanding forward, with 3 pairs of short lateral furrows; eyes set well away from glabella, opposite *3p*; fixigenae with long genal spines. Thoracic segments generally 11. Pygidium with long pair of axially recurved pleural spines from anterior segment. Surface tuberculation coarse. *M.Ord.-U.Ord.*, Eu.-Greenl.-N.Am. Himalaya.——Fig. 335,*5*. **C. pleurexanthemus*, M.Ord., E.USA; *5a*, exoskel. (reconstr.); *5b*, hypostoma; both ×1.5 (43, 450).

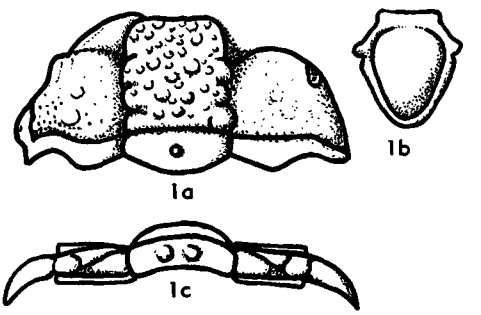
Hapsiceraurus Whittington, 1954 [**H. hispidus*]. Like *Ceraurus* but glabella parallel-sided, outer parts of genae bent down steeply, lateral and anterolateral borders broad, and with large paired tubercles on occipital and axial rings. Rostral plate short, narrow. *U.Ord.*, Arct.N.Am.-Greenl.——Fig. 336,*1*. **H. hispidus*, U.Ord., Baffin I.; *1a-c*, incompl. cran., hypostoma, thoracic segment, ×2.5 (496).

?Krattaspis Öpik, 1937 [**K. viridatus*]. Glabella expanding markedly forward, with transglabellar preoccipital furrow and 2 pairs of short lateral furrows; eyes rather close to glabella, opposite *2p* lobes and with distinct eye ridges joined to *3p* lobes; only incomplete cranidium and hypostoma known. *L.Ord.*, Est.——Fig. 335,*8*. **K. viridatus*; L.Ord.(Mäeküla), Est.; incompl. cran., ×3 (160).

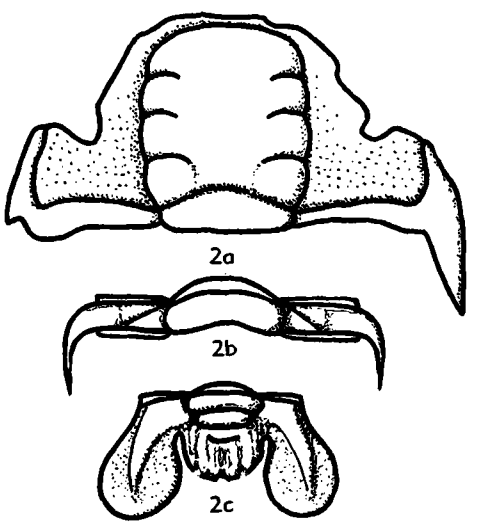
Lehua Barton, 1915 [**Cheirurus vinculum* Barrande, 1872] [=*Krejčia* Novák, in Prantl & Přibyl, 1947 (obj.)]. Glabella with 3 pairs of subequal lateral furrows, eyes opposite anterior pair. Thorax with 11 segments. Pygidium with 3 pairs of slender axially recurved spines. *L.Ord.-M.Ord.*, Eu.-S.Afr.-?India.——Fig. 335,*7*. **L. vinculum* (Barrande), M.Ord.(Sv. Dobrotíva beds), Boh.; *7a-c*, cran., thoracic segment, pyg., ×1 (370).

Osekaspis Prantl & Přibyl, 1947 [**Cheirurus comes* Barrande, 1872]. Glabella subrectangular, with 3 pairs of lateral furrows, preoccipital pair not reaching occipital furrow; eyes rather close to glabella opposite *2p* lobes. Surface partly pitted minutely. Thorax and pygidium unknown. *M. Ord.*, Czech.——Fig. 335,*3*. **O. comes* (Bar-*culum* (Barrande), M.Ord.(Sv. Dobrotíva beds), Boh.; *7a-c*, cran., thoracic segment, pyg., ×1 (370).

Pseudocheirurus Prantl & Přibyl, 1947 [**Cheirurus beyrichi* Barrande, 1846]. Glabella with 3 pairs of lateral furrows, preoccipital pair reaching occipital furrow; fixigenae about as wide *(tr.)* as occipital ring. Pygidium with 3 pairs of broad, bluntly rounded pleural spines. *U.Sil.*, Czech.——Fig. 335,*4*. **P. beyrichi* (Barrande), *4a-c*, ceph., thoracic segment, pyg., all ×2 (370).



Hapsiceraurus



Remipyga

Fig. 336. Cheiruridae (Cheirurinae) (p. O433).

Remipyga Whittington, 1954 [**R. glabra*]. Like *Ceraurinella* but glabella subrectangular in outline, with 3 gently curved lateral furrows directed backward-inward. Pygidium with paddle-shaped 1st pleural spine expanding distally and bearing strong median carina. *U.Ord.*, Arct.N.Am.——Fig. 336,*2*. **R. glabra*, U.Ord., Baffin I.; *2a-c*, incompl. cran., thoracic segment, pyg., ×3.75 (496).

Subfamily CYRTOMETOPINAE Öpik, 1937

Glabella tapering or widening forward, or oval in outline, with 3 pairs of more or less differentiated lateral furrows, preoccipital pair usually curved backward, commonly meeting occipital furrow; sutural ridges present or not, eye ridges lacking. Middle body of hypostoma usually about as wide as long. Thorax with 10 to 12 seg-

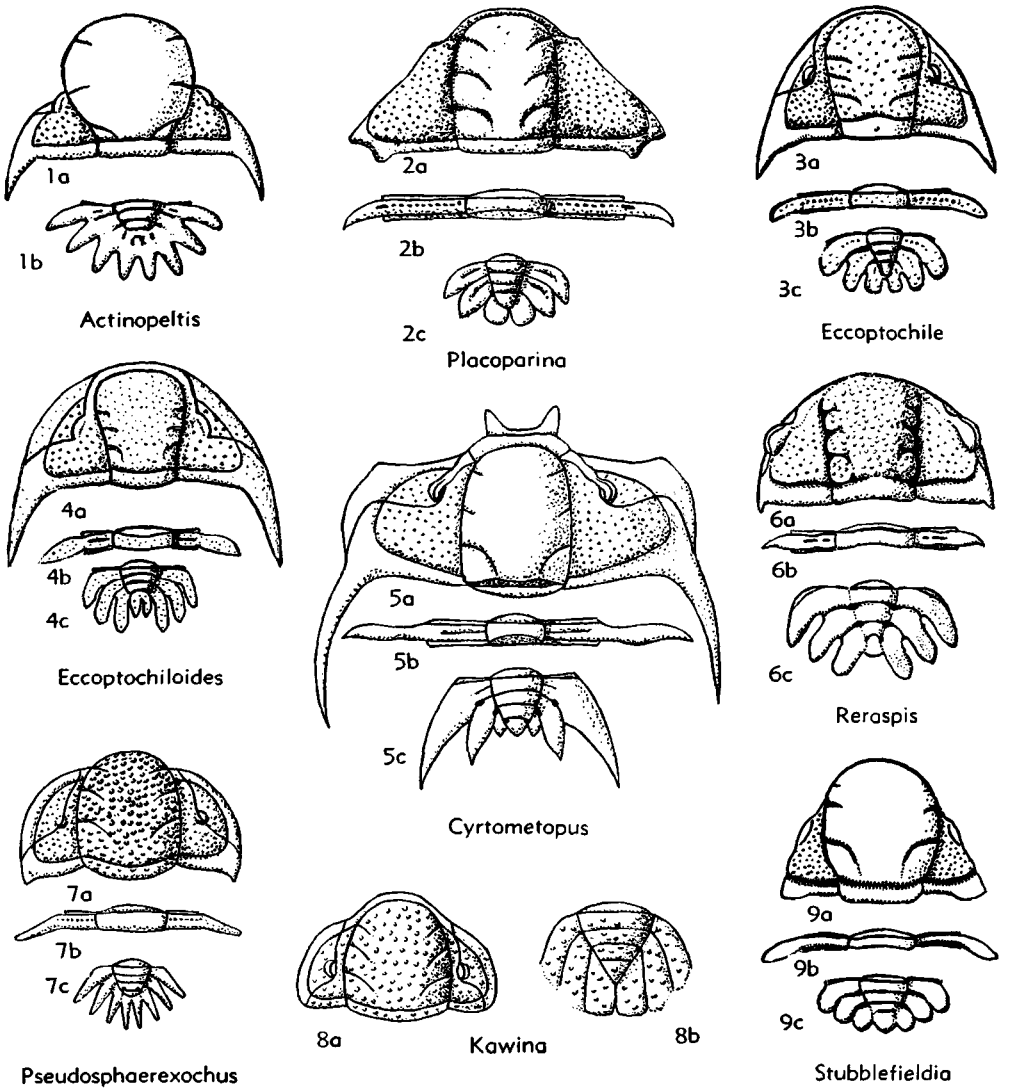


FIG. 337. Cheiruridae (Cyrtometopinae) (p. O434-O435).

ments, with spinose or bluntly rounded pleurae bearing transverse furrows that may be represented by a row of pits, or effaced. Pygidium with 3 or 4 pairs of pleural spines. *L.Ord.-Sil.*

Cyrtometopus ANGELIN, 1854 [**Calymene clavifrons* DALMAN, 1827]. Glabella with convex sides, preoccipital lateral furrows curved to meet occipital furrow; posterior sections of facial sutures sigmoidal, for some distance transverse; eyes opposite *3p* lobes, sutural ridges in front of eyes; genal spines strong. Thoracic pleurae with short furrows. Pygidium with 3 pairs of pleural spines, progressively smaller backward. *L.Ord.*, Eu.-?Asia.

——FIG. 337,*5*. **C. clavifrons* (DALMAN), L.Ord., N.Eu.; *5a-c*, ceph., thoracic segment, pyg., all ×1 (382, 468).

Actinopeltis HAWLE & CORDA, 1847 [**A. carolialexandri* (=**Cheirurus globosus* BARRANDE, 1846)] [*non Actinopeltis* POULSEN, 1946 (=*Grinnellaspis* POULSEN, 1948)]. Bulbous glabella protruding over anterior margin, with preoccipital lateral furrows curved to meet occipital furrow; eyes opposite *2p* lobes; posterior sections of facial sutures almost transverse. Thorax with 11 segments, pointed pleurae with transverse row of minute pits. Pygidium with 4 pairs of pleural spines. *U. Ord.*, Boh.——FIG. 337,*1*. **A. globosus* (BAR-

RANDE), U.Ord. (Králuv Drur beds), Boh.; *1a,b*, ceph., pyg., both ×1.5 (370).

Eccoptochile HAWLE & CORDA, 1847 [**Cheirurus claviger* BEYRICH, 1845; SD BARTON, 1920]. Glabella with 3 pairs of subequal lateral furrows, preoccipital pair not reaching occipital furrow. Pygidium with 3 or 4 pairs of broad, bluntly rounded spines. *M.Ord.-U.Ord.*, Eu.

E. (Eccoptochile). Thorax with 12 segments, pleurae with transverse row of pits. Pygidium with 3 pairs of pleural spines. *M.Ord.*, Eu.——FIG. 337,*3*. **E. (E.) clavigera* (BEYRICH), M.Ord., Boh.; *3a-c*, ceph., thoracic segment, pyg., all ×0.5 (370).

E. (Eccoptochiloides) PRANTL & PŘIBYL, 1947 [**Cheirurus tumescens* BARRANDE, 1852]. Thorax with 10 segments bearing short pleural furrows. Pygidium with 4 pairs of pleural spines. *M.Ord.-U.Ord.*, Eu.——FIG. 337,*4*. **E. (E.) tumescens* (BARRANDE), U.Ord.(Lodenice beds), Boh.; *4a-c*, ceph., thoracic segment, pyg., all ×1.5 (370).

E. (Placoparina) WHITTARD, 1940 [**Cryphaeus sedgwicki* M'COY, 1849]. Like *E. (Eccoptochile)* but with pedunculated eyes close to anterior border. *M.Ord.*, Eng.——FIG. 337,*2*. **E. (P.) sedgwicki* (M'COY); *2a-c*, cran., thoracic segment, pyg., all ×1 (495).

Kawina BARTON, 1915 [**Cheirurus vulcanus* BILLINGS, 1865]. Glabella tapering slightly forward. Pygidium with 3 pairs of ribs. Poorly known. *L.Ord.*, N.Am.——FIG. 337,*8*. **K. vulcanus* (BILLINGS), L.Ord., E. Can.; *8a,b*, ceph., incompl. pyg., both ×1 (379).

Pseudosphaerexochus SCHMIDT, 1881 [**Sphaerexochus hemicranium* KUTORGA, 1854; SD REED, 1896] [?=*Zethus* PANDER, 1830 (*non* FABRICIUS, 1805), **Z. uniplicatus;* SD EICHWALD, 1855 (?=**P. hemicranium*)]. Glabella oval in outline; posterior sections of facial sutures running obliquely backward. Thoracic pleurae with transverse row of pits. Pygidium with 3 or 4 pairs of pointed pleural spines. *L.Ord.-Sil.*, Eu.-?N.Am.

P. (Pseudosphaerexochus). Pygidium with 4 pairs of pleural spines. *M.Ord.-Sil.*, Eu.-?N.Am.——FIG. 337,*7*. **P. hemicranium* (KUTORGA); *7a-c*, ceph., thoracic segment, pyg., all ×2 (370).

P. (Pateraspis) PRANTL & PŘIBYL, 1947 [**Cheirurus pater* BARRANDE, 1872]. Pygidium with 3 pairs of pleural spines. Thorax with 12 segments. *L. Ord.-M.Ord.*, Boh.——FIG. 338. **P. pater* (BARRANDE), M.Ord.(Sárka beds), Boh.; *a-d*, ceph., thoracic segment, pyg., hypostoma, all ×1 (370).

Reraspis ÖPIK, 1937 [**Cyrtometopus plautini* SCHMIDT, 1881]. Glabella expanding slightly forward, with deep lateral furrows; posterior sections of facial sutures oblique; sutural ridges present; eyes close to lateral margins. Thorax with 10 segments, pleurae with interrupted pleural furrows. Pygidium with 3 pairs of flattened pleural spines.

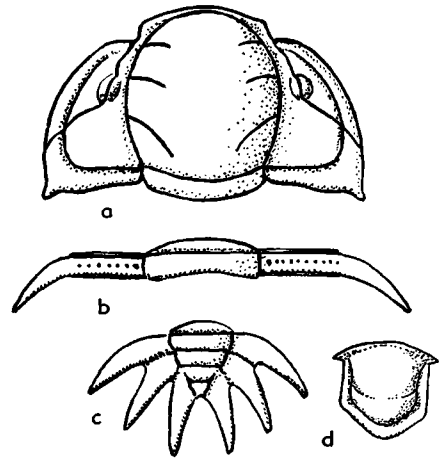


FIG. 338. **Pseudosphaerexochus (Pateraspis) pater* (BARRANDE) (Cheiruridae), M.Ord., Czech.; *a-d*, ceph., thoracic segment, pyg., hypostoma, all ×1 (370).

M.Ord.-U.Ord., Est.——FIG. 337,*6*. **R. plautini* (SCHMIDT), M.Ord.(Kukruse), Est.; *6a-c*, ceph., thoracic segment, pyg., all ×2.2 (160).

Stubblefieldia PRANTL & PŘIBYL, 1947 [**Cheirurus neglectus* BARRANDE, 1872]. Glabella bulbous. Thoracic segments 11, pleurae without furrows ending in bluntly pointed spines. Pygidium with 3 pairs of short, bluntly rounded spines and a similar terminal spine. *U.Ord.*, Boh.——FIG. 337, *9*. **S. neglecta* (BARRANDE); *9a-c*, cran., thoracic segment, pyg., all ×1 (370).

Subfamily ACANTHOPARYPHINAE
Whittington & Evitt, 1953

Glabella tapering toward anterior margin, more or less inclined forward; eyes opposite *1p* or *2p* lobes. Hypostoma with prominent lateral shoulders and relatively wide lateral notch. Thoracic pleurae with transverse row of pits. Pygidium with 2 pairs of pleural spines, anterior pairs commonly more strongly developed than others. *L.Ord.-U.Ord.*

Acanthoparypha WHITTINGTON & EVITT, 1953 [**A. perforata*]. Glabella without spine and not divided in 3 longitudinally; without occipital spine. *M. Ord.*, N.Am.-Eu.——FIG. 339. **A. perforata*, Va.; restored incompl. exoskel., ×5.7 (359*).

?Hadrohybus RAYMOND, 1925 [**H. dunbari*]. Glabella without lateral furrows but with spinelike inflation, smooth. Only cranidium known. *M.Ord.*, Newf.——FIG. 341,*5*. **H. dunbari;* incompl. cran., ×1 (449).

Holia BRADLEY, 1930 [**H. magnaspina*]. Glabella faintly divided in 3 longitudinally, without large

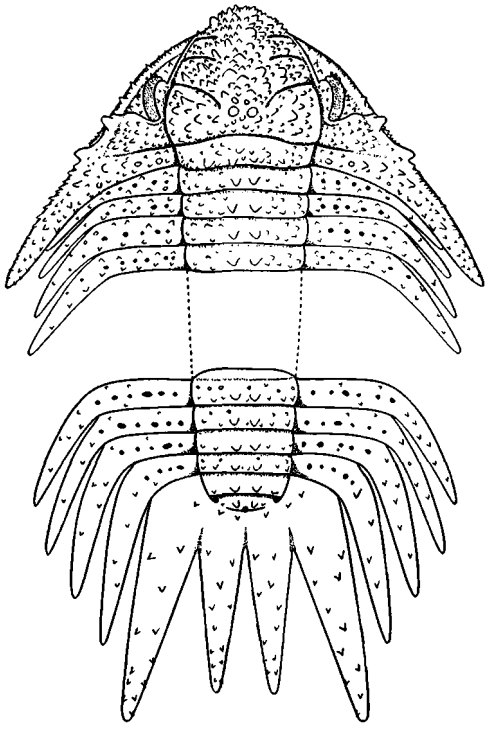


FIG. 339. **Acanthoparypha perforata* WHITTINGTON & EVITT (Cheiruridae), M.Ord., Va.; incompl. exoskel. (reconstr.), ×5.7 (359).

glabellar spine; occipital spine present. *M.Ord.*, N.Am.——FIG. 340. *H. secristi* WHITTINGTON & EVITT, Va.; restored incompl. exoskel., ×8.5 (359*).

Nieszkowskia SCHMIDT, 1881 [**Sphaeroexochus cephaloceros* NIESZKOWSKI, 1857; SD REED, 1896]. Glabella with spine and not divided in 3 longitudinally; without occipital spine. *?L.Ord., M.Ord.-U.Ord.*, Eu.-N.Am.——FIG. 341,*4*. **N. cephaloceros* (NIESZKOWSKI), M.Ord., Est.; *4a*, restored ceph., *4b*, side view of ceph., *4c*, pyg., all ×1 (468n).

Subfamily SPHAEREXOCHINAE Öpik, 1937

Glabella dominating, almost circular in outline, strongly inflated, overhanging anterior margin and front parts of fixigenae, which are markedly narrower *(tr.)* than glabella; genal spines rudimentary or absent. Hypostoma cyrtometopinoid. *M.Ord.-Sil., ?Dev.*

Sphaerexochus BEYRICH, 1845 [**S. mirus*]. Preoccipital pair of lateral glabellar furrows distinct, curved, usually reaching occipital furrow, with 2 additional pairs of short lateral glabellar furrows in some species. Thorax with 10 segments, pleurae with poorly defined flanges, bluntly rounded spines, and lacking pleural furrows. Pygidium with 3 pairs of short and broad, bluntly rounded spines. Surface smooth. *M.Ord.-Sil.*, Eu.-N.Am.-India-Austral.——FIG. 341,*2*. **S. mirus*, L.Sil., Boh.; *2a,b*, cran.; *2c,d*, thoracic segment, pyg., all ×1 (370).

Pompeckia WARBURG, 1925 [**Sphaerexochus wegelini* ANGELIN, 1854]. Preoccipital lateral glabellar furrows not recurved to meet occipital furrow. Pleurae with short furrows running obliquely forward. Pygidium with 3 pairs of pleural spines and terminal spine. Surface smooth. *U.Ord.*, N. Eu.——FIG. 341,*1*. **P. wegelini* (ANGELIN), U. Ord., Swed.; *1a,b*, cran., *1c-e*, thoracic segment, pyg., hypostoma, all ×1 (323).

Subfamily DEIPHONINAE Raymond, 1913

Glabella in front of preoccipital furrow greatly inflated and wider than rest of glabella. Thorax with ?8 or 9 segments. *M. Ord.-Sil.*

Deiphon BARRANDE, 1850 [**D. forbesi*]. Librigenae very small, fixigenae reduced to a long genal spine. Thorax with 9 segments, pleurae not in contact with each other. Pygidium with 2 pairs of pleural spines, posterior pair largest. *Sil.*, Eu.-N. Am.——FIG. 342. **D. forbesi*, Wenlock, Eng.; exoskel. (reconstr.), ×1.75 (341, 466*).

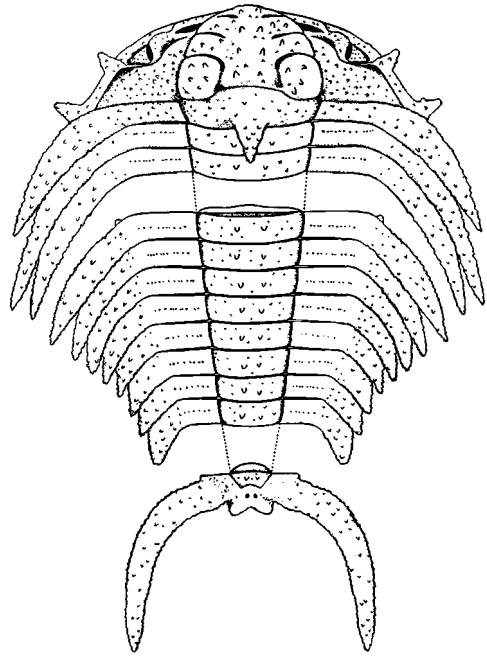


FIG. 340. **Holia secresti* WHITTINGTON & EVITT (Cheiruridae), M.Ord., Va.; incomple. exoskel. (reconstr.), ×8.5 (359).

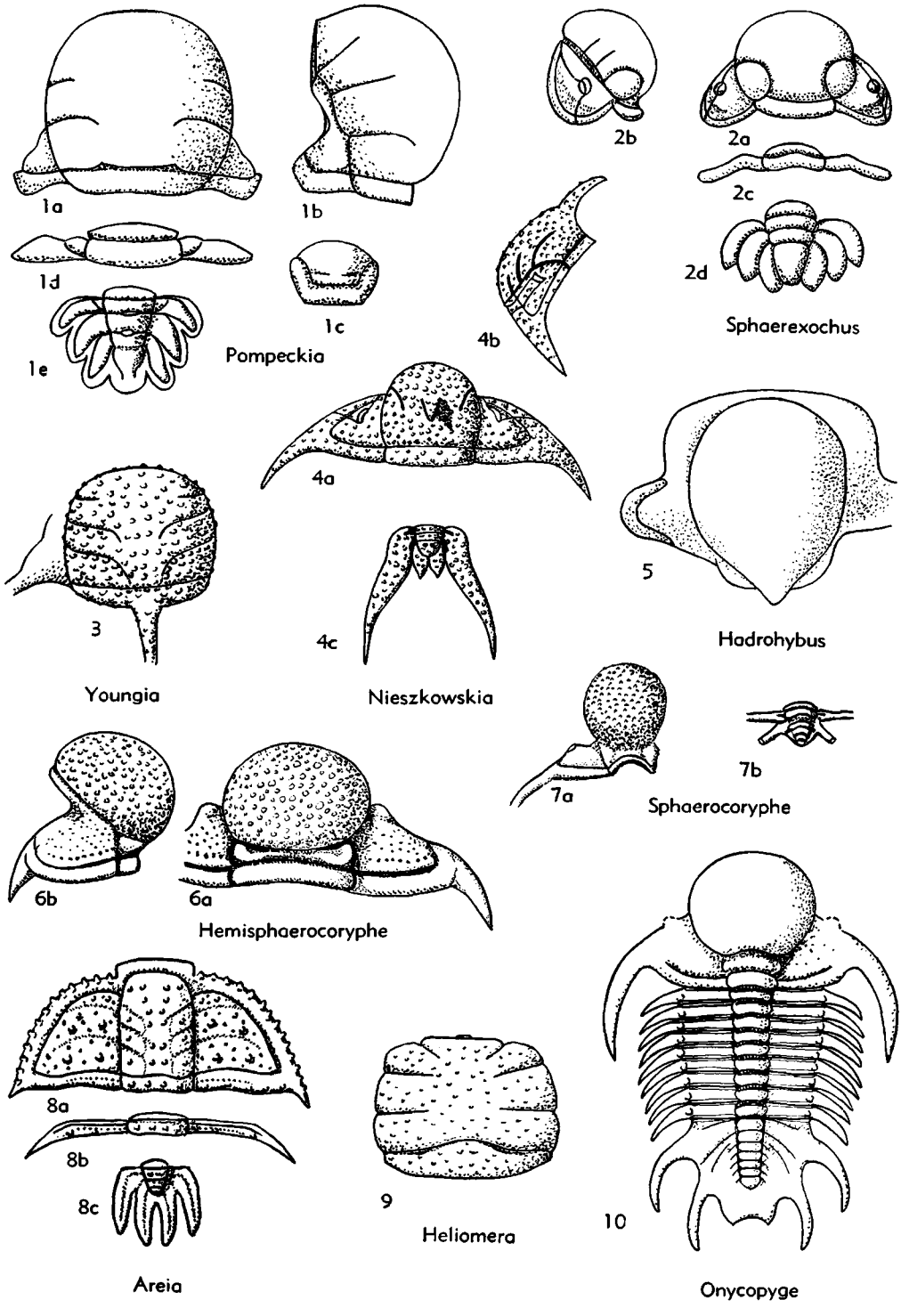


FIG. 341. Cheiruridae (Acanthoparyphinae, Sphaerexochinae, Deiphoninae, Areiinae, Heliomerinae, Subfamily Uncertain) (p. O435-O439).

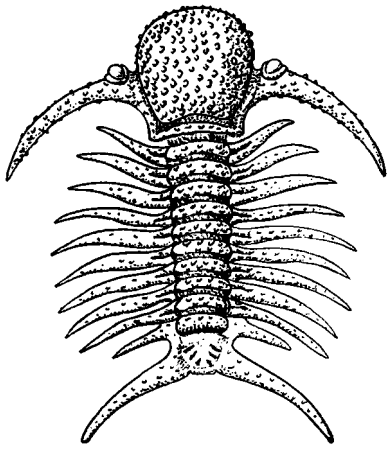


FIG. 342. **Deiphon forbesi* BARRANDE (Cheiruridae), M.Sil., Eng.; exoskel. (reconstr.), ×1.75 (466).

Hemisphaerocoryphe REED, 1896 [**Sphaerexochus pseudohemicranium* NIESZKOWSKI, 1859; SD BARTON, 1920]. Well-developed fixigenae with genal spine; bulbous part of glabella only slightly wider than remainder. *M.Ord.-U.Ord.*, N.Eu.——FIG. 341,*6*. **H. pseudohemicranium* (NIESZKOWSKI), M.Ord. (Jöhvi), Est.; *6a,b*, cran., both ×1.5 (160).

Onycopyge WOODWARD, 1880 [**O. liversidgei*]. Resembles *Deiphon* but with less reduced fixigenae and with pleurae in contact with each other. Thorax with ?8 or 9 segments. Pygidium with 3 pairs of pleural spines, posterior pair broad-based. *Sil.*, Austral.(N.S.W.).——FIG. 341,*10*. **O. liversidgei*, restored exoskel., ×1.5 (341).

Sphaerocoryphe ANGELIN, 1854 [**S. dentata* (ICZN pend.)] [=*Sphaerometopus* ANGELIN, 1854 (suppression pend. ICZN)]. Like *Hemisphaerocoryphe* but bulbous part of glabella more dominating. *M. Ord.-U.Ord.*, Eu.-N.Am.——FIG. 341,*7*. *S. punctata* ANGELIN, 1854, U.Ord., Swed.; *7a,b*, incompl. ceph. and pyg., both ×2 (323).

Subfamily AREIINAE Prantl & Přibyl, 1947

Glabella with subparallel sides; no facial sutures or eyes. Thorax with 9 or 10 segments, pleurae with transverse rows of pits. Pygidium with 2 pairs of long pleural spines. *M.Ord.-U.Ord.*

Areia BARRANDE, 1872 [**A. bohemica* BARRANDE, 1872; SD VOGDES, 1890]. Characters of subfamily. *M.Ord.-U.Ord.*, Boh.——FIG. 341,*8*. **A. bohemica*, U.Ord., Boh.; *8a-c*, ceph., thoracic segment, pyg., all ×2 (370).

?Subfamily HELIOMERINAE Evitt, 1951

Glabella dominating, wider than long and not strongly convex, with 3 pairs of lateral furrows in more or less radial orientation; fixigenae and librigenae very narrow. Hypostoma rectangular, cyrtometopinoid. Thoracic axis very wide, tapering backward, proximal parts of pleurae very narrow *(tr.)*, distal parts comprising hollow projections. Pygidial segments few and poorly differentiated from the thoracic ones. *M.Ord.-U. Ord.*

Heliomera RAYMOND, 1905 [**Cheirurus sol* BILLINGS, 1865]. Inner ends of lateral glabellar furrows not joined by longitudinal furrows. *M.Ord.*, Newf.——FIG. 341,*9*. **H. sol* (BILLINGS); cephalic axis, ×5 (42).

Heliomeroides EVITT, 1951 [**H. teres*]. Median glabellar lobe set off by distinct longitudinal furrows joining inner ends of lateral glabellar furrows. *L.Ord.-M.Ord.*, N.Am.——FIG. 343. **H. teres*, M.Ord., Va.; incompl., restored exoskel., ×4.25 (42*).

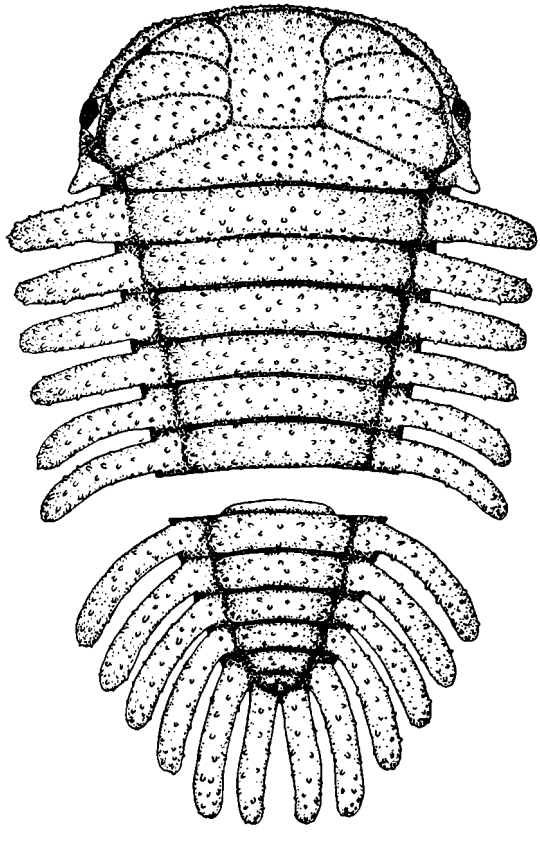


FIG. 343. **Heliomeroides teres* EVITT (Cheiruridae), M.Ord., Va.; incompl. exoskel. (reconstr.), ×4.25 (42).

Subfamily UNCERTAIN

Youngia LINDSTRÖM, 1885 [**Cheirurus trispinosus* YOUNG, 1868; SD VOGDES, 1917, p. 8] [*non Youngia* JONES & KIRKBY, 1886]. Glabella about as long as wide, with 3 pairs of lateral furrows; stout occipital spine; fixigenae narrow *(tr.)*, with long genal spine. *Sil.-L.Dev.*, Scot.-Ural.——FIG. 341,*3*. **Y. trispinosa* (YOUNG); incompl. cran., ×1 (452).

Family PLIOMERIDAE Raymond, 1913

[*nom. transl.* ÖPIK, 1937 (*ex* Pliomerinae RAYMOND, 1913)] [=Amphionidae PICTET, 1854]

Cephalon semicircular to semielliptical in outline; facial sutures proparian, exceptionally gonatoparian or opisthoparian; glabella moderately convex, with 2 or 3 pairs of lateral glabellar furrows; preglabellar field absent; eyes small to medium size, exceptionally absent. Thorax with 11 to 19 segments; pleurae smooth, ridged or furrowed. Pygidium with 2 to 6 axial rings and terminal piece; pleural regions with as many pleurae as there are axial rings; pleurae ending in free spines or blunt edges. *L.Ord.-U.Ord.*

Subfamily PLIOMERINAE Raymond, 1913

Cephalon with proparian or gonatoparian sutures; glabella about as wide as long, evenly expanding forward, with 3 pairs of lateral glabellar furrows, of which anterior *(3p)* pair is usually located in front of anterolateral angles of glabella; genal angles rounded; eyes submedian to posterior. Pygidium with 4 or 5 axial rings and terminal piece. *L.Ord.-U.Ord.*

Pliomera ANGELIN, 1852 [**Asaphus fischeri* EICHWALD, 1825; SD VODGES, 1925 (=*Calymene polytoma* DALMAN, 1827 (subj.); *Calymene frontiloba* STSCHEGLOFF, 1827 (sub.)] [=*Amphion* PANDER, 1830 (*non* HÜBNER, 1816)]. Facial sutures gonatoparian; anterior *(3p)* lateral glabellar furrows located in front of anterolateral angles of glabella, reaching anterior border furrow; frontal glabellar lobe with mesial indentation; anterior cephalic border bearing 7 to 9 denticulations; fixigenae L-shaped, pitted; eyes small, posterior; palpebral lobes raised; eye ridges absent. Thorax with 12 to 18 segments. Pygidium with 4 or 5 axial rings and minute terminal piece; pleurae ending in very short spines or blunt points, last pair completely embracing terminal axial segment. *M.Ord.*, Norway-Swed.-Est.-Arg. —— FIG. 344, 345,*5*. **P. fischeri* (EICHWALD), Est.; 344, exoskel. (reconstr.), ×2.7; 345,*5*, hypostoma, ×2 (405n, based on 439, 468).

Cybelopsis POULSEN, 1927 [**C. speciosa*]. Differs from *Pliomera* in lacking mesial indentation on frontal glabellar lobe and denticulations on anterior cephalic border, and in having proparian sutures; eyes moderately long, submedian, located at level of median *(2p)* lateral glabellar lobes; palpebral lobes elongated. Thorax with 13 segments. Pygidium cybeliform, with 5 axial rings, long triangular terminal axial piece bearing 2 longitudinal rows of small pits on each side of axial line; 5 pairs of reclined pleurae ending in blunt points. *L.Ord.*, Greenl.-USA(Utah).——FIG. 345,*4*. **C. speciosa; 4a*, cran. (Utah), ×1.7; *4b*, pyg. (Greenl.), ×1.7; *4c*, hypostoma (Utah), ×2; (*4a,c*, 407*; *4b*, 445*).

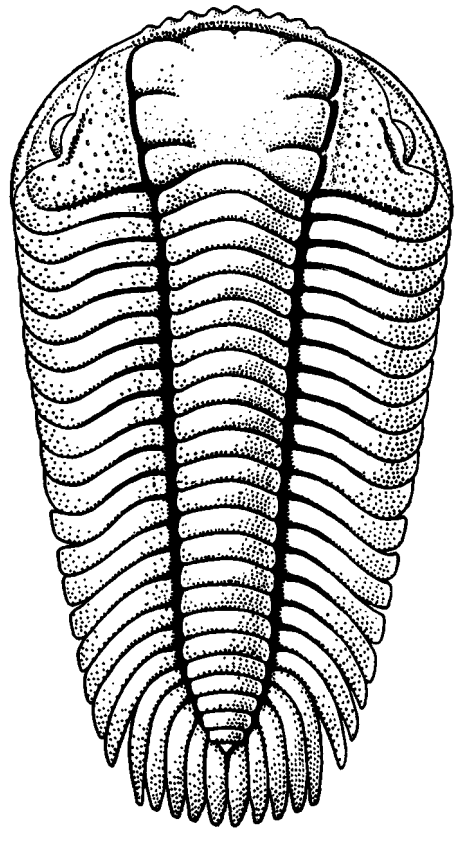


FIG. 344. **Pliomera fischeri* (EICHWALD) (Pliomeridae), M.Ord., Est.; exoskel. (reconstr.), ×2.7 (405n).

Pliomerina CHOUGAEVA, 1956 [**Pliomera martelli* REED, 1917] [=*Pliomeraspis* HARRINGTON, 1957 (obj.)]. Differs from *Pliomera* in lacking mesial indentation on frontal glabellar lobe and denticulations on anterior cephalic border, and in having anterior *(3p)* lateral glabellar furrows springing from anterolateral corners of glabella, much larger frontal glabellar lobe with pair of oviform longitudinal depressions separated by low sagittal crest, and much smaller preoccipital lateral glabellar lobes. *M.Ord.*, China(Yunnan).

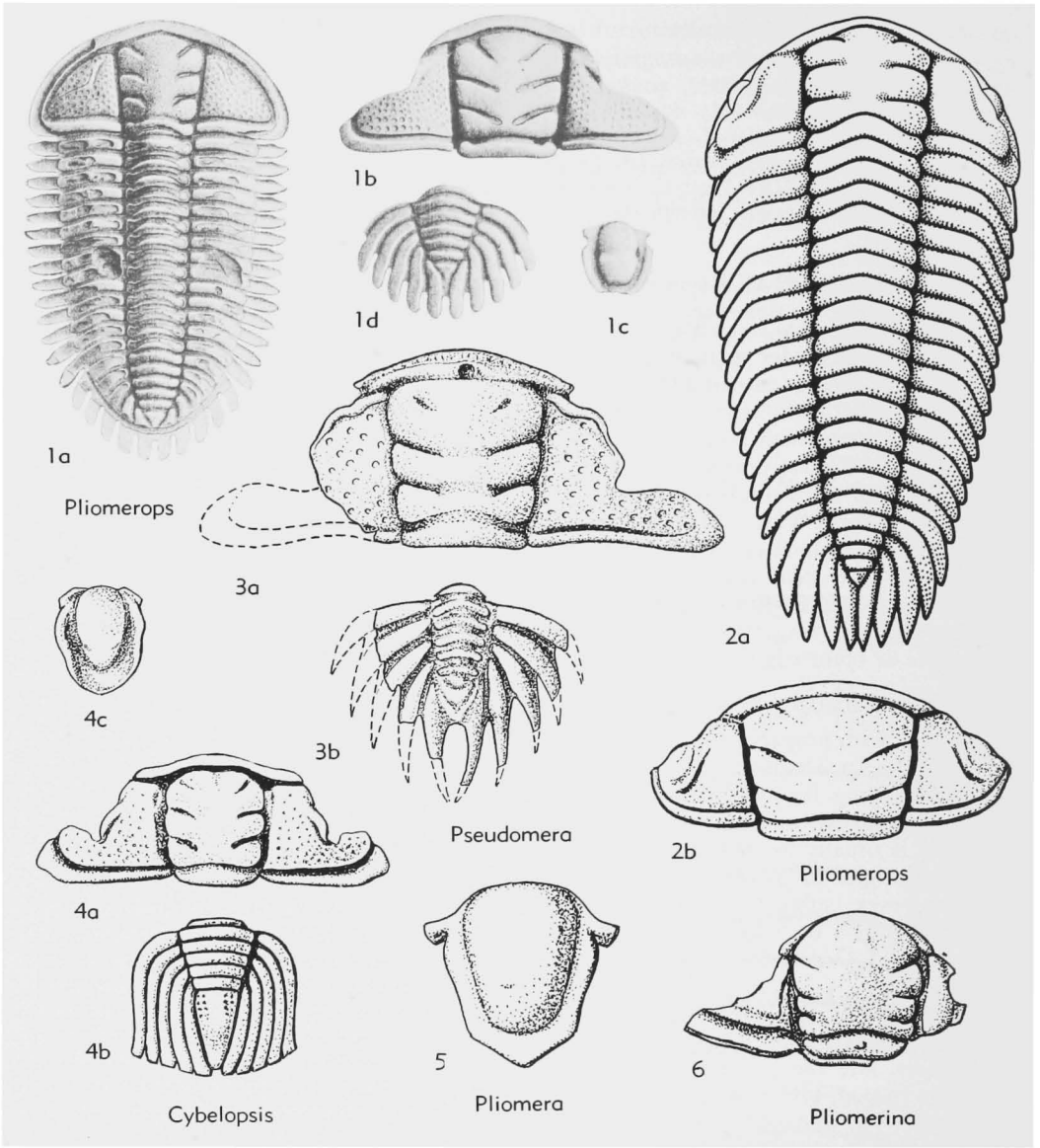


FIG. 345. Pliomeridae (Pliomerinae) (p. O439-O440).

——FIG. 345,*6*. **P. martelli* (REED); cran. (holotype), ×6.7 (452*).

Pliomerops RAYMOND, 1905 [**Amphion canadensis* BILLINGS, 1859]. Differs from *Pliomera* in lacking indentation on frontal glabellar lobe and denticulations on anterior cephalic border, in having proparian facial sutures, and small submedian eyes. Thorax with 14 to 19 segments. Pygidium with 5 axial rings and long terminal axial piece. *M.Ord.-U.Ord.*, Can.(Que.-Newf.)-USA(Vt.-N.Y.-Va.-Tenn.-Okla.)-Eu.-(Eng.-Swed.-Czech.). ——FIG. 345,*2*. **P. canadensis* (BILLINGS), M.Ord. (Tenn.); *2b*, cran., ×1 (390*).——FIG. 345,*1*. *P. senilis* (BARRANDE), M.Ord., Czech.; *1a*, exoskel. (lectotype), ×0.7; *1b-d*, cran., pyg., hypostoma, ×0.7 (370).

Pseudomera HOLLIDAY, 1942 [**Amphion barrandei* BILLINGS, 1865]. Differs from *Pliomera* in lacking denticulations on anterior cephalic border and in having proparian sutures; anterior *(3p)* lateral glabellar furrows not reaching anterior border furrow; fixigenae without anterior areas, anterior border furrow with deep mesial pit; eyes moderately large, submedian; long palpebro-ocular ridges. Pygidium with 5 axial rings, long terminal axial piece with lunate furrow, and pleurae ending

in long free spines. *L.Ord.*, Can.(Newf.), Greenl. ——FIG. 345,*3*. **P. barrandei* (BILLINGS), Newf.; *3a*, cran. (holotype), ×2; *3b*, pyg. (paratype), ×1.35 (408*).

Subfamily PILEKIINAE Sdzuy, 1955

[*nom. transl.* HARRINGTON, herein (*ex* Pilekiidae SDZUY, 1955)]

Cephalon with proparian sutures; glabella oval in outline, parallel-sided or tapering forward, with 3 pairs of lateral glabellar furrows; genal angles produced into spines or exceptionally ?rounded; eyes anterior; eye ridges or palpebro-ocular ridges present or absent. Thorax with ?11 or ?12 segments; pleurae furrowed. Pygidium with 2 to 4 axial rings and terminal piece; 2 to 4 pairs of furrowed pleurae ending in long free spines. *L.Ord.*

Pilekia BARTON, 1915 [**Cheirurus apollo* BILLINGS, 1864]. Glabella prominent, wider than long, strongly tapering forward, strawberry-shaped; lateral glabellar furrows directed inward and slightly backward; length *(exsag.)* of successive lateral glabellar lobes increasing from front to back; frontal glabellar lobe short and small; surface of glabella granulose; fixigenae narrow *(tr.)* without anterior areas, pitted; eyes small, well forward, close to glabella; palpebro-ocular ridges short; posterior sections of facial sutures cutting lateral margins immediately in front of genal angles which are ?rounded or produced into spines. Thorax of ?12 segments; pleurae with oblique furrows, pleural extremities produced into long curved spines. Pygidium with 4 axial rings and triangular terminal axial piece reaching posterior margin; pleural regions with 4 pairs of furrowed pleurae ending in long free spines arranged in groups of 2. *L.Ord.*, Can.(Que.), USA(Vt.-Utah-Ohio).——FIG. 346,*1b,c*. **P. apollo* (BILLINGS), Vt.; *1b*, cran., ×2.7; *1c*, pyg., ×0.7 (449).——FIG. 346,*1a*. *P. trio* HINTZE, Utah; cran. (holotype) ×3 (407).

Anacheirurus REED, 1896 [**Cheirurus (Eccoptochile) frederici* SALTER, 1864]. Differs from *Pilekia* in having glabella slightly longer, gently tapering forward, with evenly spaced lateral glabellar furrows; eyes rather far from glabella without eye ridges or palpebro-ocular lobes; posterior sections of facial sutures cutting lateral margins well in front of spinose genal angles. Thorax with ?11 segments. Pygidium apparently similar to that of *Parapilekia*. *L.Ord.(Tremadoc.)*, Wales.——FIG. 346,*4*. **A. frederici* (SALTER); distorted specimen (lectotype), ×1.——FIG. 346,*3*. *A. frederici?* (SALTER); *3a*, cran., ×0.7; *3b*, pyg., ×0.7 (406n).

Metapilekia HARRINGTON, 1938 [**M. bilirata*]. Differs from *Pilekia* in having glabella as long as wide, gently tapering forward, longer *(sag.)* and larger frontal glabellar lobe; yoke-shaped anterior cephalic border; very wide fixigenae with well-developed anterior areas; eyes located far from glabella, eye ridges long, arcuate fixigenal ridges extending from level of mesial *(2p)* lateral glabellar furrows to genal angles; posterior sections of facial sutures cutting lateral margins well in front of spinose genal angles. Pygidium with 3 axial rings, small triangular terminal axial piece and 3 pairs of pleurae ending in long free spines directed backward. *L.Ord.*, Arg.——FIG. 346,*6*. **M. bilirata; 6a*, cran. (holotype), ×1.2; *6b*, pyg., ×4.65 (405).

Metapliomerops KOBAYASHI, 1934 [**Pilekia extenuata* RAYMOND, 1924]. Differs from *Pilekia* in lacking palpebro-ocular ridges and in having glabella longer than wide, evenly tapering forward, with regularly spaced lateral glabellar furrows. Pygidium with 5 axial rings and terminal piece, 4 pairs of furrowed pleurae ending in long free spines, and traces of 2 more pairs of pleurae behind posterior pair, each produced into incipient spines. *L.Ord.*, USA(Vt.).——FIG. 346,*2*. **M. extenuatus* (RAYMOND); *2a*, cran. (holotype), ×4.3; *2b*, pyg. (paratype), ×2.7 (449).

Parapilekia KOBAYASHI, 1934 [**Calymene? speciosa* DALMAN, 1827; SD HOLLIDAY, 1942]. Differs from *Pilekia* in having glabella longer than wide, oval in outline, with lateral glabellar lobes of subequal length *(exsag.)*; longer frontal glabellar lobe; wider fixigenae; posterior sections of facial sutures cutting lateral margins well in front of spinose genal angles. Pygidium with 4 axial rings and terminal axial piece, which does not reach posterior margin; 4 pairs of pleurae ending in evenly distributed long free spines. *L.Ord.*, Swed.-Czech. ——FIG. 346,*8*. **P. speciosa* (DALMAN), Swed.; *8a,b*, cran., pyg., ×0.7 (432).

?Emsurina SIVOV, 1955 [**E. sibirica*]. Cranidium imperfectly known, resembles *Pilekia*. Other parts of exoskeleton unknown. Horizon given as *Up.U. Cam.*, but may be *L.Ord.(Tremadoc.)*, Sib. (HA).

?Seisonia KOBAYASHI, 1934 [**S. sphericauda*]. Cranidium imperfectly known, similar to that of *Parapilekia*. Pygidium with 2 axial rings and short, posteriorly rounded terminal axial piece, which does not reach posterior margin, and 2 pairs of broad furrowed pleurae ending in long free spatulate spines. *L.Ord.*, S.Korea.——FIG. 346,*7*. **S. sphericauda; 7a*, cran. (paratype), ×2.5; *7b*, pyg. (holotype), ×1 (419).

?Tesselacauda Ross, 1951 [**T. depressa*]. Differs from *Pilekia* in having glabella longer than wide, subrectangular in outline, evenly spaced lateral glabellar furrows; very wide posterior areas of fixigenae; genal angles bluntly pointed; incomplete palpebro-ocular ridges, ill defined from anterior cephalic border. Pygidium with 4 axial rings and terminal piece; 4 pairs of paddle-shaped pleurae with square ends, anterior 2 pairs bearing oblique pleural furrows. *L.Ord.*, USA(Idaho-Utah). ——FIG. 346,*5*. **T. depressa*, Utah; *5a*, cran.

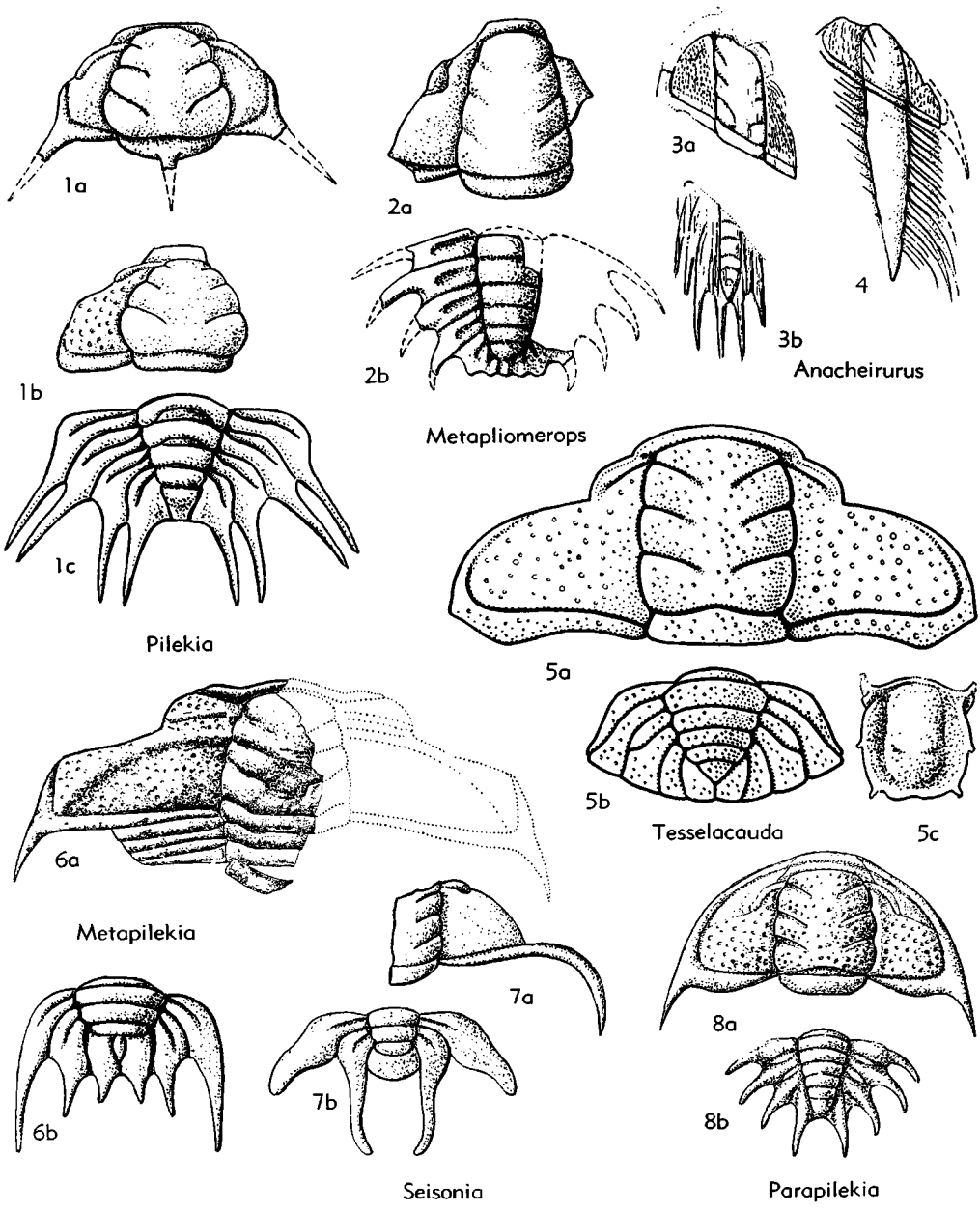


FIG. 346. Pliomeridae (Pilekiinae) (p. O441).

(holotype), ×2; *5b*, pyg. (paratype), ×2; *5c*, hypostoma (paratype) ×5.3 (463).

Subfamily PROTOPLIOMEROPINAE Hupé, 1953

[*nom. correct.* HARRINGTON, herein (*pro* Protopliomeropsinae HUPÉ, 1953)]

Cephalon with proparian sutures; glabella longer than wide, with 3 pairs of evenly spaced lateral glabellar furrows, of which anterior *(3p)* pair is usually located at level of anterolateral angles of glabella or behind it; eyes anterior to submedian; genal angles rounded or produced into spines. Thoracic pleurae smooth or ridged. Pygidium with 4 to 6 axial rings and terminal piece; pleurae smooth. *L.Ord.*

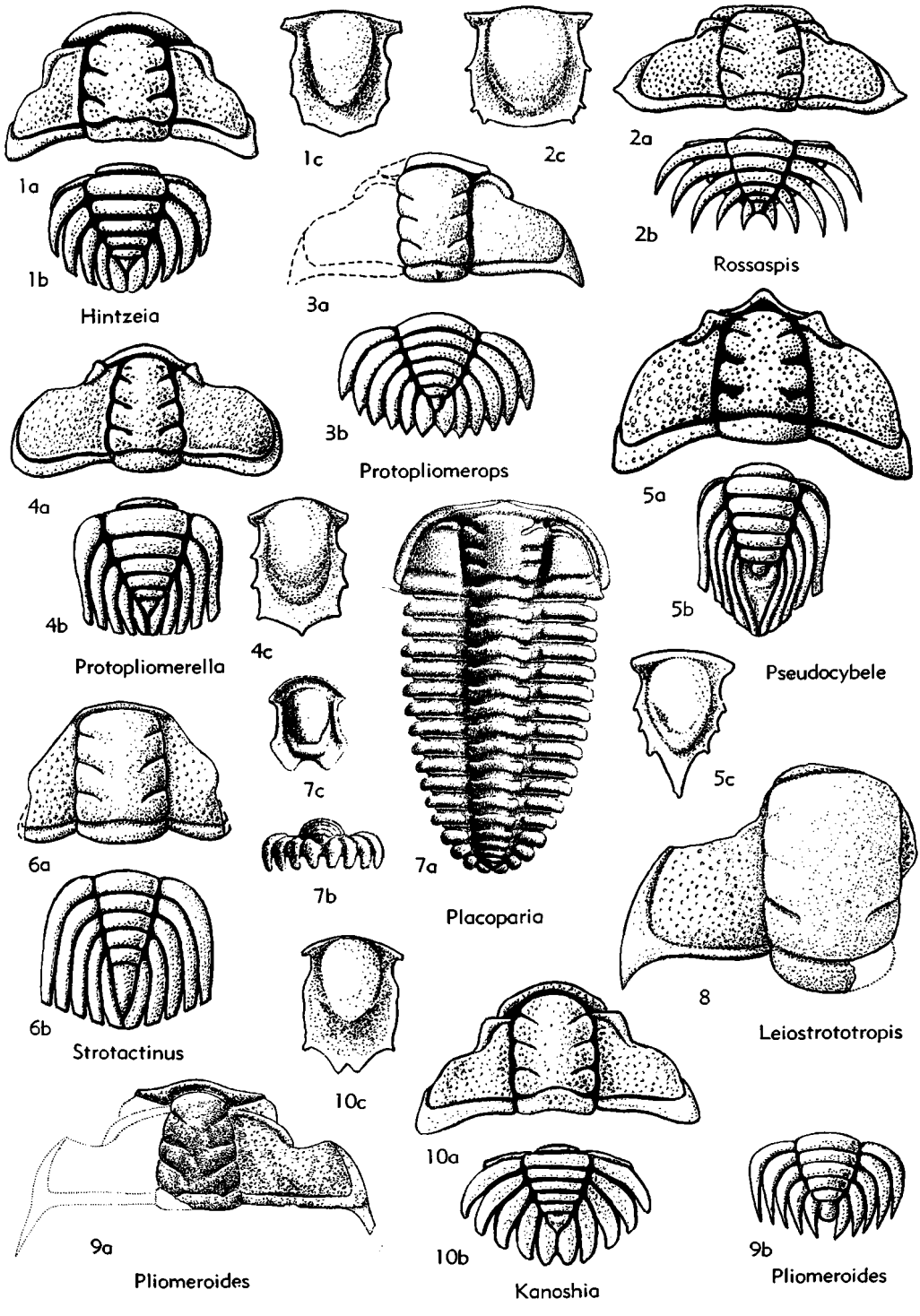


FIG. 347. Pliomeridae (Protopliomeropinae, Placopariinae) (p. O444-O445).

Protopliomerops KOBAYASHI, 1934 [**P. seisonensis*] [=*Strototropis* RAYMOND, 1937 (subj.); examination of holotype cranidium of *S. laeviuscula* RAYMOND, type species of *Strototropis*, shows that what RAYMOND regarded as anterior sections of facial sutures are anterior border furrow of cranidium, behind which short palpebro-ocular ridges are developed]. Glabella parallel-sided, elongately subquadrate in outline; anterior *(3p)* pair of lateral glabellar furrows located well behind anterolateral angles of glabella; anterior areas of fixigenae absent, posterior areas wide *(tr.)*, subtriangular; genal angles produced into spines; eyes anterior, located near glabella; palpebro-ocular ridges conspicuous. Number of thoracic segments unknown; pleurae slightly inflated, with spinose extremities. Pygidium with 5 or 6 axial rings and triangular terminal axial piece; pleurae ending in free spines; last pair completely embracing terminal axial segment. Dorsal surface of cranidium finely granulose. *L.Ord.*, S.Korea.-Bol.-USA(Vt.-?Utah).——FIG. 347,*3a*. **P. seisonensis;* cran. (syntype) (S. Korea), ×10 (419*).——FIG. 347,*3b*. *P. punctatus* KOBAYASHI; pyg. (holotype) (S.Korea), ×2 (419*).

Hintzeia HARRINGTON, 1957 [**Protopliomerops aemula* HINTZE, 1952]. Differs from *Protopliomerops* in having glabella tapering forward or slightly elliptical in outline, anterior *(3p)* lateral glabellar furrows located in front of anterolateral angles of glabella; eyes anterior or submedian; genal angles rounded. Hypostoma pointed posteriorly. *L.Ord.*, USA(Utah-Nev.-Idaho)-Arg.——FIG. 347,*1*. **H. aemula* (HINTZE), Utah; *1a*, cran. (paratype), ×4.7; *1b*, pyg. (paratype), ×4.15; *1c*, hypostoma (paratype), ×4.15 (407*).

Kanoshia HARRINGTON, 1957 [**Pseudomera kanoshensis* HINTZE, 1952]. Differs from *Protopliomerops* in having anterior *(3p)* pair of lateral glabellar furrows located at level of anterolateral angles of glabella; eyes longer, less anteriorly located; genal angles rounded; surface of glabella granulose; fixigenae pitted. Pygidium with 5 axial rings. Hypostoma bifurcate, with very wide posterior border. *L.Ord.*, USA(Utah).——FIG. 347, *10*. **K. kanoshensis* (HINTZE); *10a*, cran. (holotype), ×4; *10b*, pyg. (paratype), ×3; *10c*, hypostoma (paratype), ×3.35 (407*).

Leiostrototropis RAYMOND, 1937 [**L. phlegeri*]. Differs from *Protopliomerops* in having larger, more convex glabella with very faint anterior *(3p)* lateral glabellar furrows directed inward and slightly forward, and faint median *(2p)* lateral glabellar furrows. Thorax, pygidium and hypostoma unknown. *L.Ord.*, USA(Vt.).——FIG. 347,*8*. **L. phlegeri;* cran. (holotype), ×2.7 (405n from photograph of holotype.)

Pliomeroides HARRINGTON & LEANZA, 1957 (**Protopliomerops deferrariisi* HARRINGTON, 1938]. Differs from *Protopliomerops* in having glabella strongly tapering forward; eyes submedian, located moderately far from glabella at level of median *(2p)* lateral glabellar lobes; eye ridges well developed, curved; anterior areas of fixigenae well developed. *L.Ord.*, Arg.-Swed.-Norway.——FIG. 347,*9*. **P. deferrariisi* (HARRINGTON), Arg.; *9a*, cran. (holotype), ×1.2; *9b*, pyg., ×3, Arg. (405*).

Protopliomerella HARRINGTON, 1957 [**Protopliomerops contracta* Ross, 1952]. Differs from *Protopliomerops* in having glabella strongly tapering forward, anterior *(3p)* lateral glabellar furrows located well behind anterolateral angles of glabella, supplementary *(4p)* pair of lateral glabellar depressions at about level of anterolateral angles of glabella; genal angles rounded. Pygidium with much wider axis and narrow *(tr.)* wirelike pleurae. Hypostoma with strong posterior spine. *L.Ord.*, USA(Idaho-Utah).——FIG. 347,*4*. **P. contracta* (Ross), Idaho; *4a*, cran. (holotype), ×4; *4b*, pyg. (paratype), ×10; *4c*, hypostoma (paratype), ×7 (463*).

Pseudocybele Ross, 1951 [**P. nasuta*]. Differs from *Protopliomerops* in having accessory *(4p)* pair of faint lateral glabellar creases; genal angles rounded; eyes small, located well forward, close to glabellar; anterior cephalic border angulate; anterior border furrow with mesial pit and smaller anterior pits. Thorax with 15 segments. Pygidium cybeliform, with 5 axial rings and long subtriangular terminal axial piece; 5 pairs of reclined pleurae ending in blunt points. *L.Ord.*, USA(Utah-Idaho-Nev.).——FIG. 347,*5*. **P. nasuta*, Utah; *5a*, cran. (paratype), ×3.5; *5b*, pyg., ×3.25; *5c*, hypostoma (paratype), ×8.3 (407*, 463*).

Rossaspis HARRINGTON, 1957 [**Protopliomerops superciliosa* Ross, 1951]. Differs from *Protopliomerops* in having glabella elliptical in outline, anterior *(3p)* lateral glabellar furrows located at anterolateral angles of glabella; genal angles bluntly spinose. Pygidium with narrower axis and outstretched pleurae directed outward, then gently curved backward-outward, terminal axial pieces trapezoidal in outline reaching posterior margin, separating posterior pleurae. Hypostoma rounded posteriorly. *L.Ord.*, USA(Idaho)-Arg.——FIG. 347, *2*. **R. superciliosa* (Ross), Idaho; *2a*, cran. (holotype), ×4; *2b*, pyg. (paratype), ×4; *2c*, hypostoma (paratype), ×10.5 (463*).

Strotactinus BRADLEY, 1925 [**Amphion salteri* BILLINGS, 1861]. Differs from *Protopliomerops* in having eyes moderately long, submedian, located at level of median *(2p)* lateral glabellar lobes; eye ridges absent; fixigenae narrow *(tr.)*. Pygidium cybeliform, with 5 axial rings and long triangular terminal axial piece; 5 pairs of reclined pleurae ending in blunt points. *L.Ord.*, Can.(Que.).——FIG. 347,*6*. **S. salteri* (BILLINGS); *6a,b*, cran., pyg., ×2.7 (381*).

Subfamily PLIOMERELLINAE Hupé, 1953

Cephalon with proparian sutures; glabella about as wide as long, evenly expanded forward, with 2 pairs of lateral glabellar furrows converging toward center of glabella; eyes moderately large, submedian. Thorax with 19 segments. Pygidium with 5 axial rings and long terminal piece. *M.Ord.-U.Ord.*

Pliomerella Reed, 1941 [**P. serotina*]. Glabella subpentagonal in outline; fixigenae narrow *(tr.)*, L-shaped; posterior sections of facial sutures directed backward behind eyes. Pygidium with long subrectangular terminal axial piece reaching posterior margin. *M.Ord.-U.Ord.*, G.Brit.-USA(Va.). ——Fig. 348,*2a*. **P. serotina*, U.Ord., Scot.; cran. (holotype), ×1.5 (452).——Fig. 348,*2b*. *P. americana* Cooper, M.Ord., Va.; pyg. (paratype), ×2.3 (390).

Subfamily PLACOPARIINAE Hupé, 1953

Cephalon with opisthoparian sutures; glabella somewhat longer than wide, evenly expanded forward, with 3 pairs of lateral glabellar furrows, of which anterior *(3p)* pair reaches axial furrows at anterolateral angles of glabella; fixigenae shaped as quarter circle, without anterior areas; genal angles pointed; eyes absent; eye ridges present; librigenae very narrow. Thorax with 12 segments; pleural extremities rounded. Pygidium small, with 4 axial rings and minute terminal axial piece; pleurae ending in free spatulate spines. *M.Ord.*

Placoparia Hawle & Corda, 1847 [**Trilobites zippei* Boeck, 1828]. Anterior *(3p)* lateral glabellar furrows directed inward-backward, median *(2p)* and pre-occipital *(1p)* furrows directed normally to axis; facial sutures running very close to margin of cephalon; entire surface of cranidium finely granulose. Hypostoma bifurcate. *M.Ord.*, Eng.-Wales-Fr.-Sp.-Port.-Czech.-N. Afr. —— Fig. 347,*7*. **P. zippei* (Boeck), Czech.; *7a*, complete specimen, ×1.3; *7b*, pyg., posterior, ×1.3; *7c*, hypostoma, ×1.3 (370*).

Subfamily DIAPHANOMETOPINAE Jaanusson, nov.

Cephalon with proparian sutures; glabella long, flattened; lateral glabellar furrows very faintly defined or absent; cephalon surrounded; rostral plate triangular (in some species), connecting sutures meeting each other at posterior margin of doublure. Hypostoma unknown. Thorax with 11 or 12 segments; pleurae with long diagonal pleural furrow and well-developed facet. Pygidial pleurae consisting of 4 tergites and terminal piece; ends of all or only of anterior tergites free; foremost 2 tergites with diagonal pleural furrows. *L.Ord.*

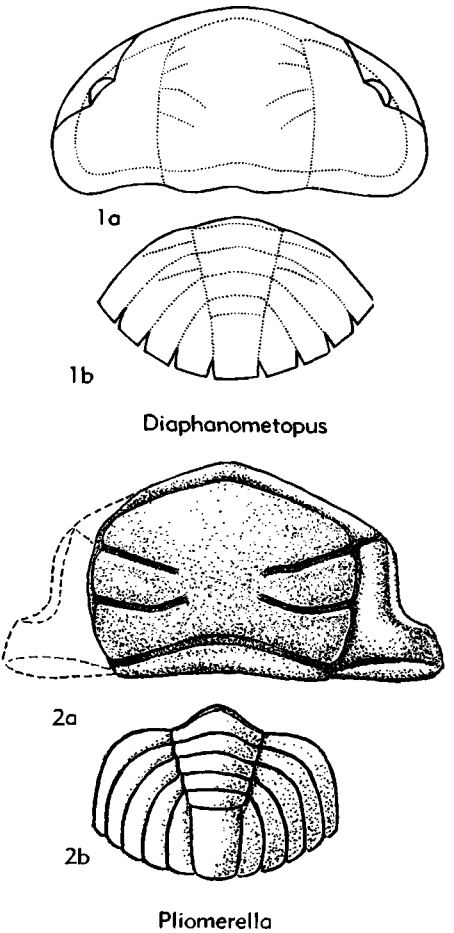


Fig. 348. Pliomeridae (Pliomerellinae, Diaphanometopinae) (p. O445).

Diaphanometopus Fr. Schmidt, 1881 [**D. volborthi*]. Characters of subfamily. *L.Ord.(Arenig.-Llanvirn.)*, Baltoscandia.——Fig. 348,*1*. **D. volborthi; 1a*, ceph., ×2; *1b*, pyg., ×2 (414).

Family ENCRINURIDAE Angelin, 1854

Glabella with subparallel or slightly convex sides, or widening forward. Rostral plate wide to very narrow *(tr.)*; hypostoma with elongate middle body. Thorax of 10 to 12 segments, pleurae with transverse pleural furrow or lacking them. Pygidium with or

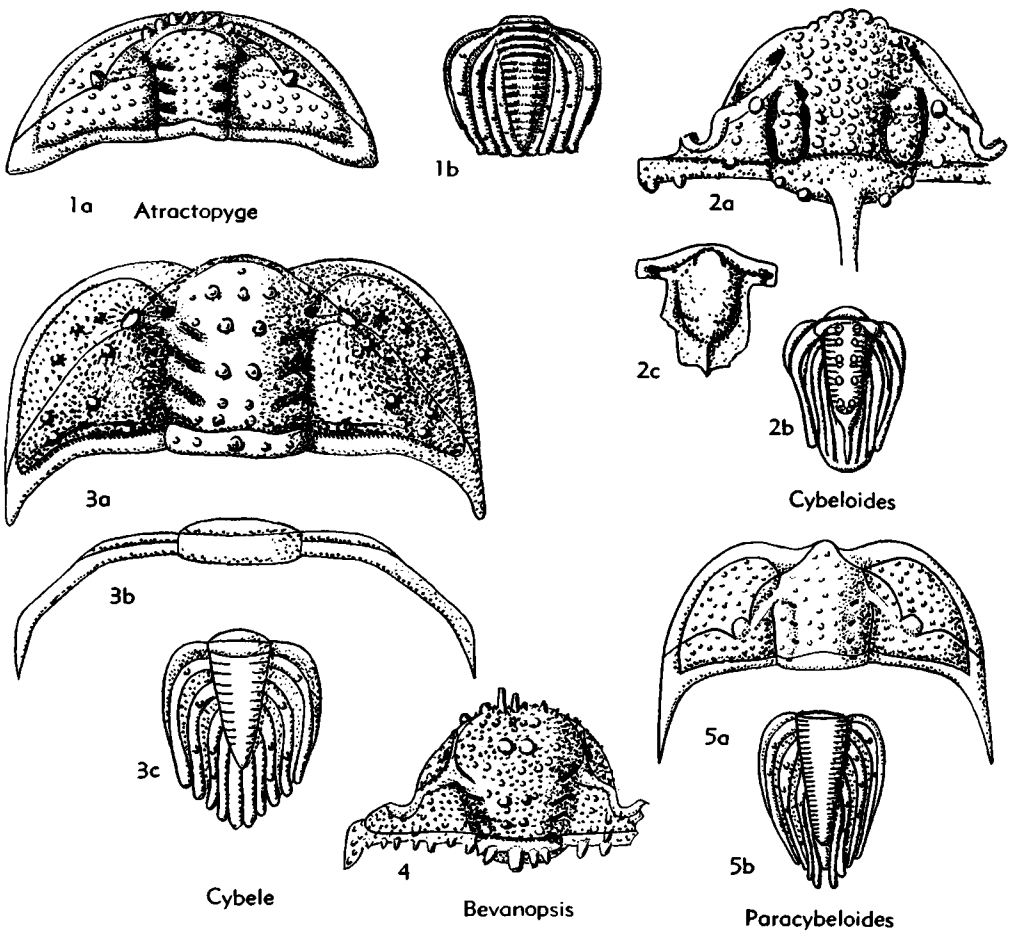


FIG. 349. Encrinuridae (Cybelinae) (p. O448).

without pleural spines, with 2 to 16 pairs of ribs and a considerably greater number of axial rings (except in Staurocephalinae). Surface generally tuberculate or pitted or both (91, 227). *L.Ord.-Sil.*

The Cybelinae gave rise to the Encrinurinae. It is uncertain whether the Dindymeninae developed from the Cybelinae or the Encrinurinae.

Subfamily ENCRINURINAE Angelin, 1854

[*nom. transl.* HUPÉ, 1955 (*ex* Encrinuridae ANGELIN, 1854)]

Glabella expanding forward; facial sutures generally crossing. No eye ridges. Thorax of cephalic axis. Thorax with 11 or 12 segments, pleurae without pleural furrows. Pygidium with 5 to 16 pairs of ribs. *M.Ord.-Sil.*

Encrinurus EMMRICH, 1844 [**Entomostracites punctatus* WAHLENBERG, 1821 (1819), by suppression of *Trilobus punctatus* BRÜNNICH, 1781 (proposed by R. P. TRIPP, 1956, ICZN pend.)] [=*Cryptonymus* EICHWALD, 1840 (obj.), *non Cryptonymus* EICHWALD, 1825]. Glabella widening markedly forward, with 3 pairs of lateral or transglabellar furrows; eyes more or less stalked. Thorax with 11 or 12 segments. Pygidium subtriangular, longer than broad, with ?5 to 10 pairs of ribs. *M.Ord.-Sil.*, cosmop.

E. (Encrinurus). Glabella with 3 pairs of short lateral furrows, more or less obscured by coarse tuberculation. *M.Ord.-Sil.* cosmop.——FIG. 350,*4*. *E.* sp. cf. *E. punctatus* (WAHLENBERG), *4a*, ceph., front; *4b*, hypostoma; *4c*, exoskel.; all ×2.2 (406n, reconstr. based on material from Llandov. Sh., Oslo, Norway).

E. (Coronocephalus) GRABAU, 1924 [**Encrinurus (Coronocephalus) rex*]. Three pairs of trans-

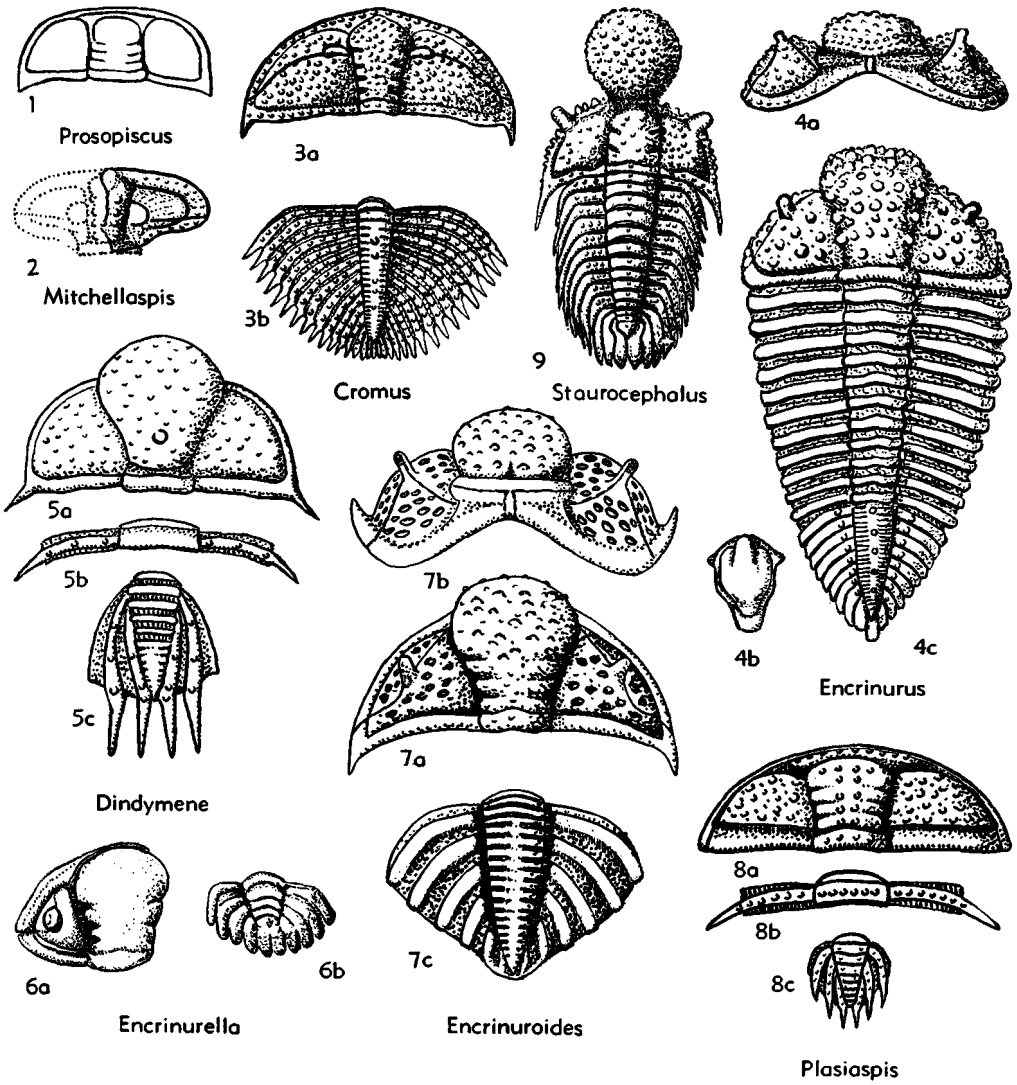


FIG. 350. Encrinuridae (Encrinurinae, Dindymeninae, Staurocephalinae) (p. O446-O449).

glabellar furrows accentuated by intervening rows of tubercles. *L.Sil.*, China.

Cromus BARRANDE, 1852 [**C. intercostatus*; SD VOGDES, 1890]. Glabella widening slightly forward, with 4 pairs of lateral furrows; eyes moderately close or very close to glabella, opposite its anterior half. Thorax with 10 segments. Pygidium with 10 to 16 pairs of ribs. *Sil.*, Eu.——FIG. 350, *3. *C. intercostatus*, Sil., Boh., *3a*, ceph.; *3b*, pyg., both ×1 (370).

Encrinuroides REED, 1931 [**Cybele sexcostatus* SALTER, 1848]. Like *Encrinurus* but glabella with more distinct lateral furrows and anterior medial furrow. Thorax with 11 segments. Pygidium broader than long, with 5 or 6 pairs of ribs. *M. Ord.-U.Ord.*, Eu.-N.Am.——FIG. 350,*7*. **E. sexcostatus* (SALTER), Rhiwlas Ls., Bala, Wales; *7a,b*, ceph. (reconstr.), dorsal, front; *7c*, pyg., ×1.5 (350).

?**Mitchellaspis** HENNINGSMOEN, *nom. subst.* herein [*pro Mitchellia* VOGDES, 1917 (305, p. 17) (*non* DE KONINCK, 1877)] [**Encrinurus? duntroonensis* ETHERIDGE & MITCHELL, 1916]. Resembles *Cromus*, with eyes close to glabella but far back, and with transverse posterior sections of facial sutures. *U.Sil.*, Austral.(N.S.W.).——FIG. 350,*2*. **M. duntroonensis* (ETHERIDGE & MITCHELL); incompl. ceph., ×1 (398).

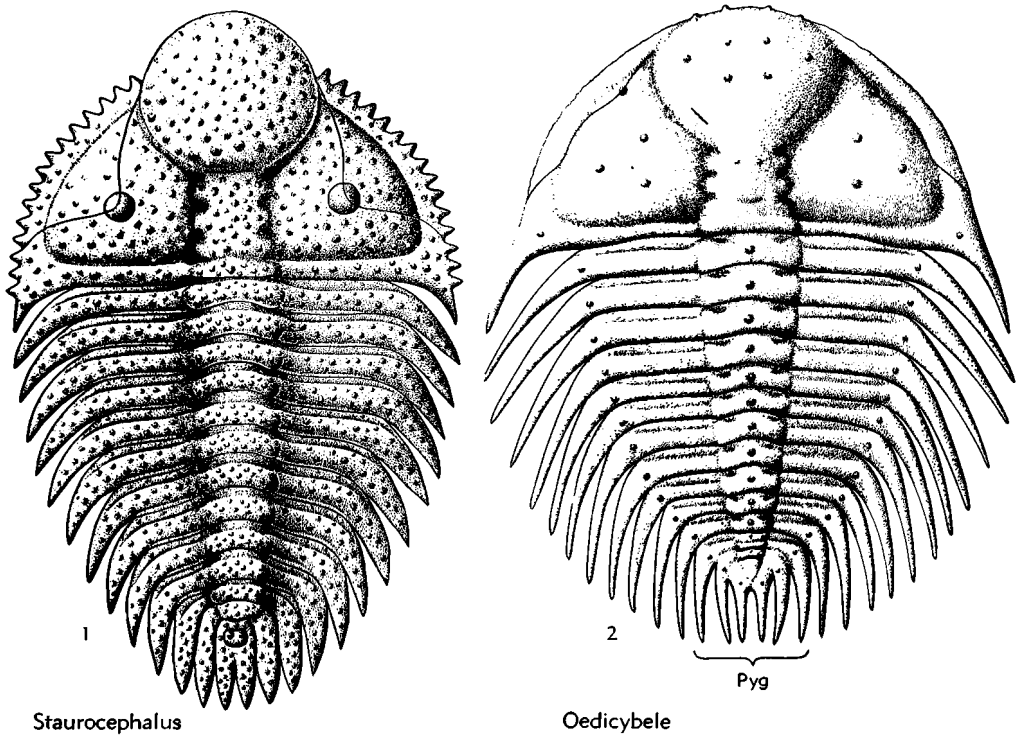


FIG. 351. Encrinuridae (Staurocephalinae) (p. O449).

Subfamily CYBELINAE Holliday, 1942

[*nom transl.* HUPÉ, 1955 (by error as "sous-famille de Cybelidae") (*ex* Cybelidae HOLLIDAY, 1942)] [emend. HUPÉ, 1955]

Eye ridges more or less distinct. Thorax with 11 or 12 segments. Pygidium with 4 or 5 pairs of ribs. *L.Ord.-U.Ord.*

Cybele LOVÉN, 1846 [**Calymene? bellatula* DALMAN, 1827; SD VOGDES, 1890] [=*Cybelina* REED, 1928]. Glabella with subparallel or slightly convex sides, with 3 pairs of subequal lateral furrows; eyes pedunculate, opposite anterior half of glabella. Thorax with 12 segments, pleurae bearing transverse furrows. Pygidium with 5 pairs of ribs. *L.Ord.*, Eu.-N.Am.——FIG. 349,*3*. **C. bellatula* (DALMAN), Expansus Sh., Oslo, Norway; *3a-c*, ceph., thoracic segment, pyg., ×3 (406n).

Atractopyge HAWLE & CORDA, 1847 [**Calymene verrucosa* DALMAN, 1827] [=*Cybellela* REED, 1928 (**Zethus rex* NIESZKOWSKI, 1857); *Cybelella* WEBER & LERMONTOVA in RJABININ, 1934 *(nom. van.)*]. Glabella with subparallel sides or widening somewhat forward, with 3 pairs of lateral furrows; row of tubercles or spines in front of glabella; eyes stalked or sessile. Pygidium wtih 4 pairs of ribs. *M.Ord.-U.Ord.*, Eu.-N.Am.——FIG. 349,*1*. **A. verrucosa* (DALMAN), Red Tretaspis Sh., Billingen, Västergötland, Swed.; type material, *1a,b*, ceph., pyg., ×0.6 (406n).

Bevanopsis COOPER, 1953 [**B. ulrichi*]. Glabella widening forward, with 3 pairs of lateral furrows; eyes far back, eye ridges distinct. Thorax and pygidium unknown. *M.Ord.*, E.N.Am.——FIG. 349,*4*. **B. ulrichi*, Va.; cran., ×6 (26).

Cybeloides SLOCOM, 1913 [**C. iowensis*]. Three lateral glabellar lobes more or less distinctly separated from remainder of the glabella by longitudinal furrows, eyes far back, eye ridges distinct. Pygidium with 4 pairs of ribs. *M.Ord.*, N. Am.-Eu.——FIG. 349,*2*. *C. virginiensis* COOPER, Va.; *2a-c*, ceph., pyg., hypostoma, ×3 (26).

Paracybeloides HUPÉ, 1955 [**Cybele loveni girvanensis* REED, 1906]. Like *Cybeloides* but with lateral glabellar furrows represented by pits, not united into longitudinal furrows. Thorax with 11 segments. *M.Ord.*, Eu.-N.Am.——FIG. 349,*5*. **P. girvanensis* (REED), Scot.; *5a*, restored ceph.; *5b*, pyg., both ×1.5 (411, 452).

Subfamily DINDYMENINAE Henningsmoen, nov.

Eyes lacking. Thorax with 11 or 12 segments, without pleural furrows. Pygidium with 2 or 3 pairs of ribs. *M.Ord.-U.Ord.*

Dindymene HAWLE & CORDA, 1847 [**D. fredericiaugusti*; SD BARRANDE, 1852]. Glabella widening forward and projecting over anterior border; facial sutures present or not. Thorax with 10

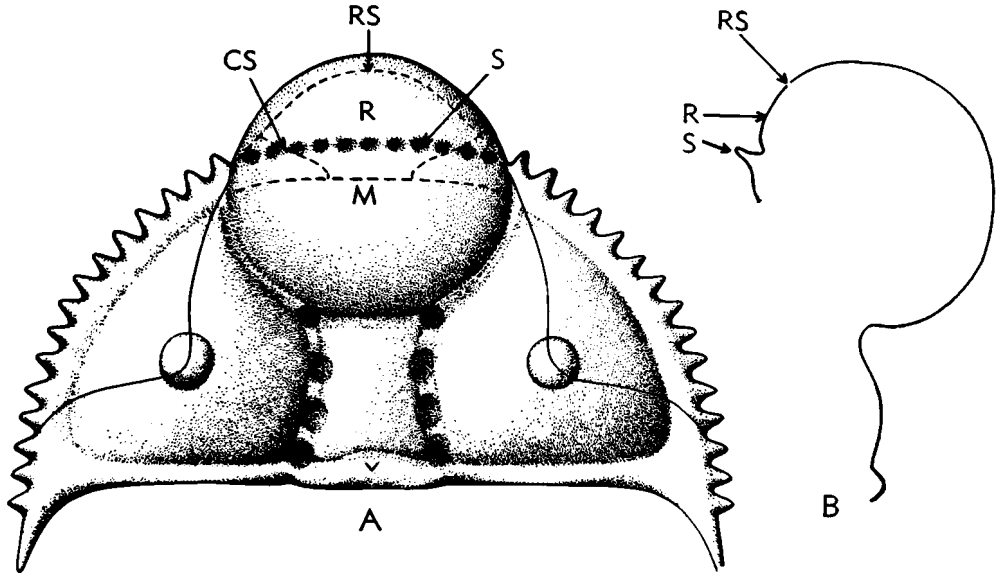


FIG. 352. *Staurocephalus clavifrons* ANGELIN (Encrinuridae), U.Ord., Baltic region (Swed.-Pol.), ×8.5 (reconstr.). *A*, Dorsal view of cephalon, with representation of features on the underside in the anterior region. *B*, Sagittal profile of cephalon. (Explanation—*CS*, connective suture; *M*, margin of cephalon; *R*, rostral suture; *S*, spine.) (91).

segments. Pygidium with 2 pairs of ribs. *M.Ord.-U.Ord.*, Eu.——FIG. 350,*5*. **D. fredericiaugusti* (BARRANDE), Boh.; *5a-c*, ceph., thoracic segment, pyg., all ×2 (370).

Plasiaspis PRANTL & PŘIBYL, 1949 [**Dindymene bohemica* BARRANDE, 1872]. Glabella widening slightly forward, not projecting over anterior border; facial sutures close to margin. Thorax with 12 segments. Pygidium with 3 pairs of ribs. *M.Ord.*, Boh.——FIG. 350,*8*. **P. bohemica* (BARRANDE), *8a*, ceph.; *8b*, thoracic segment; *8c*, pyg.; all ×1.5 (370).

?Prosopiscus SALTER, in SALTER & BLANFORD, 1865 [**P. mimus*]. Resembles *Plasiaspis* but glabella tapers slightly forward. *M.Ord.* Himalaya.——FIG. 350,*1*. **P. mimus*; ceph. (reconstr.), ×1 (6).

Subfamily STAUROCEPHALINAE Prantl & Přibyl, 1947

Glabella with inflated anterior lobe, overhanging in front, and narrow, parallel-sided posterior portion with 3 pairs of lateral glabellar furrows; fixigenae with genal spines. Thorax with 10 or 11 segments, pleurae with long spines. Pygidium with 3 or 4 axial rings and 3 pairs of pleural spines, pointing backward. *M.Ord.-Sil.*

Staurocephalus BARRANDE, 1846 [**S. murchisoni*]. Glabella with anterior lobe extremely inflated, separated from posterior part by transglabellar furrows. Ventral sutures of euptychopariid type; rostral plate large and long *(sag.)*, divided into anterior part, forming direct continuation of inflated lobe of glabella, and posterior subtrapezoidal part. Hypostoma with flattish margin bearing wings and raised central portion with 2 knobs. Thorax with 10 segments. *M.Ord.-Sil.*, Eu.-N.Am.-Austral.(N.S.W.)-C.Asia.——FIG. 350,*9*. **S. murchisoni*, Sil.(Wenlock), Eng.; exoskel., ×2.5 (267).——FIG. 351,*1*, 352. *S. clavifrons* ANGELIN, U.Ord., Pol.-Swed.; 351,*1*, exoskel. (reconstr.), ×5.2 (91*); 352*A,B*, ceph. (reconstr.), dorsal view showing features of under side, profile, ×8 (91).

Oedicybele WHITTINGTON, 1938 [**O. kingi*] [=*Jemtella* THORSLUND, 1940 (obj.)]. Anterior lobe of glabella inflated and separated from posterior part by short lateral glabellar furrows. Ventral sutures and hypostoma unknown. Thorax with 11 segments. *U.Ord.*, Eu.——FIG. 351,*2*. **O. kingi*, U.Ord., Pol.-Swed.; exoskel. (reconstr.), ×5.2 (91*).

Family UNCERTAIN

Ectenonotus RAYMOND, 1920 [**Amphion westoni* BILLINGS, 1865]. Glabella with subparallel sides and 3 pairs of lateral furrows, anterior pair in front of anterior corners. Pygidium with 8 to 10 pairs of ribs and a greater number of axial rings. *L.Ord.*, N.Am.-Ire.——FIG. 353,*4*. **E. westoni* (BILLINGS), N.Am.; *4a,b*, incompl. cran., pyg., pyg., both ×4 (452).

Encrinurella REED, 1915 [**Pliomera ingsangensis*

Reed, 1906]. Glabella widening forward, with 3 pairs of lateral furrows; genal spines absent. Pygidium pliomerid-like, with 5 pairs of pleural spines. *M.Ord.*, E.Asia(N.Shan).——Fig. 350,6. **E. ingsangensis* (Reed); *6a*, incomplete ceph.; *6b*, pyg., both ×4 (452).

Suborder CALYMENINA Swinnerton, 1915

[=Superfamily Calymenidea Rud. Richter, 1933; superfamily Calymenacea Kobayashi, 1935; superfamily Calymenoidae Hupé, 1953 (attributed to Swinnerton, 1915)] [Type—*Calymene* Brongniart, 1822]

Exoskeleton medium to large in size. Cephalon semicircular to subtriangular, with or without border. Glabella narrowing forward, bell-shaped to trapezoidal in outline, with 4 or fewer pairs of lateral furrows of varying depth (in a few forms no furrows); posterior adaxial parts of fixigenae commonly differentiated as distinct quarter-circle-shaped tracts (paraglabellar areas); genal spines mostly lacking (present only in a few Ordovician genera); posterior sections of facial sutures cutting margins of cephalon mostly at or in front of genal angles. Hypostoma subrectangular, small anterior wings with indented posterior margin (except in a few early forms with rounded margin). Thorax narrowing moderately backward; almost uniformly composed of 13 segments but rarely with fewer; axis occupying 0.3 or more of thoracic width; pleural ends rounded. Pygidium transversely elliptical to elongate triangular, mostly medium to large (small in early genera only), with number of segments ranging from few in early genera to many in later genera; pleural portions downward-backward from axis. *L. Ord.-M.Dev.*

Opinions differ as to whether trilobites assigned to the Calymenina are opisthoparian. In this connection, it is pertinent to note that (1) affinities of the Calymenina (especially early forms) to ptychopariid trilobites are far greater than with any other trilobite group, and (2) some Calymenina (e.g. *Pharostoma, Pharostomina, Bavarilla*) possess genuine librigenal spines, whereas no genus of the assemblage incontestably bears fixigenal spines in the adult.

Two fairly homogeneous evolutionary lines can be recognized in the Calymenina, which respectively are grouped in the families Calymenidae and Homalonotidae. They must have split apart early in Ordovician time or before. The Homalonotidae may have been derived from the early Tremadocian genus *Bavarilla* or a similar form. The Calymenidae may be descendants of the early Tremadocian *Pharostomina*, or alternatively, may have branched off from the homalonotid stem somewhat later in Ordovician time through *Synhomalonotus*. The first possibility seems to be more probable.

Family CALYMENIDAE Burmeister, 1843

[=Calymmenidae Angelin, 1854]

Cephalon semicircular, convex, glabella bell-shaped or parabolic, widest across occipital ring or preoccipital lateral may or may not project in front of genae, with 2 to 4 pairs of lateral furrows; lateral lobes of glabella diminishing in size forward, tending to be isolated by shallow furrows from median lobe and independently convex, 2nd *(2p)* and 3rd *(3p)* lateral lobes (counting forward) may be papillate (that is, with distal edge in contact with projection from gena on opposite side of axial furrow); axial furrows bordering lateral glabellar lobes deep, anterior pit deep; genae highest adjacent to axial furrows, sloping steeply downward anterolaterally; relatively small eye lobes situated on highest part of genae opposite *2p* or *3p* glabellar lobes; low eye ridges may be present; convex anterior, lateral, and posterior cephalic borders clearly defined by broad furrows, which become shallow or die out close to facial sutures; doublure rolled under borders and not extending inside them; frontal area variable in length *(sag.)*, in some forms extending into frontal spine; preglabellar furrow and anterior border variable in form; anterior sections of facial sutures running directly forward from eyes and then curving inward to cross border outside projected line of axial furrows. Rostral suture transverse on doublure in some genera, connective sutures converging backward; rostral plate widest at anterior margin and sharply flexed upward under border; posterior sections of sutures running backward-outward in anterolaterally convex curve to cross border at rounded genal angles which may bear short spine or tubercle on posterior edge inside of suture lines. In *Pharostoma* (and *?Bathycheilus*) sutures cut posterior mar-

gins just inside relatively long genal spines. Hypostoma longer than wide, subovate middle body divided by short, shallow, diagonal middle furrows so that posterior lobe is crescentic; macula faint, smooth; anterior lobe may have raised central portion; exoskeleton at anterior border flexed so that edge faces ventrally, hypostoma with large anterior wing bearing prominent wing process, posterior wing small; wide lateral notch, behind which lateral and posterior borders are wide, with deep median notch adjoining parts of border drawn out into blunt points. Thorax with ?11, 12, or 13 segments; axis convex; pleurae bent downward at fulcrum and almost vertical distally; axial rings undivided, but distal portion swollen; deep articulating furrows and apodemal pits, inner part of pleurae horizontal, with deep slightly diagonal pleural furrow, outer part with wide facet partly indented by pleural furrow; articulating processes and sockets in axial furrows and at fulcra; narrow doublure around outer part of pleurae, projecting inward at anterior edges. Pygidium with axis extending almost to posterior margin, sloping steeply backward and sideward; anterior edge of pleural fields curving back, maximum width between anterolateral corners; axis divided by 5 to 8 ring furrows that are deepest abaxially, posterior tip of axis unfurrowed; pleural fields unfurrowed or with deep pleural furrows and shallow interpleural grooves; mostly without border; pygidial doublure narrow and rolled tightly under margins. External surface commonly granulose, tuberculate, or both, with deeper parts of furrows smooth. Fine canals penetrating exoskeleton scattered over surface, largest on anterior border of cephalon and posterior part of pygidium, smaller in tubercles along axis (44, 275). *L. Ord.(Arenig.)-M.Dev.*

Subfamily CALYMENINAE Burmeister, 1843

[*nom. transl.* Hupé, 1955 (*ex* Calymenidae Burmeister, 1843]

Glabella with 2 to 4 pairs of lateral furrows, without differentiated oval areas at adaxial ends of *1p* furrows; axial furrows moderately narrow and deep, with or without anterior pits; facial sutures gonatoparian (except *Bathycheilus*); genal angles typically not produced in spines. *L.Ord.-M.Dev.*

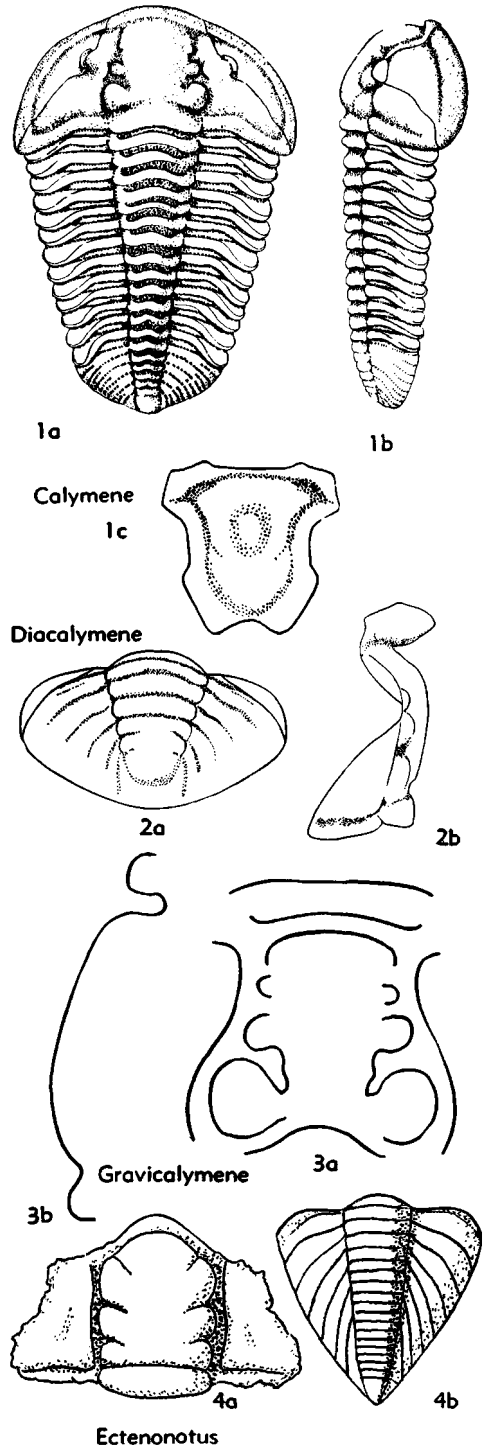


Fig. 353. Calymenidae (Calymeninae); Encrinuridae *(4a,b)* (p. O449-O452).

Calymene BRONGNIART, 1822 (ICZN pend.) [**C. blumenbachii*] [=*Calymena* DESMAREST, 1817]; *Calymmene* KOENIG, 1825 (obj.); *Calymaena* BERTHOLD, 1827 (obj.); *Calymmena* AGASSIZ, 1846]. Glabella convex, standing high above genae and projecting well in front of them, anterior lobe sloping steeply forward; with 3 pairs of lateral lobes, *1p* and *2p* isolated by shallow longitudinal furrows, all independently convex, *2p* lobes papillate; eye lobes opposite *2p* glabellar lobes; preglabellar furrow narrow, deep; anterior border evenly convex. Hypostoma with subrectangular raised area, highest anteriorly, in center of anterior lobe of middle body. Thorax with 13 (rarely 12) segments. Pygidium with 6 complete axial rings and 6 deep pleural furrows, which extend to margin of borderless pleural regions, interpleural grooves shallow, best-marked distally. *L.Sil.-M. Dev.*, Eu.-N.Am.-S.Am.-Austral.——FIG. 353,*1*. **C. blumenbachii*, M.Sil., Eng.; *1a,b*, exoskel. (reconstr.), dorsal, lateral, ×0.7; *1c*, hypostoma, ×1.3 (496n).

Calymenesun KOBAYASHI, 1951 [**Calymmene tingi* SUN, 1931]. Glabella with 3 pairs of lateral furrows, anterior pair *(3p)* faint; with long *(sag.)* frontal area extended into long frontal spine (106). *M.Ord.*, SW.China.——FIG. 354,*5*. **C. tingi* (SUN); cran., ×1.5 (478).

Diacalymene KEGEL, 1927 [**Calymene diademata* BARRANDE, 1846]. Like *Calymene*, with glabella extending forward as far as most anterior part of genae or slightly beyond; preglabellar furrow broad and deep, anterior side of this furrow sloping at first steeply, then gently to horizontal, before reaching sharp flexure at outer edge of anterior border; border descends steeply outward, vertically, or slightly inward to rostral suture; also, anterior border between sutures may be strongly arched transversely. Hypostoma with subcircular raised area or narrow longitudinal ridge in center of anterior lobe of middle body. Thorax with 13 segments; outer parts of pleurae bent downward less steeply than in *Calymene*. Pygidium relatively wide, pleural furrows dying out about half way across pleural regions, no interpleural grooves; ribs between last 2 pairs of pleural furrows form prominent ridges adjoining tip of axis. *U.Ord.-U.Sil.*, Eu.-N.Am.——FIG. 353, *2*. **D. diademata* (BARRANDE), M.Sil.-U.Sil., Boh.; *2a,b*, pyg., cran., ×1 (496n).

Flexicalymene SHIRLEY, 1936 [**Calymene caractaci* SALTER, 1865] [=*Orimops* RAFINESQUE, 1832, ICZN pend.]. Glabella with 3 pairs of lateral lobes; axial furrows contracted slightly opposite *1p* and *2p* lateral furrows; preglabellar furrow broad *(sag., exsag.)*; eye lobes opposite, ahead, or behind *2p* glabellar lobes. Hypostoma without raised area in center of anterior lobe of middle body. Thorax with 12 or 13 segments. Pygidium with deep pleural furrows and shallow interpleural grooves extending close to margins of pleural regions. *M.Ord.-U.Ord., ?Sil.*

F. (Flexicalymene). Anterior side of preglabellar furrow inclined upward with no break in slope to sharp narrow crest of anterior border; anterior slope of border descending vertically to rostral suture (44, 347, 356). *M.Ord.-U.Ord., ?Sil.*, Eu.-N.Am.——FIG. 354,*1*. *F. senaria* (CONRAD), M.Ord., N.Am.; *1a-c*, ceph., dorsal, lateral, anterior; *1d,e*, hypostoma, exterior, lateral; all ×2 (496n).

F. (Reacalymene) SHIRLEY, 1936 [**Reacalymene limba* SHIRLEY, 1936]. Distinguished by abrupt change in slope between steep anterior edge of preglabellar furrow and surface of frontal area, which slopes gently up to outer edge of anterior border. *M.Ord.-U.Ord.*, Eu.-(Eng.), ?N.Am.

Gravicalymene SHIRLEY, 1936 [**G. convolva*]. Glabella with 3 pairs of lobes, none papillate; deep preglabellar furrow with anterior edge merging into thick *(sag.)* rolled anterior border. *U.Ord.-L. Dev.*, Wales-SE.Asia-Austral.-N.Z.——FIG. 353,*3*. **G. convolva*, U.Ord., Wales; *3a,b*, ceph., outline of middle portion, sagittal profile, ×1, ×1.75 (275*).

Liocalymene RAYMOND, 1916 [**Hemicrypturus clintonii* VANUXEM, 1842]. Glabella with 3 pairs of lateral lobes, apparently nonpapillate. Pygidium with smooth pleural regions. *L.Sil.-M.Sil.*, E.N.Am.

Metacalymene KEGEL, 1927 [**Calymene baylei* BARRANDE, 1846]. Exoskeleton less convex than typical in family, with outer parts of pleural regions curved downward less sharply. Glabella with 4 pairs of lateral furrows, *3p* furrows short and shallow, *3p* lobes faintly convex; small eye lobes opposite *3p* glabellar lobes; eye ridges well defined; frontal area continuing slope of frontal glabellar lobe, then flattening out and faintly ridged by low anterior border; lateral cephalic border low. Hypostoma with circular raised area in anterior part of anterior lobe of middle body. *U.Sil.*, Boh.——FIG. 354,*2*. **M. baylei* (BARRANDE); *2a,b*, ceph., dorsal, right lateral; *2c*, pyg.; all ×1.25 (496n).

Platycalymene SHIRLEY, 1936 [**Asaphus duplicatus* MURCHISON, 1839]. Like *Metacalymene* but only 3 pairs of lateral glabellar furrows and lobes and frontal area consisting of deep preglabellar furrow and convex rolled anterior border. *M.Ord.*, Br.I.-Swed.

Papillicalymene SHIRLEY, 1936 [**Calymmene papillata* LINDSTRÖM, 1885]. Glabella with *2p* and *3p* lateral lobes and anterolateral corner of frontal lobe papillate. *Sil.*, Swed.

Ptychometopus SCHMIDT, 1894 [**Calymene (P.) volborthi*]. Glabella with 3 pairs of lateral furrows; eye lobes opposite *2p* furrows; low ridges rising in front of extremity of preglabellar furrow run sideward across fixigenae near anterior border. Thorax with 11 segments. Pygidium with 4 axial rings and 3 pleural furrows. *L.Ord.*, USSR

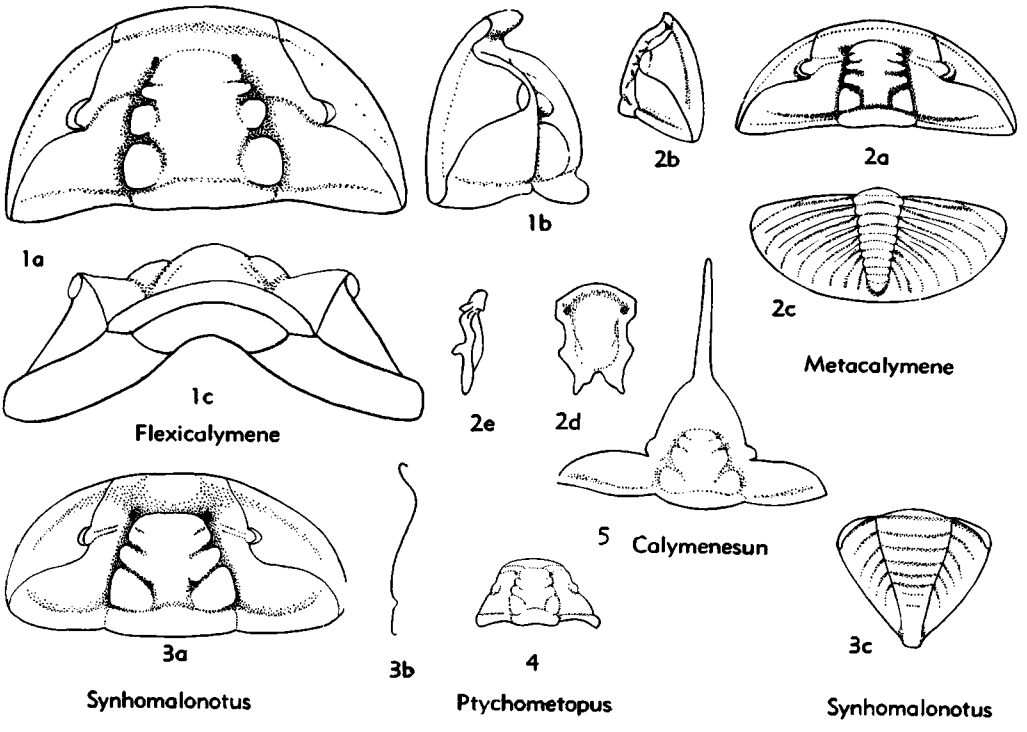


FIG. 354. Calymenidae (Calymeninae) (p. O452-O453).

(Balt.).——FIG. 354,*4*. **P. volborthi* (SCHMIDT); cran., ×1.5 (468).

Reedocalymene KOBAYASHI, 1951 [**Calymene unicornis* REED, 1917]. Like *Calymenesum* but frontal area comprising spatulate projection 1.5 times length *(sag.)* of glabella, with median part in front of glabella inflated and tapering anterior part with sagittal ridge (106). *Low.M.Ord.*, SW. China.

Synhomalonotus POMPECKJ, 1898 [**Calymene tristani* BRONGNIART, 1822]. Glabella subparabolic in outline, anterior margin straight medially, with 3 pairs of lateral glabellar furrows, *1p* furrows long and with slight forward turn at inner end, *3p* furrows short and faint; frontal area relatively long *(sag.)*, bent upward along sagittal line, with curvature strongest at anterior margin and diminishing toward preglabellar furrow; small eye lobes opposite *2p* or *3p* glabellar lobes. Pygidium almost as long as wide, tip projecting beyond pleural regions, with 6 or 7 axial rings and deep pleural furrows. [This genus is regarded by K. SDZUY as belonging to the Homalonotidae (Eohomalonotinae).] *L.Ord.-Low.M.Ord.*, Eng.-Wales, Fr.-Port.-S.Am.-N.Afr.-W.China. —— FIG. 354,*3*. **S. tristani* (BRONGNIART), Low.M.Ord., Fr.-Port.-N.Afr.; *3a,b*, ceph., dorsal, sagittal profile; *3c*, pyg.; all ×0.75 (496n).

Bathycheilus HOLUB, 1908 [**Dalmanites perplexus* BARRANDE, 1872]. Like *Pharostoma* (Pharostomatinae) but glabella with 2 lateral furrows and lobes, without convex oval areas at inner ends of *1p* (preoccipital) furrows, and much narrower across *2p* lobes than *1p* (preoccipital) lateral lobes; occipital furrow absent medially; axial furrows widen opposite preoccipital lobes into semicircular ala-like depressions; eye lobes exceptionally large for family, opposite *1p* glabellar lobes; eye ridges absent; course of facial sutures apparently as in *Pharostoma*. Cephalon surrounded by wide border described as channel (may be external mold of doublure) and continued by genal spines reaching back to pygidium. Hypostoma unknown. Thorax with more than 11 segments. Length of pygidium 0.75 of width. *Low.M.Ord.(Llanvirn.)*, Boh. ——FIG. 355. **B. perplexus* (BARRANDE); exoskel., ×2 (66*).

Pharostomina SDZUY, 1955 [**P. öpiki*] [=*Colpocoryphoides* HARRINGTON & LEANZA, 1957]. Differs from *Pharostoma* (Pharostomatinae) in that oval areas at inner ends of preoccipital lateral glabellar furrows are lacking; genae not markedly convex in front of eye lobes; genal spines short; no row of spines on under side of cephalic border. Hypostoma without median notch in posterior border. Pygidium with short posterior part of axis

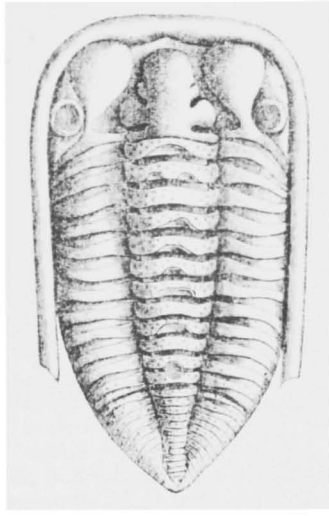


FIG. 355. **Bathycheilus perplexus* (BARRANDE) (Calymenidae), M.Ord.(Llanvirn.), Boh.; exoskel., ×2 (66).

and narrow pleural border. *L.Ord.*, Ger.-S.Am. ——FIG. 356. **P. oepiki*, Leimitz Sh., Tremadoc.; *a*, cran., ×4; *b*, fragmentary exoskel., ×5 (272).

Subfamily PHAROSTOMATINAE Hupé, 1953

[*nom. transl. et correct.* WHITTINGTON, herein (*ex* Pharostomidae HUPÉ, 1953)]

Glabella with 3 pairs of lateral furrows and lobes, with faintly convex oval areas outlined by narrow smooth zone at inner ends of *1p* (preoccipital) furrows; axial furrows widening opposite *1p* and *2p* lobes, most conspicuously opposite *1p* lobes; with deep anterior pit; small eye lobes opposite *2p* glabellar lobes; eye ridges distinct; genae most strongly convex in front of eye lobes; cephalic border broadest *(sag.)* anteriorly, prolonged laterally into genal spines, with row of close-set small spines on under side of border; posterior sections of facial sutures crossing lateral border furrows opposite preoccipital glabellar lobes and extending over borders to inner edge at genal angles. Hypostoma of typical calymenid form. Thorax with 13 segments, with broad *(tr.)*, horizontal inner parts, outer parts bent down vertically; pleural furrows deep. Pygidial axis with 6 rings and long, convex posterior part; pleural regions with deep pleural furrows. Surface tuberculate. *M.Ord.-U.Ord.*

Pharostoma HAWLE & CORDA, 1847 [**Calymene pulchra* BARRANDE, 1846] [=*Prionocheilus* ROUAULT, 1847]. Characters of subfamily. *M.Ord.-U. Ord.*, Eu.-Que.-Asia.——FIG. 357. **P. pulchrum* (BARRANDE), M.Ord., Boh.; *a*, exoskel., ×1.25; *b*, ceph., lateral, ×1.25; *c*, hypostoma, ×1.25 (496n).

Family HOMALONOTIDAE
E. J. Chapman, 1890

Cephalon with or without faintly defined broad border; glabella subtrapezoidal, with 4 or fewer pairs of glabellar furrows, usually shallow or may be entirely lacking, *1p* (preoccipital) furrows commonly bent sigmoidal; arcuate tracts (preglabellar areas) adjoining base of glabella on fixigenae commonly well defined by their independent convexity, absence of pitting, or faint bounding furrows; librigenal spines present only in oldest genus known; posterior sections of facial sutures in all later genera cutting margins of cephalon at genal angles or in front of them. Rostral suture commonly transverse, in primitive genera on lower side or at anterior margin of cephalon, in

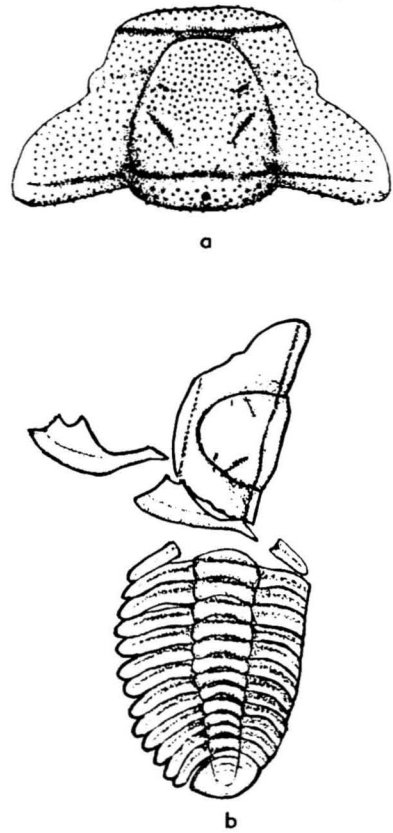


FIG. 356. **Pharostomina oepiki* SDZUY (Calymenidae), L.Ord., Ger.; *a*, cran., ×4; *b*, fragmentary exoskel., ×2.5 (272).

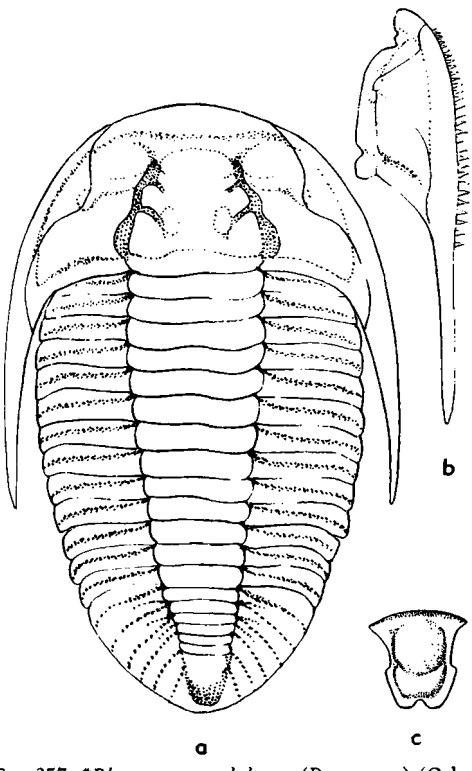


FIG. 357. **Pharostoma pulchrum* (BARRANDE) (Calymenidae), M.Ord., Boh.; *a*, exoskel., ×1; *b*, ceph., lateral, ×1; *c*, hypostoma, ×1.5 (496n).

advanced genera on upper side; rostral plate subtriangular, pointed behind. Hypostoma subquadrate to trapezoidal, with small anterior wings; posterior margin rounded in very primitive forms, indented in advanced. Thorax with 13 segments; axis well defined, moderately wide in early genera, indistinct and very broad in later ones; pleural extremities rounded or angular, never pointed. Pygidium transversely elliptical to elongate triangular in outline, strongly convex, with pleural regions bent downward somewhat strongly at sides; with few (primitive genera) to many segments (advanced genera). *L.Ord.-M.Dev.*

Subfamily BAVARILLINAE Sdzuy, 1957

Cephalon with ill-defined anteriorly widened border; anterior margin with short pointed or blunt projection; glabella trapezoidal, well defined, but axial furrows shallow, with 3 pairs of lateral glabellar furrows, *1p* (preoccipital) furrows sigmoidal and in some specimens bifurcated; eyes large, eye ridges transverse; posterior sections of facial sutures intersecting posterior margins of cephalon; librigenae provided with short spines. Rostral suture on lower side of cephalon. Hypostoma rounded behind. Thoracic axis well defined, only about 0.3 as wide as thorax. Pygidium much wider than long, composed of 2 or 3 segments. *L.Ord.*

Bavarilla BARRANDE, 1868 [**Conocephalites (Bavarilla) hofensis*]. Characters of subfamily. [This oldest known homalonotid is the only one incontestably having opisthoparian facial sutures and possessing the smallest pygidium. It may be ancestral to later Homalonotidae.] *L.Ord.*, Czech.-Ger. ——FIG. 358,*7*. **B. hofensis* (BARRANDE), L.Ord., Ger.; *7a*, exoskel. (reconstr.), ×1.5; *7b,c*, hypostoma, ×1.5 (470).

Subfamily EOHOMALONOTINAE Hupé, 1953

Cephalon usually with ill-defined anteriorly widened border; glabella subtrapezoidal, more or less rounded in front; usually with 2 to 4 pairs of lateral glabellar furrows, *1p* furrows sigmoidal; paraglabellar areas commonly outlined; eyes somewhat larger than in Homalonotinae; eye ridges usually present; posterior sections of facial sutures cutting genal angles; rostral suture on lower side of cephalon, at anterior margin, or on upper side close to it. Hypostoma rounded or indented behind. Thoracic axis usually well defined, width medium to large. Pygidium mostly triangular with strongly bent anterior margin, rarely parabolic in outline and longer than wide; trilobation and segmentation distinct, with 6 to 12 segments; ribs usually reaching margin of pygidium. *L.Ord.-U.Ord.*

Calymenella BERGERON, 1890 [**C. boisseli*]. Cephalon with ill-defined border; glabella defined by shallow but distinct axial furrows, with 2 or 3 pairs of weak lateral glabellar furrows, *1p* (preoccipital) sigmoidal; paraglabellar areas defined; eye ridges present, oblique; posterior sections of facial sutures intersecting margins of cephalon near genal angles. Rostral suture a wide even curve. Hypostoma with rounded or indented posterior margin. Thorax with distinctly set off axis of moderate width (appearing to be very broad because pleural regions are bent strongly downward). Pygidium wider than long, broadly triangular, with semicircular anterior margin; trilobation and segmentation distinct, with 6 to 8 segments; axis rapidly narrowing backward, not reaching posterior margin (179). *M.Ord.(Llandeil.)-U.Ord.*, Eng.-Fr.-Ger.-Czech.-Medit.-N.Afr.

C. **(Calymenella)**. Anterior margin of cephalon drawn out into blunt or pointed projection; front of glabella moderately rounded. Rostral suture on lower side or along anterior margin of cephalon. Pygidium with distinct interpleural grooves. [The projecting anterior cephalic margin is reminiscent of *Bavarilla,* whereas the rostral suture and segmentation of the pygidium correspond to characters of *Synhomalonotus.*] *M.Ord.(Llandeil.)-U.Ord.(Caradoc.),* Fr.-Ger.-Czech.-N.Afr. ——FIG. 358,*8*. **C. (C.) boisseli,* M.Ord., Fr.; *8a,b,* cran. (reconstr.), pyg., ×1 (377).——FIG. 358,*9*. *C. (C.) media* (BARRANDE), U.Ord., Czech.; exoskel. (reconstr.), ×0.9 (411*).

C. **(Eohomalonotus)** REED, 1918 [**Asaphus brongniarti* DESLONGCHAMPS, 1822]. Anterior margin of cephalon not projecting; front of glabella weakly rounded. Rostral suture on anterior margin of cephalon or close to it on upper side. Pygidium without distinct interpleural grooves. *M.Ord.(Llandeil.)-U.Ord.,* Eng.-Fr.-Czech.-Medit. ——FIG. 358,*3a,b*. **C. (E.) brongniarti* (DESLONGCHAMPS), M.Ord., Fr.; *3a,* cran. (reconstr.), ×1.1 (348, 470n); *3b,* pyg., ×1.1 (461n).——FIG. 358,*3c*. *C. (E.) bohemicus* (BARRANDE), M. Ord., Czech.; hypostoma, ×1.1 (370).

Synhomalonotus POMPECKJ, 1898 [**Calymene tristani* BRONGNIART, 1822]. Described (p. 453) as genus of Calymenidae but believed by SDZUY to belong in this subfamily of the Homalonotidae, as indicated by shape of glabella, nature of cephalic border, presence of distinct paraglabellar areas, and general cuneiform shape of exoskeleton. The exceptional relief of the cephalon is not viewed as a significant taxonomic character indicating calymenid affinities. Illustrations of the type species given here differ slightly from those in Fig. 354,*3,* for example, in showing paraglabellar areas of the cephalon; sources of the compared figures are not exactly the same.——FIG. 359,*2*. **S. tristani* (BRONGNIART), M.Ord., Medit.; *2a,b,* cran., pyg., ×1 (470n).

Brongniartella REED, 1918 [*pro Brongniartia* SALTER, 1865 (*non* LEACH, 1824; *nec* EATON, 1832)] [**Homalonotus bisulcatus* SALTER, 1851]. Cephalon semicircular to semielliptical, without border; glabella well defined, urceolate to tapering forward, generally unfurrowed; axial furrows strongly converging forward at sides of occipital ring; paraglabellar areas outlined in some specimens; frontal area rather wide; posterior sections of facial sutures intersecting margins of cephalon near genal angles. Rostral suture a wide curve on upper side of cephalon near or on anterior margin. Thorax with wide, indistinctly marked axis. Pygidium rounded, parabolic, longer than wide, with rather indistinct border; axis well defined, ending considerably in front of posterior margin, with 9 to 12 segments and a postaxial ridge in some forms; ribs not extended to lateral margins of pygidium. [*Brongniartella* differs from other Eohomalonotinae in lack of a cephalic border; usually unlobed glabella; shape of occipital ring; indistinct, broad thoracic axis, and shape, length, and border of the pygidium. In these features the genus approaches the Homalonotinae.]. *U.Ord.,* Eu.-N.Afr.-N.Am. ——FIG. 358,*1*. **B. bisulcata* (SALTER), Eng.; *1a,b,* ceph., pyg., ×0.5 (466).

Subfamily COLPOCORYPHINAE Hupé, 1955

Cephalon semicircular or semielliptical, much wider than long; border defined in front only, very narrow, touching front of glabella, in anterior view strongly bent down at sides; glabella narrowing forward considerably, with smoothly convex sides, anterior end truncate, circumglabellar furrows sharp and rather deep, with 2 to 4 pairs of lateral glabellar furrows, *1p* bent backward in simple curve; paraglabellar areas present or absent; eyes usually far forward, eye lobes strikingly small, not elevated above genae, hardly interrupting general course of facial sutures; weak eye ridges may be present; fixigenae very wide *(tr.);* posterior sections of facial sutures forming evenly convex curves that cut margins of cephalon near genal angles. Rostral suture apparently on anterior margin. Thorax with well-marked moderately wide axis. Pygidium transversely elliptical or subtriangular, wider than long; trilobation distinct; axis nearly reaching posterior margin; segmentation reduced. [*Colpocoryphe* and *Plaesiacomia,* previously assigned to different families, agree well in essential characters. They are interpreted to represent a separate line of homalonotid specialization in which *Plaesiacomia* seems to be more advanced than *Colpocoryphe.*] *L.Ord.-M.Ord.(Llandeil.).*

Colpocoryphe NOVÁK in PERNER, 1918 [**Calymene arago* ROUAULT, 1849] [="Gruppe der *Calymmene arago*" POMPECKJ, 1898]. Cephalon convex, much wider than long; glabella occupying less than 0.3 of cephalic width (in dorsal view seemingly more than 0.3 because of convexity of cephalon); with 3 or 4 pairs of distinct lateral glabellar furrows, *1p* and *2p* furrows deep; eye ridges rather weak. Thorax with moderately wide axis. Pygidium triangular, with strongly curved anterior margin; axis with 8 or fewer rings, extended nearly to posterior margin, connected to it by short postaxial ridge; pleural fields behind articulating half rib nearly smooth, with 2 or 3 very indistinct ribs; wide border distinctly set off by marked change in convexity. *L.Ord.-M.Ord. (Llandeil.),* Fr.-Czech.-Medit.-N.Afr.-N.Am.(Fla.)-China.——FIGS. 358,*5,* 359,*1*. **C. arago* (ROU-

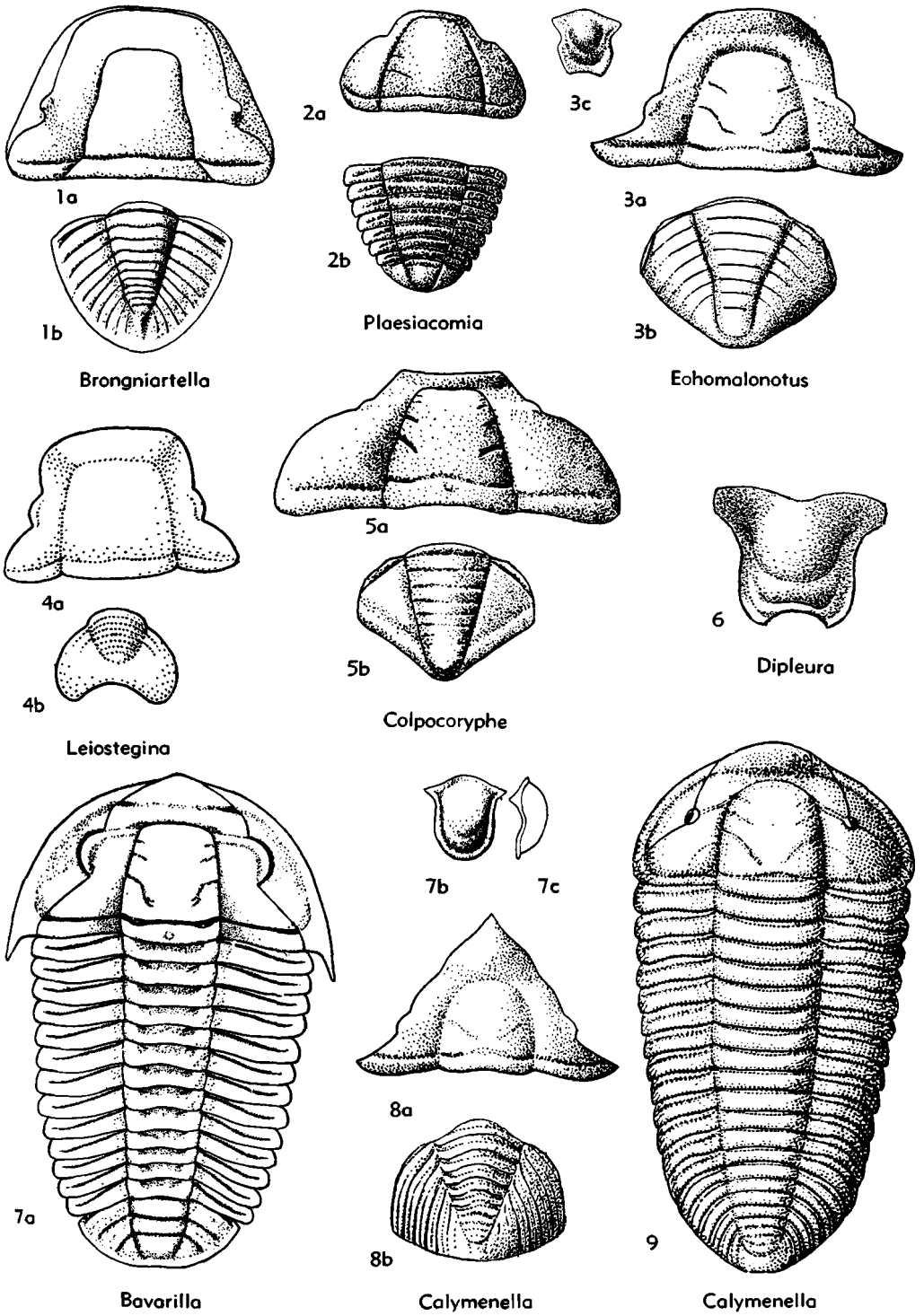


FIG. 358. Homalonotidae (Bavarillinae, Eohomalonotinae, Colpocoryphinae, Homalonotinae) (p. O455-O460).

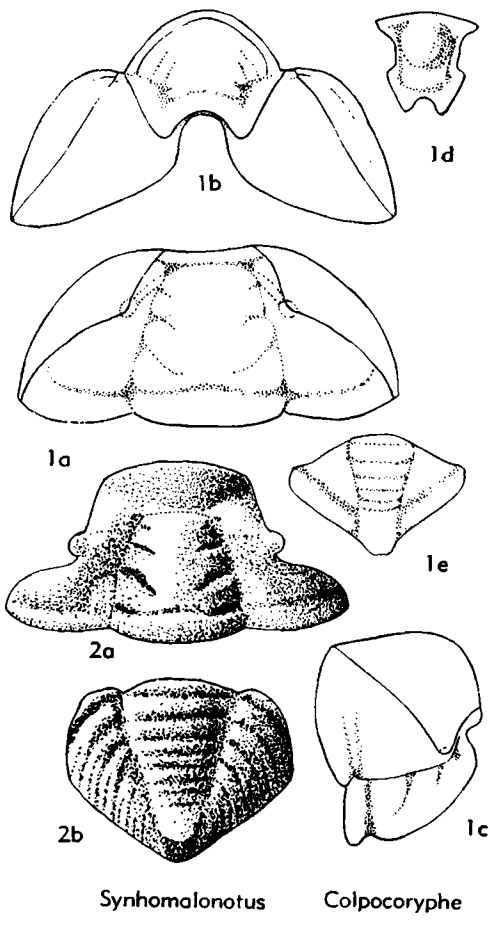


FIG. 359. Homalonotidae (Eohomalonotinae, Colpocoryphinae) (p. O456).

AULT), M.Ord., Czech.; 358,*5a,b*, cran., pyg., ×1.5 (470n); 359,*1a-c*, ceph., dorsal, front, side, ×1.5; 359,*1d,e*, hypostoma, pyg, ×1.5 (496).

Plaesiacomia HAWLE & CORDA, 1847 [**P. rara*]. Cephalon convex, semicircular; glabella broader than genae, with 2 or 3 pairs of weakly impressed lateral glabellar furrows; paraglabellar areas present, eye ridges lacking. Thoracic axis wide. Pygidium small, much wider than long, transversely elliptical; axis triangular, narrowing backward rapidly, nearly reaching posterior margin; only a single axial ring; pleural regions smooth. [*Plaesiacomia* differs from *Colpocoryphe* in its smaller pygidium.] *M.Ord.(Llandeil.)*, Fr.-Czech.-N.Afr.-?Medit.——FIG. 358,*2*. **P. rara*, Czech.; *2a,b*, ceph., pyg., and part of thorax, ×3.5 (370).

?Leiostegina KOBAYASHI, 1937 [**L. inexpectans*]. Cranidium subtrapezoidal; glabella long, truncate tapering, smooth; eyes small, at mid-length of cranidium; fixigenae narrow *(tr.)*; facial sutures parallel in front of eyes and diagonal behind them. Pygidium convex, relatively small, with posterior margin bent up at middle; axis tapering, with 8 rings; marginal brim narrow, ill defined. *U.Ord.(Caradoc.)*, Bol.——FIG. 358,*4*. **L. inexpectans*; cran., pyg., ×1 (425).

Subfamily HOMALONOTINAE E. J. Chapman, 1890

[*nom. transl.* HUPÉ, 1953 (*ex* Homalonotidae E. J. CHAPMAN, 1890) [=Trimerinae HUPÉ, 1953]

Cephalon tending to be subtriangular in outline, moderately convex; border almost invariably lacking; glabella urceolate to trapezoidal, lateral glabellar furrows indistinct or absent; axial furrows shallow, generally not defined at sides of occipital ring; paraglabellar areas commonly distinct; eyes small, rising high on convex genae; posterior sections of facial sutures cutting margin of cephalon at or in front of genal angles. Rostral suture uniformly on upper side of cephalon. Hypostoma subquadrate, with small to medium-sized anterior wings and deeply indented posterior margin. Thorax with very wide axis, trilobation tending to be very indistinct. Pygidium longer than wide, triangular, rarely semicircular to parabolic; composed of many segments; axis in most genera triangular in outline, very broad anteriorly, trilobation commonly indistinct but segmentation mostly well defined. *M.Sil.-M.Dev.*

Homalonotus KÖNIG, 1825 [**H. knighti*] [=*Koenigia* SALTER, 1865 (obj.)]. Cephalon much wider than long, seemingly with sharply defined border, touching glabella along the front, deep indentations at sides of rostral plate making anterior margin tricuspid, margin appearing strongly folded in anterior view; dorsal surface of cephalon convex upward, middle part with rostral plate being convex downward; glabella trapezoidal, slightly narrowing forward, sharply cut off in front by border, glabellar lobation indistinct; paraglabellar areas fairly well marked; posterior sections of facial sutures cutting margins near genal angles. Rostral suture not far from front of glabella, transverse, with small median point; rostral plate without spine. Thorax and pygidium with trilobation very indistinct. Pygidium triangular, pointed behind, segmentation distinct except in posterior portion. [As remarked by REED (1918), this genus is specialized and hardly typical of the family. Interpretation of structure of anterior portion of cephalon is difficult; the border seems not to have been described previously even though shown clearly in published figures.] *U.Sil.*,

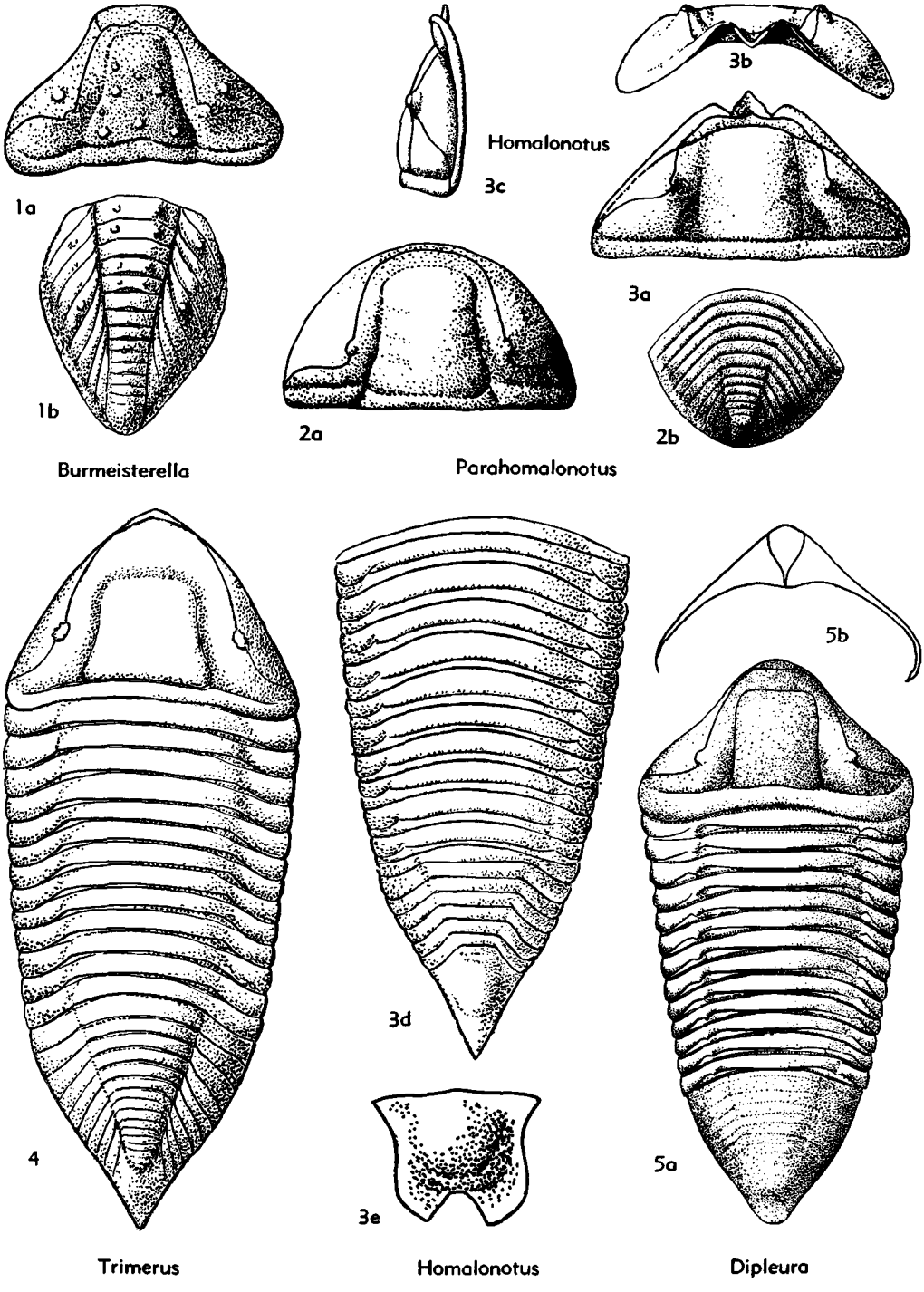


FIG. 360. Homalonotidae (Homalonotinae) (p. O458-O461).

Eng.-Swed.-Nova Scotia.——Fig. 360,*3a-c*. *H. rhinotropis* Angelin, Swed.; *3a,b*, ceph. (reconstr.), dorsal, anterior, ×0.5 (431); *3c*, ceph., lateral, ×0.5 (368).——Fig. 360,*3d,e*. **H. knighti*, Eng.; *3d,e*, thorax with pygidium, hypostoma, ×0.6, ×1 (466).

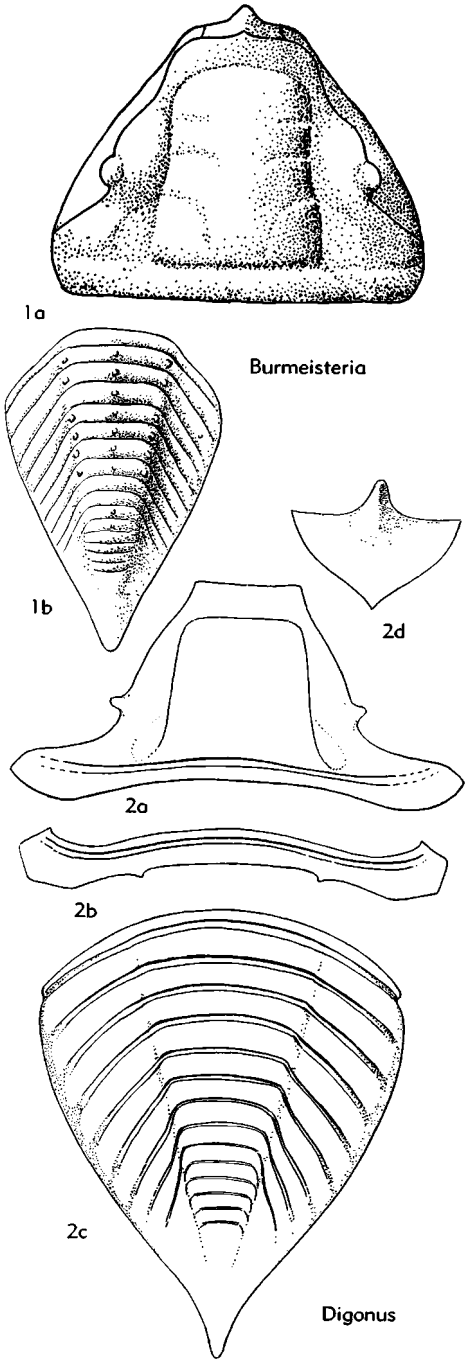


Fig. 361. Homalonotidae (Homalonotinae) (p. O460-O461).

Trimerus Green, 1832 [**T. delphinocephalus*]. Cephalon subtriangular, without border; glabella subtrapezoidal, with indistinct lobation, postsutural portion of frontal area large. Rostral plate smooth. Thoracic axis very poorly defined. Pygidium triangular; axis not extended to posterior margin. [Closely related to *Burmeisteria*.] *M.Sil.-M.Dev.*, N. Eu.-N. Am.-S. Am.-N. Afr.-?Austral.-Mongol.

T. (Trimerus). Cephalon more than a half as long as wide, glabella slightly narrowing forward, some species with indistinct lobation; paraglabellar areas defined. Rostral suture forming somewhat pointed arch close to anterior margin. Pygidium acuminate behind, with faint trilobation but distinct segmentation. *M.Sil.* N.Eu.-N. Am.-?Austral.-Mongolia.——Fig. 360,*4*. **T. (T.) delphinocephalus*, N.Y.; exoskel. (reconstr.), ×0.6 (403).

T. (Dipleura) Green, 1832 [**D. dekayi*]. Cephalon less than half as long as wide; glabella almost imperceptibly narrowing forward, lobation recognizable only in young stages; paraglabellar areas not distinct. Rostral suture tending to become straight transverse. Pygidium obtusely pointed behind, with very indistinct trilobation and segmentation. [Reed (1918) has emphasized the straight rostral suture as characteristic of *Dipleura* but many published figures of the type species indicate great variation.] *L.Dev.-M.Dev.*, N.Am.-S.Am.-Ger.-N.Afr.——Figs. 358,*6*; 360,*5*. **T. (D.) dekayi*, M.Dev., N.Y.; 358,*6*, hypostoma, ×1 (404); 360,*5a,b*, exoskel. (reconstr.), cephalic doublure with rostral plate, ×0.5 (404).

Burmeisteria Salter, 1865 [**Homalonotus herschelii* Murchison, 1839]. Cephalon subtriangular, without border; glabella urceolate to trapezoidal; paraglabellar areas distinct; postsutural portion of frontal area of moderate size. Rostral suture transverse, more or less straight; rostral plate with short blunt median spine. Thorax with very broad axis and indistinct trilobation. Pygidium triangular, pointed behind; axis not reaching posterior margin; trilobation and segmentation fairly distinct. [On basis of type species only, *Burmeisteria* and *Digonus* might be accepted as independent genera, but South African species indicate that assignment of subgeneric rank is appropriate.]. *?U.Sil., L.Dev.*, Eu.-Afr.-S.Am.-N.Z.

B. (Burmeisteria). Glabella urceolate, slightly tapering forward, distinctly lobate; rostral suture composed of 2 slightly sigmoidal halves meeting in weak median point or straight across. Whole exoskeleton may be ornamented by scattered spines. *L.Dev.*, S.Afr.-Sahara-Malvin I.-N.Z.——Fig. 361,*1*. **B. (B.) herschelii* (Murchison), Afr.; *1a*, ceph., ×0.8 (470n); *1b*, pyg., ×0.8 (466).

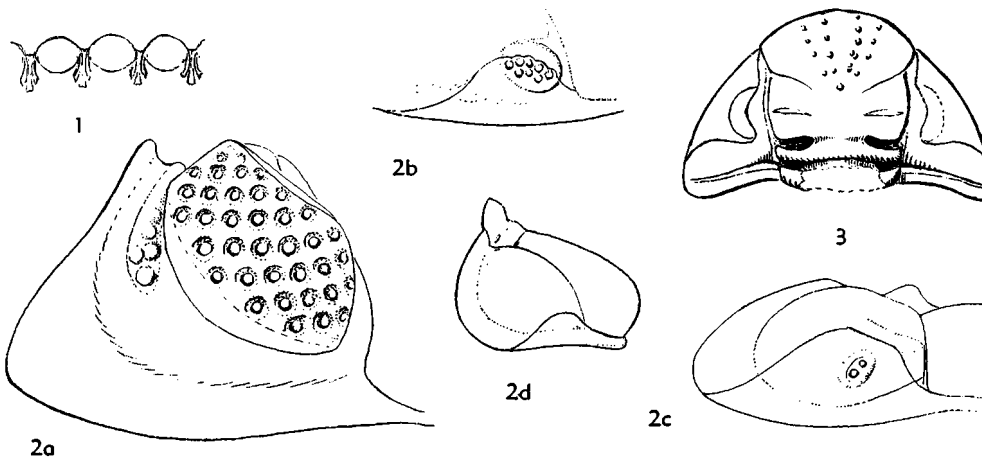


FIG. 362. Morphological features of Phacopina.——*1*, Section through schizochroal lenses of eye of *Phacops schlotheimi*, M.Dev., Ger.; ×15 (424, 1901).——*2a-d*, Degeneration of schizochroal eyes of Phacopinae, showing diminished number of lenses accompanied by reduction and ultimate disappearance of palpebral lobes and by alteration in course of facial sutures as evolution progresses; *2a, Phacops latifrons*, M.Dev., Ger., with normal eyes, ×2.5; *2b, Cryphops cryptophthalmus*, U.Dev., Ger., with reduced eyes (*cryptophthalmus* pattern), ×7; *2c, Nephranops incisus incisus*, U.Dev., Ger., with vestigial lenses, ×2; *2d, N. incisus dillanus*, U.Dev., Ger., showing absence of eyes and palpebral lobes and change in facial sutures, ×2 (all 460, 1933).——*3, Acastoides henni*, L.Dev., Ger., showing radially arranged nodes on frontal lobe of glabella (internal mold), possibly representing scars of muscle attachment, ×2 (244).

B. (Digonus) GÜRICH, 1909 [**Homalonotus gigas* F. A. ROEMER, 1843]. Glabella trapezoidal, broad, without lobation; anterior sections of facial sutures bending abruptly into straight or slightly concave rostral suture. Pleural ends of thoracic segments angular (type species). *?U.Sil., L.Dev.*, Belg.-Ger.-?Eng.-Medit.-N.Afr.-S.Afr.-Bol.-Brazil-?Arg.-N.Z.——FIG. 361,*2*. **B. (D.) gigas* (F. A. ROEMER), L.Dev., Ger.; *2a-d*, cran., thoracic segment, pyg., rostral plate, ×1.5 (461n).

Burmeisterella REED, 1918 [**Homalonotus (Burmeisteria) elongatus* SALTER, 1865]. Cephalon (unknown in type species) subtriangular, without border; glabella subtrapezoidal; paraglabellar areas more or less distinct; postsutural portion of frontal area very narrow. Rostral suture transverse, straight or gently curved, in some with small median point; rostral plate with stout median prominence. Thoracic axis faintly marked. Pygidium parabolic in outline, rounded or pointed behind, surrounded by smooth narrow border; axis rather narrow, distinct, reaching to or nearly to posterior margin, may bear 1 or 2 terminal spines. Surface ornamented by regularly spaced spines. *L.Dev.*, Eng.-Belg.-Ger.——FIG. 360,*1a*, **B. bifurcata* REED, Eng.; ceph. (reconstr.), ×0.5 (452).——FIG. 360,*1b*. **B. elongata* (SALTER), Eng.; pyg., ×0.5 (466).

Parahomalonotus REED, 1918 [**Homalonotus gervillei* DE VERNEUIL, 1850]. Cephalon semicircular, without border; glabella slightly urceolate, with gently rounded front, some species with indistinct lobation; paraglabellar areas not known. Rostral suture regularly arched close to anterior margin; rostral plate apparently smooth. Thorax with obsolete trilobation. Pygidium semicircular or semioval, little longer than wide, with strongly curved anterior margin; narrow ill-defined border not crossed by ribs; axis of moderate width, anterior part poorly defined, not quite reaching posterior margin but connected to it by postaxial ridge; segmentation generally distinct. *L.Dev.*, Fr.-Ger.-N.Afr.——FIG. 360,*2*. **P. gervillei* (VERNEUIL), Fr.; *2a,b*, ceph., pyg. (reconstr.), ×0.5 (373, 470n).

Suborder PHACOPINA Struve, nov.

[=Superfamily Phacopidae RUD. RICHTER, 1933; Phacopidacea DELO, 1935; Phacopacea HENNINGSMOEN, 1951; Phacopoidae HUPÉ, 1953] [The first author to define main features of this assemblage seems to have been QUENSTEDT (1837, Wiegmann's Arch. Naturgesch., Berlin, Jahrg. 3, Band 1, p. 343), although he cannot be recognized as its nomenclatural author. —W. STRUVE.] [Type—*Phacops* EMMRICH, 1839] [*Authorship*. The following diagnosis and discussion of Phacopina was contributed by RUD. RICHTER.]

Cephalon with schizochroal eyes, proparian facial sutures, supramarginal or marginal in front without rostral plate. Thorax with 11 segments, pleurae furrowed, articulating facets distinct. *L.Ord.-Up.U.Dev.*

The schizochroal eyes (Fig. 362) of Phacopina are generally well developed and in many genera quite large. However, several genera (especially belonging to the Phacopinae and Phacopidellinae) display a gradual degeneration of eyes (Fig. 362,*2a-d*), during

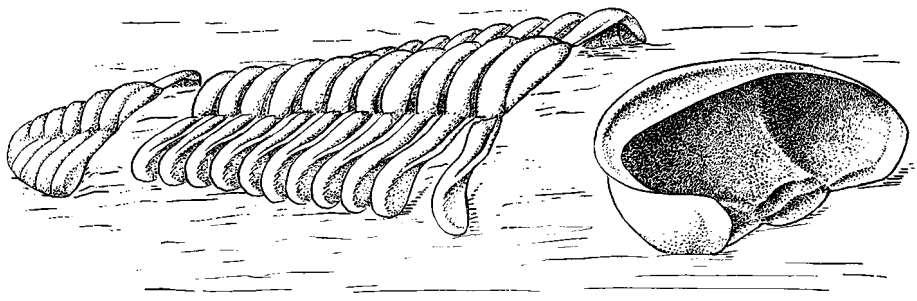


FIG. 363. Displaced parts of exoskeleton of *Trimerocephalus* as left behind after the "Salterian mode of molting," hypostoma not shown (reconstr.), ×2.7 (460, 1942).

which the facial sutures tend to straighten and migrate outward (Fig. 291*A-F*). The vestigal eyes move toward anterior corners of the genae, remaining reniform *(Nephranops)* or more commonly becoming elliptical in outline (*cryptophthalmus* pattern); the facial sutures may shift close to the cephalic margin and eventually become entirely marginal *(Ductina)*. On the frontal lobe, pits (or nodes by reversion of relief) may appear, perhaps representing scars of stomach muscles (Fig. 362,*3*); they are arranged in a radiating pattern.

Even in forms with normal eyes, the facial sutures are ankylosed in some genera (Phacopinae, especially *Phacops,* and Phacopidellinae) so that in ecdysis and death, librigenae remain connected with the cranidium. In several genera with ankylosed sutures and degenerated eyes (e.g., *Trimerocephalus, Nephranops, Cryphops, Dianops, Denckmannites*), the molting animal evidently emerged from the exoskeleton between cephalon and thorax, the cephalon being turned upside down with the back forward and entirely separated from the thorax; this is the "Salterian mode of molting" (RUD. RICHTER, 1937; Fig. 363). When in eyeless genera the sutures migrate into a marginal position, they become functional again, allowing parts of the animal inside the carapace to be extruded forward between the cephalon and doublure (as typically in *Harpes, Limulus, Triops*), with thorax and cephalon remaining connected; this is the *"Ductina* mode of molting" (RICHTER & RICHTER, 1926). In *Trimerocephalus,* as MAKSIMOVA (1955) has pointed out, the type of molting undergoes change during ontogeny from the *Ductina* mode to the Salterian mode.

Superfamily PHACOPACEA Hawle & Corda, 1847

[*nom. transl.* RUD. RICHTER, 1933; *nom. correct.* HENNINGSMOEN, 1951 (*pro* Phacopidea RUD. RICHTER, 1933)] [=Phacopoidae HUPÉ, 1953]

Micropygous. Cephalon with strongly divergent axial furrows; glabella with frontal lobe generally obliterating frontal area and fusing with *3p* and *2p* lateral glabellar lobes to form a single tricomposite lobe that in most genera is distinctly separated from an "intercalating ring" (connected *1p* lobes); *3p* lateral furrows definitely bipartite but *2p* furrows single and faint to obsolete in most genera; eyes in anterior position; genal angles generally well rounded and lacking genal spines; vincular furrow generally present. *Sil.-U.Dev.*

Family PHACOPIDAE Hawle & Corda, 1847

[*nom. correct.* SALTER, 1864 (*pro* family Phacopides HAWLE & CORDA, 1847)] [*Authorship.* The selection of genera assigned to this family and their arrangement in subfamilies is by RUD. RICHTER, who also furnished data on all genera, except *Plagiolaria*, prepared by W. STRUVE.]

Glabella broadening markedly forward, with *2p* and *3p* lateral glabellar furrows obsolescent, *3p* furrows (?composite) consisting of an anterior branch subparallel to axial furrows and a posterior branch directed transversely (except *Bouleia*), *1p* furrows transglabellar (with some exceptions) so that *1p* glabellar lobes thus form a more or less distinct "intercalating ring"; genal angles rounded, lobiform, or angular, no genal spines. Thoracic pleurae with rounded ends. Pygidium well rounded, semicircular or shorter, margin entire, without lateral and posterior projections. *Sil.-U.Dev.*

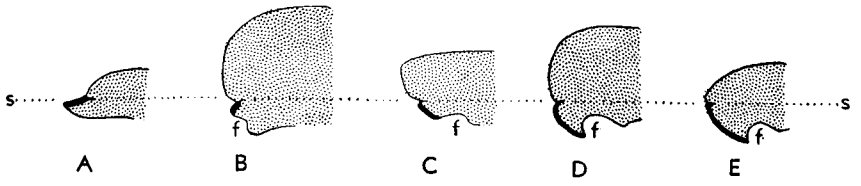


FIG. 364. Sagittal sections through anterior part of phacopid cephala aligned on intersections of facial sutures (s—s), beneath which thick lines denote cephalic border and "f" the vincular furrow (*A*, dalmanitid genera; *B, Phacops; C, Trimerocephalus; D, Nephranops; E, Dianops; B-E* belong to Phacopinae) (247).

Subfamily PHACOPINAE Hawle & Corda, 1847

[*nom. transl.* REED, 1905 (*ex* Phacopidae HAWLE & CORDA, 1847)]

Exoskeleton compact. Glabella inflated, anterior slope steep or overhanging, "intercalating ring" separated from anterior part of glabella at least by shallow depression (except *Eocryphops, Dianops*), that commonly is very distinct, with tendency to decay in isolated nodes; subcephalic furrow (Fig. 364) on doublure continuous along whole cephalon (but in *Eophacops* and *Reedops* reduced mesially). [The edge of the pygidium and ends of the pleurae fit into the subcephalic (vincular) furrow, when the body is enrolled; initially simple, the furrow may be modified to fit better into a series of pits (Fig. 365,*6b*).] Hypostoma triangular to trapezoidal, wings inclined vertically, posterior margin denticulated in some genera (Fig. 365,*7d,e*). Pygidium short. *Sil.-U.Dev.*

Phacops EMMRICH, 1839 [**Calymmene latifrons* BRONN, 1825; SD BARRANDE, 1852] [=*?Somatrikelon* MCMURTRIE, 1819; *Portlockia* M'COY, 1846; *?Somatrikopon* VOGDES, 1925]. Vincular furrow continuous, rear edge sharp, higher than anterior; marginal ridge narrow, doublure concave. Hypostoma elongate, posterior margin with 3 denticles. *Sil.-Dev.*, cosmop.——FIG. 365,*7a,b*. **P. latifrons* (BRONN), M.Dev., Ger.(Gerolstein); *7a,b*, ceph., dorsal, side, ×1.2 (461n).——FIGS. 365,*7c*; 366,*2*. *P. schlotheimi* (BRONN), M.Dev., Ger. (Gees, Gerolstein); 365,*7c*, enrolled specimen showing pygidium and doublure of cephalon with vincular furrow, ×2; 366,*2*, enrolled specimen (librigena shaded), ×4 (461).——FIG. 365,*7d,e*. *P. fecundus* BARRANDE, L.Dev., Czech.; *7d,e*, hypostoma, exterior and side, ×1 (3). [Other species illustrated in Figs. 290, 291, showing comparisons with Proetidae.]

Cryphops RICHTER & RICHTER, 1926 [*nom. conserv.* proposed STRUVE, 1958 (ICZN pend.)] [**Phacops cryptophthalmus* EMMRICH, 1844] [=*Microphthalmus* GORTANI, 1907 (*non* MECHNIKOV, 1865) (obj.); *Gortania* COSSMANN, 1909 (obj.)]. Eyes very small, with *cryptophthalmus* pattern; border broad, vincular furrow wide, deep; doublure short, concave. Pygidium very short and broad *(tr.)*. *U.Dev.*, Eu.——FIG. 365,*1*. **C. cryptophthalmus* (EMMRICH), Ger. (Oberscheld); *1a,b*, ceph., dorsal, side; *1c*, ceph., anterior edge from below showing vincular furrow; all ×4 (461).

Dereimsia KOZLOWSKI, 1923 [**Phacops (Dereimsia) sphaericeps*]. Glabella hemispherical, without traces of *2p* and *3p* lateral glabellar furrows, *1p* furrow and occipital furrow, both indicated by lateral pits that unite to form groove; *1p* glabellar lobes replaced by a depression (as in *Phacops accipitrinus* PHILLIPS, Fig. 209*F*); occipital ring elevated. *Dev.*, Bol.——FIG. 365,*5*. **D. sphaericeps* (KOZLOWSKI); cephalon, dorsal view, ×1 (111).

Dianops RICHTER & RICHTER, 1923 [**Phacops limbatus* REINH. RICHTER, 1848]. Glabella inflated, with truncated lateral corners, axial furrows curved inward, lateral glabellar furrows faint (especially *2p*), *3p* fading mesially so that here "intercalating ring" coalesces anteriorly; eyes absent; facial sutures restricted to border, marginal in front, not transecting border furrow; genae strongly vaulted; border very broad at genal angles where border furrow diminishes; vincular furrow deep, broad, with anterior edge higher than posterior; doublure long, even. Pygidium rather long, length 0.5 of width, transversely vaulted; posterior border slightly curved, anterior angulated; axial furrows and segmentation indistinct. *U.Dev.*, Eu.——FIG. 365,*2a,b*. **D. limbatus* (REINH. RICHTER), Ger. (Saalfeld), *2a,b*, ceph., dorsal, side, ×3 (461).——FIG. 365,*2c*. *D. anophthalmus* (FRECH), Ger. (Ebersdorf); ceph. from below, showing vincular furrow, ×3 (461).

Eocryphops RICHTER & RICHTER, 1931 [**Phacops kayseri* HERRMANN, 1909]. Eyes small with few lenses (*cryptophthalmus* pattern); genal angles with curved indentation, against which anterior pleurae fit; *1p* lateral glabellar furrows faint mesially. Pygidium not shorter than in *Phacops*. *Low.M.Dev.*, Eu.-N.Afr.——FIGS. 366,*1*; 367,*1*. **E. kayseri* (HERRMANN), Ger. (Marburg); 366,*1*, enrolled specimen (librigena shaded), ×6.7 (461); 367,*1a,b*, ceph., dorsal, anterior, ×1.5 (251).

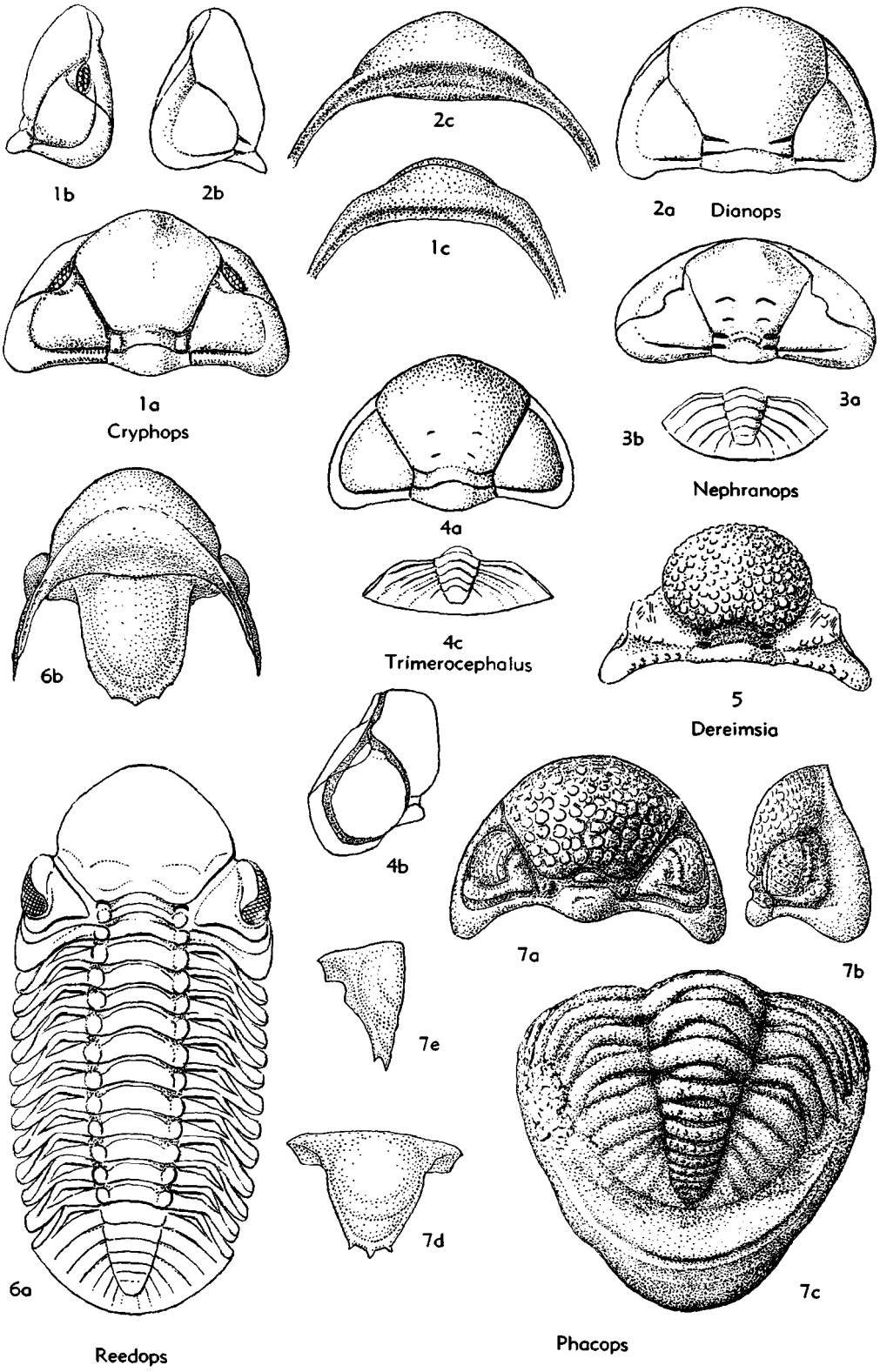
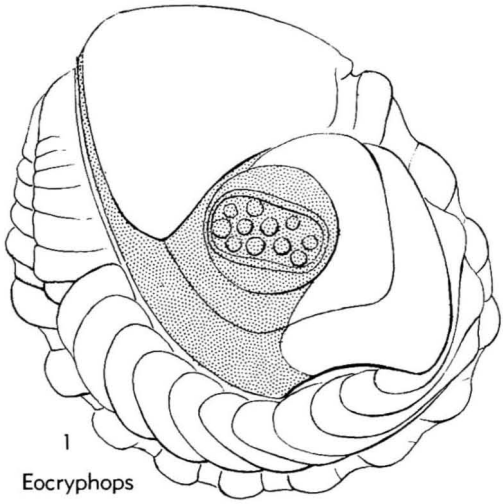


FIG. 365. Phacopidae (Phacopinae, Subfamily Uncertain) (p. O463-O466).

Eophacops DELO, 1935 [**Phacops handwerki* WELLER, 1907]. Small, cephalon with vincular furrow present laterally; doublure concave; glabella curving gently downward to anterior margin, not overhanging; axial furrows not diverging laterally. *M.Sil.*, N.Am.-NW.Eu.——FIG. 368. **E. handwerki* (WELLER), Ill. (Chicago); *a,b*, exoskel., ceph., ×2 (491).

Nephranops RICHTER & RICHTER, 1926 [**Phacops (Trimerocephalus) incisus* F. A. ROEMER, 1866]. Eyes degenerating but visual area or homologous field retains kidney-shaped outline of eyes in



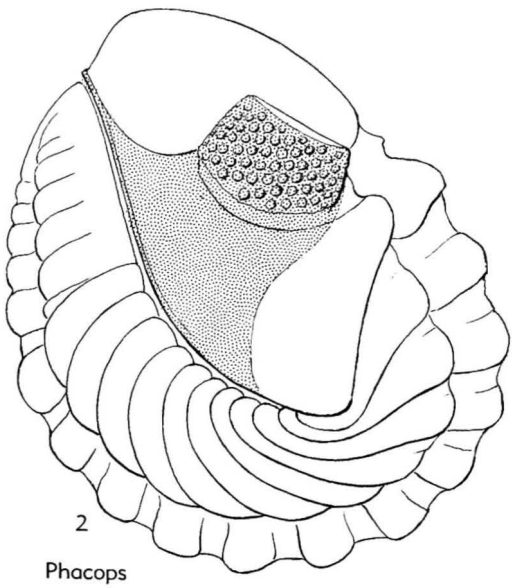


FIG. 366. Phacopidae (Phacopinae); enrolled specimens, M.Dev., Ger. (*1, Eocryphops kayseri; 2, Phacops schlotheimi*).

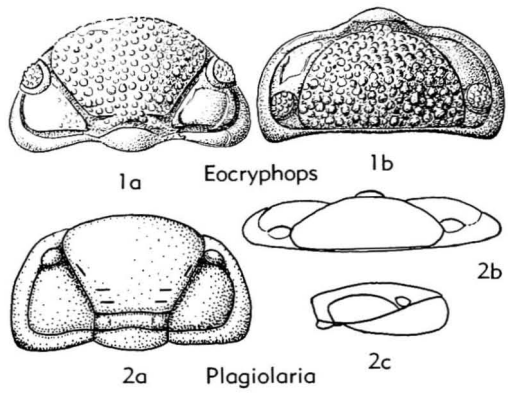


FIG. 367. Phacopidae (Phacopinae) (p. O463-O465).

Phacops, eyes of some species provided with about 10 lenses, a few with 2 lenses, and others with none; palpebral lobes invariably present, elevated; vincular furrow broad, with overhanging anterior edge, marginal ridge broad; doublure very short. Pygidium rather large, segmentation not pronounced. *U.Dev.*, Eu.——FIG. 365,*3*. **N. incisus incisus* (F. A. ROEMER), Ger. (Oberscheld); *3a,b*, ceph., pyg., ×1.5 (461).

Plagiolaria KEGEL, 1952 [*pro Plagiops* KEGEL, 1932 (*non* AMYOT, 1846; *nec* TOWNSEND, 1912; *nec* CRESSON, 1918] [**Phacops plagiophthalmus* REINH. RICHTER, 1865]. Similar to *Cryphops,* with generally broad cephalic border but very narrow below frontal lobe of glabella; border furrow in front of eyes faint to obsolete; glabella subtrapezoidal in outline, with anterior margin a gently curved line, "intercalating ring" flat, *1p* lobes slightly detached, transglabellar furrow connecting *1p* furrows nearly straight, clearly visible; occipital ring about as broad as "intercalating ring"; eyes of *cryptophthalmus* pattern on somewhat rounded

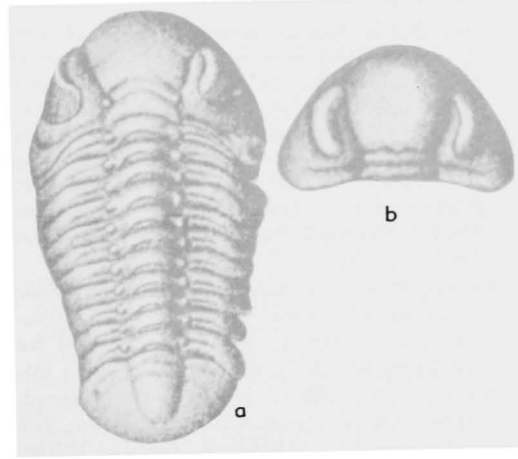


FIG. 368. **Eophacops handwerki* (WELLER), M.Sil., Ill.; *a,b*, exoskel., ceph., ×2 (491).

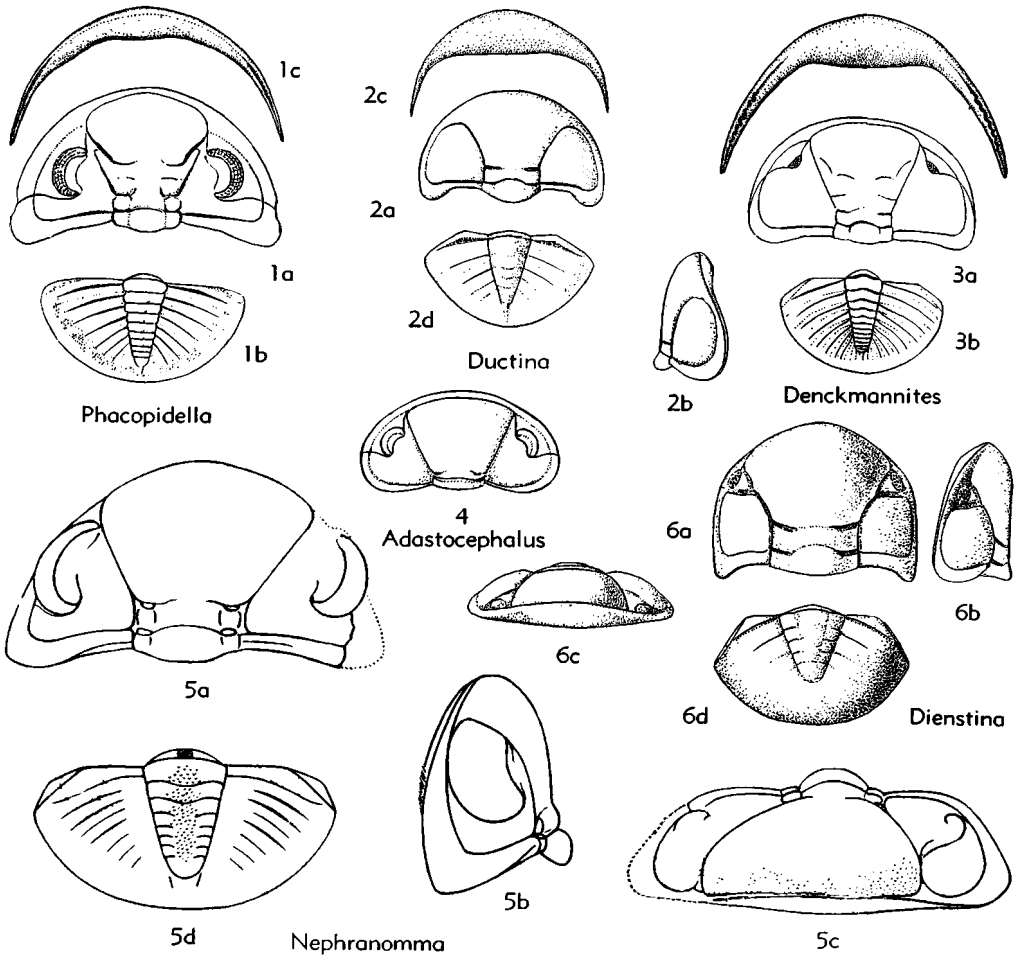


FIG. 369. Phacopidae (Phacopidellinae) (O467-O468).

knob that is separated posteriorly by broad deep furrow extending from axial furrows to lateral border furrows; vincular furrow continuous along whole subcephalic edge. Pygidium transversely elongate; with 6 distinct axial rings; pleural fields with 5 pairs of ribs that indicate border by fading away distally. *M.Dev.*, Ger.——FIG. 367,*2*. **P. plagiophthalmus* (REINH. RICHTER), Tentaculiten-Schiefer, Thuringia; *2a-c*, ceph., dorsal, anterior, side, ×4 (415).

Reedops RICHTER & RICHTER, 1925 [*pro Reedia* WEDEKIND, 1911 (*non* ASHMEAD, 1904)] [**Phacops bronni* BARRANDE, 1846]. Like *Phacops* but vincular furrow absent in front of cephalon; glabella extremely inflated, in some species protruding forward. *Sil.-U.Dev.*, Eu.-N.Am.——FIG. 365, *6*. *R. cephalotes* (HAWLE & CORDA), M.Dev., Czech.; *6a*, exoskel., ×1; *6b*, ceph. from below with hypostoma in place, vincular furrow appearing only below genae and modified into series of pits, ×1 (3).

Trimerocephalus M'COY, 1849 [**Phacops mastophthalmus* REINH. RICHTER, 1856] [=*Eutrimerocephalus* GORTANI, 1907]. Eyes absent; marginal ridge wide, convex; vincular furrow wide, deep; doublure short, flat. Pygidium as in *Cryphops*. *U. Dev.*, Eu.-Anatolia.——FIG. 365,*4*. **T. mastophthalmus* (REINH. RICHTER), Ger.; *4a,b*, ceph., dorsal, side, ×3; *4c*, pyg., ×3 (461).

Subfamily BOULEIINAE Hupé, 1955

Exoskeleton very compact. Glabella highly inflated, *1p* to *3p* lateral glabellar furrows distinct, *3p* glabellar lobes very large, distinct, *2p* small, crescentic, *1p* united to form an "intercalating ring"; genal angle sharp. Thoracic pleurae with rounded ends. Pygidium rounded, entire. *Dev.*

Bouleia KOZLOWSKI, 1923 [**Phacops dagincourti* ULRICH, 1892]. Glabella spheroidal, with deep axial furrows, *1p* to *3p* lateral glabellar furrows communicating with axial furrows, *3p* long, straight and simple, *2p* transverse, short, *1p* concave forward, *1p* and *2p* forming mesially a single large groove; exterior margin with row of pointed teeth directed downward, largest in front. Posterior ends of facial sutures near genal angles. [The opisthoparian appearance of *Bouleia*, in contrast to all other Phacopacea, presumably is caused by secondary addition of a denticulated border to the librigenae. Thus, the posterior sections of the facial sutures are visible from above to their ends, whereas regularly they reach the genal angles only along the margin, being visible only in side view of the cephalon. The posterior ends of the sutures seem actually to have the same position at the true genal angles as in other Phacopina.] *Dev.*, Bol.——FIG. 370. **B. dagincourti* (ULRICH); *a*, exoskel., ×0.7; *b,c*, ceph., ×0.7 (474n).

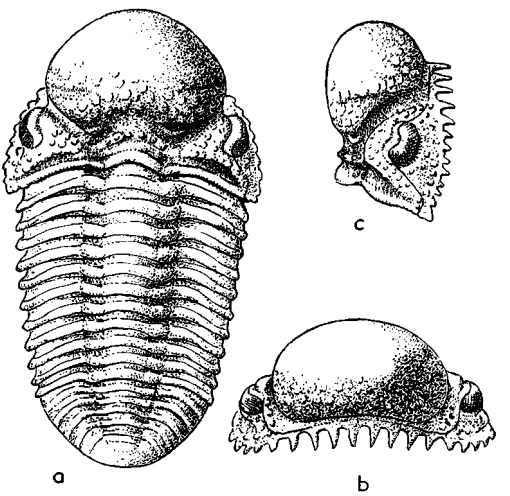


FIG. 370. *Bouleia dagincourti* (ULRICH), Dev., S. Am.(Bol.); *a*, exoskel., ×0.7; *b,c*, ceph., ×0.7 (474n).

Subfamily PHACOPIDELLINAE Delo, 1935

Exoskeleton depressed, as in Dalmanitidae, in the late genus *Dienstina* somewhat compact. Glabella not inflated, anterior slope gentle; *1p* lateral glabellar furrows united by shallow depression or separated; "intercalating ring," if developed, not sharply defined from anteromesial part of glabella; doublure flat or gently vaulted, no vincular furrow (except in *Phacopidella* and *Denckmannites*, where it is restricted to posterolateral part, Fig. 369,*1c*,*3c*). Pygidium large. *Sil.-U.Dev.*

Phacopidella REED, 1905 [**Phacops glockeri* BARRANDE, 1846] [=*Glockeria (Glockeria)* WEDEKIND, 1911]. Margin of cephalon sharp, upper and lower surfaces meeting at acute angle; *3p* and *2p* lateral glabellar lobes coalesced and detached from frontal lobe (as in Phacopinae), *3p* glabellar furrow being deeper than *2p* and uniting with dorsal furrow (as in *Dalmanites*); "intercalating ring" tripartite; eyes reniform, relatively large; posterior sections of facial sutures convexly curved on genae; genal angles truncated. Pygidium large, rounded. *Sil.*, Eu.——FIG. 369,*1*. **P. glockeri* (BARRANDE), e alpha Z., Czech.; *1a,b*, ceph., pyg., ×0.9; *1c*, subcephalic margin, showing vincular furrows only at lateral extremities, ×0.9 (474n).

Denckmannites WEDEKIND, 1914 [*pro Glockeria (Denckmannia)* WEDEKIND, 1911 (*non* BUCKMAN, 1898; *nec* HOLZAPFEL, 1908)] [**Phacops volborthi* BARRANDE, 1852; SD VOGDES, 1925] [=*Volborthia* WEDEKIND, 1911]. Margin of cephalon as in *Phacopidella;* glabellar surface uniform; frontal lobe, *3p* and *2p* lateral glabellar lobes coalesced (as in *Phacops*), *3p* glabellar furrows being not deeper than *2p* and separated from axial furrows; intercalating furrow tripartite; eyes small, with *cryptophthalmus* pattern, few lenses; posterior sections of facial sutures concavely curved on genae; genal angles truncate. Pygidium like that of *Phacopidella*. *Sil.-L.Dev.*, Eu.-N.Afr.——FIG. 369,*3a,b*. **D. volborthi* (BARRANDE), Sil., Czech.; *3a,b*, ceph., pyg., ×0.7 (3).——FIG. 369,*3c*. *D. micromma* (A. ROEMER), M.Dev., Moroc.; ceph., from below showing vincular furrow developed only laterally, undulated, ×0.9 (474n).

Dienstina RICHTER & RICHTER, 1931 [**Phacopidella diensti* RICHTER & RICHTER, 1923]. Cephalon pentagonal; *2p* and *3p* lateral glabellar furrows lacking on surface, *1p* shallow in median part; "intercalating ring" undivided; eyes reduced to *cryptophthalmus* pattern, palpebral lobes becoming triangular; posterior sections of facial sutures on genae very short, rectilinear; genal angle rounded, not truncate. Pygidium large, vaulted; axis short. *U.Dev.*, Eu.——FIG. 369,*6*. **D. diensti* (RICHTER & RICHTER), Ger. (Oberscheld); *6a-c*, ceph., dorsal, side, front, ×2; *6d*, pyg., ×2 (461).

Ductina RICHTER & RICHTER, 1931 [**Phacopidella ductifrons* RICHTER & RICHTER, 1923]. Cephalon semicircular, margin evenly rounded; glabella with anterolateral recurved wings, confluent with marginal border, *2p* and *3p* lateral glabellar furrows absent on surface, *1p* disappearing in median part, "intercalating ring" undivided; eyes and palpebral lobes absent; facial sutures restricted entirely to margin (alone among Phacopidae); genal angles rounded, not truncated. Pygidium large, axis narrow, long; axial ridge present. *U. Dev.*, Eu.——FIG. 369,*2*. **D. ductifrons* (RICHTER & RICHTER), Ger. (Dill Basin); *2a,b*, ceph., dorsal, side; *2c*, ceph. margin from below, showing

absence of vincular furrow; *2d*, pyg., all ×2.7 (*2a,b,d*, 461; *2c*, 474n).

Nephranomma ERBEN, 1952 [*Phacopidella (Nephranomma) drepanomma*]. Cephalon like that of *Phacopidella*, with large reniform eyes; lateral glabellar furrows indistinct; posterior sections of facial sutures on genae short, concave forward; genal angles not truncated, rounded. *L.Dev.-U. Dev.*, Eu.——FIG. 369,*5*. **N. drepanomma* (ERBEN), L.Dev., Ger. (Harz); *5a-c*, ceph., dorsal, side, front, ×2.3; *5d*, pyg., ×4 (39).

?Adastocephalum MITCHELL, 1919 [**A. teleotypicum*]. Cephalon short, broad; axial furrows rectilinear, *2p* and *3p* lateral glabellar furrows not discernible; eyes reniform; genal angles rounded. Pygidium unknown. [Cephalic characters doubtful owing to poor preservation.] *?L.Dev.*, N.S. Wales.——FIG. 369,*4*. **A. teleotypicum*; ceph., ×1.3 (430).

Subfamily UNCERTAIN

Pterygometopidella WEDEKIND, 1912 [**Phacops quadrilineatus* ANGELIN, 1851]. According to ANGELIN's original description, the type species has bipartite *3p* lateral glabellar furrows. Therefore the genus seems to be a phacopid. Determination of generic distinctness and family assignment are expected from study of the type species. *Sil.*, Swed. Gotl.).

Superfamily DALMANITACEA Vogdes, 1890

[*nom. transl.* STRUVE, herein (*ex* Dalmanitidae VOGDES, 1890)] [=Phacopidea RUD. RICHTER, 1933 *(partim)*; Phacopacea HENNINGSMOEN, 1951 *(partim)*; Phacopoidae HUPÉ, 1953 *(partim)*]

Generally isopygous. Cephalon commonly with well-developed preglabellar area and distinct glabellar lobation; *3p* lateral glabellar furrows well developed (except in some Calmoniidae), continuous, subbipartite exceptionally (with both parts of each furrow connected); eyes in mesial or posterior position (except in some Zeliszkellinae and Calmoniinae); genal spines generally present; true vincular furrows lacking. *L.Ord.-U. Dev.*

Family DALMANITIDAE Vogdes, 1890

[Because VOGDES (1890, p. 83) included *Phacops* in his Dalmanitidae (together with *Dalmanites, Coronura, Cryphaeus,* and *Chasmops*), the family name, when published, was a junior synonym of Phacopidae HAWLE & CORDA, 1847. Exclusion of *Phacops* by REED (1905) places Dalmanitidae in good standing.] [*Authorship*. Except for materials furnished by RUD. RICHTER on the genera *Dalmanites, Dalmannia, Dalmanitoides, Hausmannia, Heliocephalus, Malladaia, Malvernia, Odontochile, Eudolatites, Ormathops, Zeliszkella, Acastava, Acastella,* and *Acastellina*, all of the organization and content of information on this family is contributed by W. STRUVE.]

Exoskeleton flat to moderately vaulted. Segmentation of glabella scarcely modified as far as proportions of lobes are concerned, no hypertrophy of anterior glabellar lobes (frontal, *3p, 2p*), *1p* lobes tending to be narrow but invariably present; *3p* lateral glabellar furrows very distinct in almost all genera, *2p* reduced abaxially in some, *1p* furrows deepest; eyes generally large, posterior in position; genae most commonly produced into genal spines with outer edge forming straight continuation of lateral cephalic margins but may have shape of lappets; posterior sections of facial sutures form genal sulcus in many genera; no vincular furrow. *Low.M.Ord.-U.Dev.*

Subfamily DALMANITINAE Vogdes, 1890

[Includes Coronurinae PILLET, 1954; Synphoriinae DELO, 1935 (*nom. correct.* DELO, 1940, *pro* Synphorinae DELO, 1935, =Neosynphoriinae HUPÉ, 1955, *nom. subst. pro* Synphorinae DELO, 1935)]

Cephalon gently to moderately vaulted, border visible from above in front of glabella, distinct also anterolaterally in most genera, tending to develop processes; frontal lobe of glabella may be gently inflated, slightly above level of central area and with varying distinctness detached from it; longitudinal glabellar furrows generally present, *3p* lateral furrows well developed but *2p* (and exceptionally *1p*) may retreat from axial furrows; eyes moderately to very large, located near glabella and posterior border furrows in most genera; subocular grooves present; posterior sections of facial sutures in shallow to very deep genal sulci; genal angles produced as lappets or forming short to very long spines. Hypostoma elongate, narrowing backward, each lateral margin with 1 to 3 denticles, 1 posterior denticle. Pygidium generally large, with 8 to 22 rings and 7 to 15 pairs of ribs (exceptionally 6 or as many as 20); posterior and anterior pleural bands of pleural fields subequal, tending to fuse (especially adaxially), pleural furrows deep; posterior processes present in several genera. *Sil.-M.Dev.*

Dalmanites BARRANDE, 1852 [**Trilobus caudatus* BRÜNNICU, 1781; SD BARRANDE, 1852] [*pro Dalmannia* EMMRICH, 1844 (*non* ROBINEAU-DESVOIDY, 1830); *Dalmania* BARRANDE, 1852 *(nom. van.); Hausmannia* HALL & CLARKE, 1888]. Cephalon with broad flat frontal margin visible from above. Hypostoma long, with long central body, lateral margins converging, each with denticle, posteriorly a broad border without denticles but prolonged into flat tongue. Pygidium long; with slender axis showing 11 to 16 rings; pleural fields with 6 or 7

pairs of ribs; doublure narrow. *Sil.-L.Dev.*, Eu.-N.Am.-S.Am.-?Austral.——FIG. 371,*1a*. **D. caudatus* (BRÜNNICH), Eng.; exoskel., ×0.7 (267, 434).——FIG. 371,*1b*. *D. vulgaris* SALTER, Eng.; hypostoma, ×1 (267).

Anchiopella REED[1], 1907 [**Calymene anchiops*

[1] REED (1907, p. 169) referred several South African species (including *cristagalli*) "to a special subgroup of *D. anchiops*." RICHTER & RICHTER (1942, p. 174) interpreted this as an original designation of the type species of *Anchiopelia*. RENNIE (1930, p. 332-334) tended to the same opinion but was less sure. REED (1925, p. 75) definitely named for the "subgenus *Anchiopella*. . . the type species *Dalmanites anchiops*," which can be interpreted as mere confirmation of an original designation. In contradiction, REED (1927, p. 310) stated that the "type which was chosen for this special group and exemplified by *Dalmanites anchiops* GREEN was *Ph. cristagalli* (WOODW.)." This subsequent change of the type species is inadmissible under the Rules. KOZLOWSKI (1923, p. 32) named "*An. tumiloba* CLARKE" as "representative species" of *Anchiopella*, but this cannot be interpreted as a valid subsequent designation of the type species, since *A. tumiloba* was not included in the original description of the genus by REED.

In publishing the name *Anchiopsis* (based on *Calymene anchiops* GREEN as type species), DELO (1935) was misled by REED's (1927) incorrect designation of the type species of *Anchiopella*, as *Phacops cristagalli* WOODWARD. A genus founded on WOODWARD's species is *Bainella* RENNIE, 1930. It is noteworthy that DELO (1935, p. 409) does not record *Anchiopella* (*sensu* DELO, =*Bainella*) from North America (where *A. anchiops* is found) but from South Africa and South America and he ascribes to this genus mesial axial spines on the thorax, which are lacking in true *Anchiopella*. Thus DELO actually was dealing with 2 genera belonging to different families.

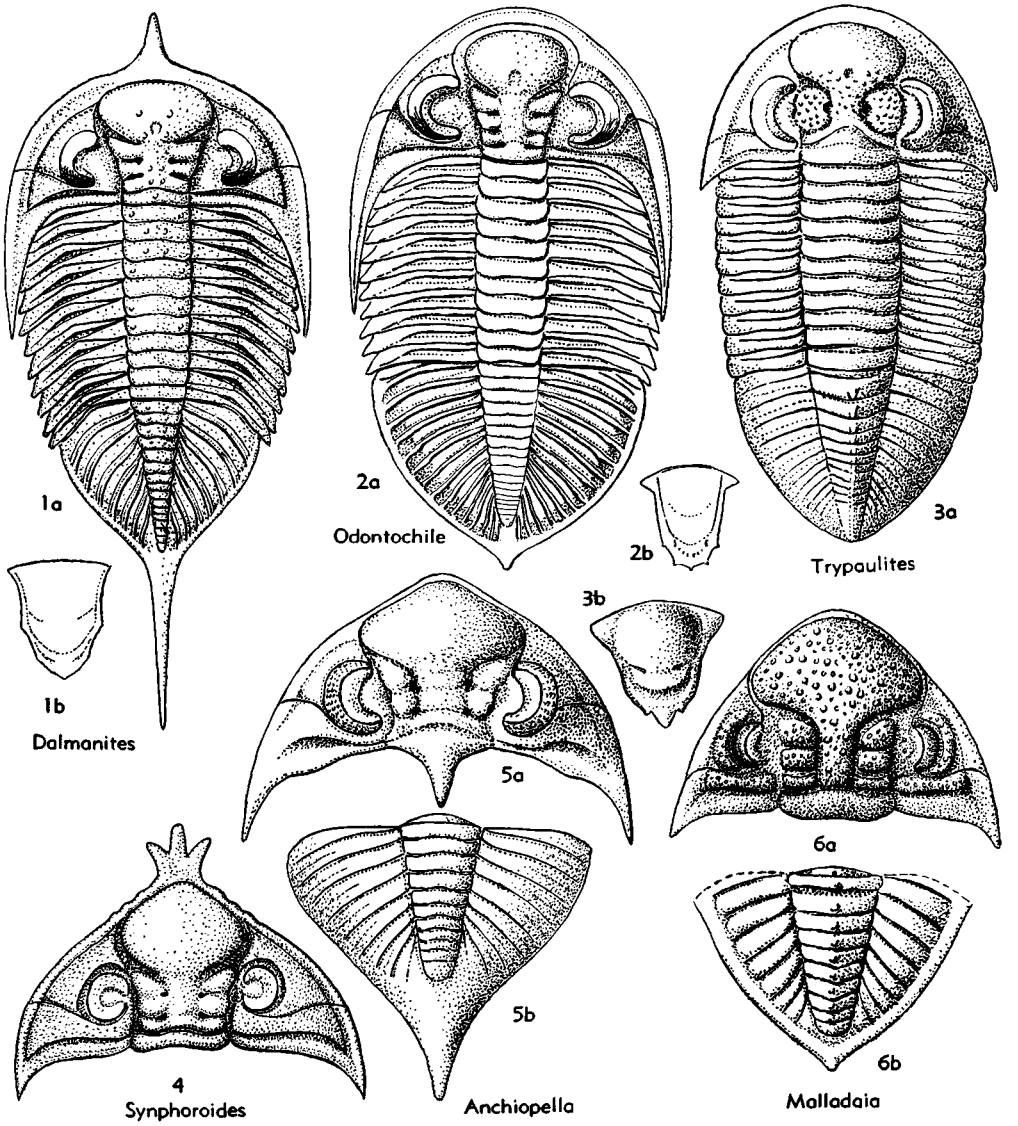


FIG. 371. Dalmanitidae (Dalmanitinae) (p. O468-O472).

GREEN, 1832] [=*Anchiopsis* DELO, 1935 (obj.)]. Cephalon wide; axial furrows moderately deep; frontal lobe of glabella may reach anterior margin, slightly detached posteriorly; *2p* and *3p* lateral glabellar lobes fused more or less completely; *3p* lateral glabellar furrows moderately deep, *2p* and *1p* with adaxial pits, shallow, but tending to be connected by transglabellar furrows, longitudinal glabellar furrows distinct; median occipital spine present; eyes small to rather large, close to posterior border furrows; genal spines present. Pygidium triangular, with long posterior process; axis short, ending bluntly, with less than 15 rings (typically 8); pleural fields with 7 to 10 pairs of ribs, interpleural furrows visible only distally; long posterior process. *L.Dev.-M.Dev.*, N.Am.——FIG. 371,*5*. **A. anchiops* (GREEN), L.Dev.(Schoharie F.), N.Y.; *5a,b*, ceph., pyg., ×1 (404).

Coronura HALL & CLARKE, 1888 [**Asaphus aspectans* CONRAD, 1841; SD VOGDES, 1893]. Exoskeleton large. Cephalon (incompletely known) wide, with granulose surface, border entire, broad; axial furrows deep; frontal lobe of glabella large, subpentangular, broadly rounded anteriorly, not detached posteriorly, *2p* and *3p* lateral glabellar lobes detached from central area by moderately distinct longitudinal furrows, *3p* lateral glabellar furrows distinct, moderately oblique, *2p* furrows shallow, with deep adaxial pits; eyes very high; posterior sections of facial sutures in deep genal sulci; genal spines present. Pygidium large, with long slender axis bearing 15 to 20 rings; pleural fields with 15 to 20 pairs of ribs; border with numerous (?anterior) pleural spines, of which the last pair is pronounced, bifid or trifid, and generally separated from each other by a broad straight margin behind pygidial axis. Surface of thorax and pygidium with scattered tubercles. *Up. L.Dev.*, N.Am.-S.Am.?(Colom.)-N.Afr. —— FIG. 372,*1*. **C. aspectans* (CONRAD), Columbus Ls., Ohio; *1a*, ceph., ×0.7 (476); *1b*, pyg., ×0.7 (404).

Corycephalus HALL & CLARKE, 1888 [**Dalmanites regalis* HALL, 1876; SD VOGDES, 1925]. Cephalon strongly vaulted, with border bearing pointed or spatulate denticles, axial furrows curving outward at somewhat hypertrophic *3p* lateral glabellar lobes; frontal glabellar lobe steeply sloping or vertical anteriorly and anterolaterally, slightly detached from central area; other glabellar lobes separated from central area by moderately distinct longitudinal furrows; *1p* to *3p* lateral glabellar furrows more or less distinct, with deep adaxial pits; eyes large, highly elevated; posterior sections of facial sutures in deep genal sulci; long genal spines present. Pygidium like that of *Dalmanites*, triangular, with entire margin; axis long, ending bluntly, with 14 rings; pleural fields with 8 or 9 pairs of ribs; long posterior process. Surface of exoskeleton with scattered tubercles. *L.Dev.*, N. Am.——FIG. 372,*3a,b*. **C. regalis* (HALL), Up.L. Dev., N.Y.; ceph., ×0.7 (404).——FIG. 372,*3c*. *C. dentatus* (BARRETT), L.Dev., N.Y.; pyg., ×1.3 (404).

Dalmanitoides DELO, 1935 [**Dalmanites drevermanni* IVOR THOMAS, 1906]. Cephalon with 5 very short frontal processes; frontal lobe of glabella slightly detached from central area, *1p* to *3p* lateral glabellar furrows well marked, short, connected by indistinct transglabellar furrows, longitudinal glabellar furrows well developed; genal spines present. Pygidium elongate, subtriangular, with slender axis reaching posterior end, bearing 18 rings; pleural fields with 14 pairs of ribs. Surface of thorax and pygidium with scattered tubercles. *L.Dev.-M.Dev.*, S.Am.(Arg.).——FIG. 372,*4*. **D. drevermanni* (I. THOMAS); *4a,b*, ceph., pyg., ×0.7 (482, 1906).

Heliocephalus DELO, 1936 [*pro Malvernia* DELO, 1935 (*non* JACOBY, 1889)] [**Phacops (Dalmania) coronatus* H. H. THOMAS, 1900 (*non Dalmania coronata* HALL, 1861, =*Odontocephalus*)]. Exoskeleton small. Cephalon with border bearing series of short wide-spaced sharp spines; glabellar lobes detached from central area by longitudinal furrows; long genal spines present. Pygidium relatively narrow and short, but with about 12 rings and 12 pairs of ribs; border broad; posterior process present. [According to Rules, type species of this genus does not call for renaming because it is not considered homonymous with HALL's species.] *M.Sil.*, Eu.——FIG. 373,*2*. **H. coronatus* (H. H. THOMAS) Wenlock., Eng.; exoskel., ×4 (481).

Malladaia OEHLERT, 1896 [**Cryphaeus (Malladaia) luciae*]. Cephalon subtriangular, with narrow anterior border; axial furrows straight and barely diverging opposite *1p* to *3p* lateral glabellar lobes but strongly curved outward around laterally protruding frontal lobe of glabella, which is fused with central area, latter being sharply separated from *1p* to *3p* lateral glabellar lobes by deep longitudinal furrows; lateral glabellar furrows deep, not in center of genal areas; posterior sections of facial sutures in deep sulci; genal spines short. Pygidium triangular, with short terminal spine; axis rather broad, ending bluntly, with 11 rings; pleural fields with 6 or 7 pairs of nearly unfurrowed ribs that end abruptly along flat border; lateral margins with faint pleural undulations showing tendency to develop denticles. *L.Dev.*, Sp.——FIG. 371,*6*. **M. luciae* (OEHLERT); *6a,b*, ceph., pyg., ×1.5 (438).

Odontocephalus CONRAD, 1840 [**Asaphus selenourus* EATON, 1832]. Cephalon ogival in outline, with anterior border bearing a series of distally broadened and coalesced processes; axial furrows nearly straight; frontal lobe of glabella inappreciably protruding laterally, more or less coalesced with central area, *2p* and *3p* lateral glabellar lobes detached from central area by generally distinct longitudinal furrows that may reach occipital

furrow; *2p* lateral glabellar furrows may be reduced distally, adaxial pits in *1p* and *2p* furrows; genal spines or lappets present. Pygidium ogival in form, generally small as compared with *Coronura,* with entire margin except for pair of pointed or blunt spines at posterior end; axis moderately broad, with about 7 to 10 rings; pleural fields with 7 to 10 pairs of distinct ribs (but 18 rings and 13 ribs in *O. magnus* STUMM). *Up.L. Dev.,* N.Am. —— FIG. 374. **O. selenourus* (EATON), Onondaga Ls., N.Y.; *a,b,* ceph., pyg., ×1 (404).

Odontochile HAWLE & CORDA, 1847 [**Asaphus hausmanni* BRONGNIART, 1822; SD TRIPP & WHIT-

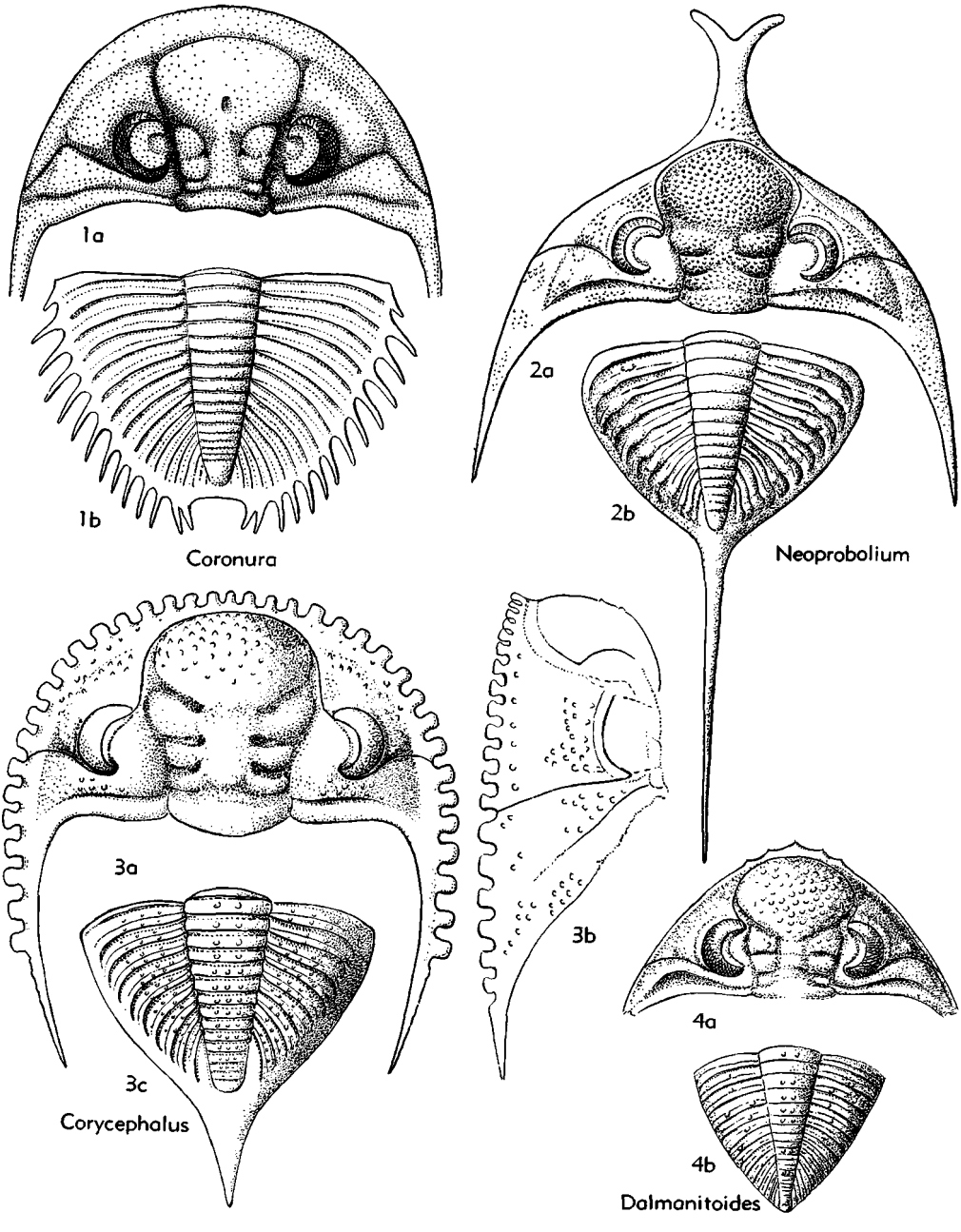


FIG. 372. Dalmanitidae (Dalmanitinae) (p. *O470-O472*).

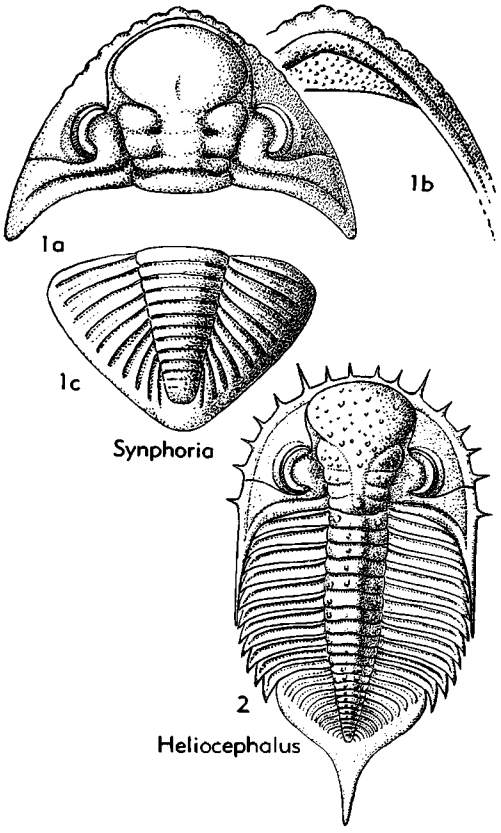


FIG. 373. Dalmanitidae (Dalmanitinae) (p. O470-O472).

TARD, 1956 (ICZN pend.)]. Cephalon resembling that of *Dalmanites,* but anterior sections of facial sutures distant from glabellar frontal lobe. Hypostoma with 5 to 7 denticles along posterior edge. Pygidium very long, with 16 to 22 rings and 12 to 15 pairs of ribs; doublure broad. *L.Dev.-M. Dev.,* Eu.-N.Am.-S.Am.-Austral.——FIG. 371,2. **O. hausmanni* (BRONGNIART), M.Dev., Czech.; *2a,b,* exoskel., hypostoma, ×1 (3).

Neoprobolium STRUVE, 1958 [*pro Probolium* OEHLERT, 1889 (*non* COSTA, 1853)] [**Asaphus nasutus* CONRAD, 1841]. Cephalon like that of *Synphoroides,* glabellar lobe may be detached posteriorly; *1p* to *3p* lateral glabellar furrows distinct, *1p* furrows being connected in some species by transglabellar furrows, longitudinal furrows more or less developed; long genal spines present. Pygidium with slender axis bearing 10 to 14 rings; pleural fields with 7 to 11 pairs of ribs; long posterior spine present. *L.Dev.,* N.Am.-Fr.——FIG. 372,2. **N. nasutum* (CONRAD), L. Helderberg. (New Scotland Ls.), N.Y.; *2a,b,* ceph., pyg., ×0.7 (403).

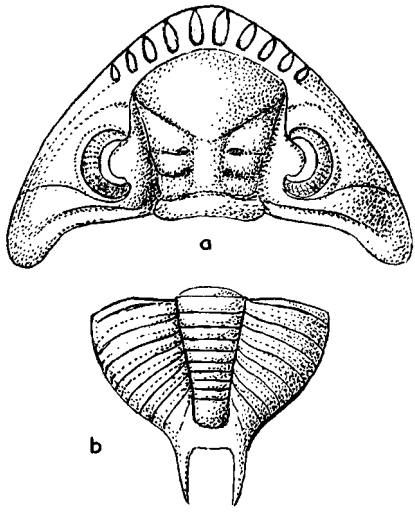
Synphoria CLARKE[1], 1900 [**Dalmanites (Synphoria) stemmatus* CLARKE, 1900; SD VOGDES, 1925] [=*Eocorycephalus* REED, 1925 (obj.); *Neosynphoria* PILLET, 1954 (obj.)]. Cephalon resembling that of *Dalmanitoides;* anterior and anterolateral margins entire or crenulate; frontal glabellar lobe and *1p* to *3p* lateral lobes detached from central area by shallow furrows, *2p* and *3p* lobes fused abaxially; *1p* and *3p* lateral glabellar furrows distinct, *2p* reduced abaxially, *1p* and *2p* being faintly transglabellar in some and bearing deep adaxial pits; genal lappets or short spines present. Pygidium subtriangular with rather broad axis bearing 10 to 15 rings; pleural fields with about 9 pairs of ribs; posterior spine may be present. *L.Dev.,* N.Am.-S. Am.——FIG. 373,*1*. **S. stemmata* (CLARKE), Becraft Ls., N.Y.; *1a,b,* ceph., dorsal and ventral; *1c,* pyg.; all ×0.7 (23).

Synphoroides DELO, 1940 [**Dalmanites (Probolium) biardi* CLARKE, 1907]. Cephalon closely resembling that of *Synphoria* and *Neoprobolium;* crenulated anterior margin produced in a short (bifid or trifid) frontal process; frontal glabellar lobe more or less detached from central area; *1p* and *2p* furrows with adaxial pits connected in some species by transglabellar furrows, longitudinal furrows fairly distinct; short to long genal spines present. Pygidium subtriangular; with rather slender axis that may reach posterior margin, with 12 to 18 rings; pleural fields with 9 to 16 pairs of ribs; pointed posterior lappet may be present. *L. Dev.,* N.Am.——FIG. 371,*4*. **S. biardi* (CLARKE), Can.(E.Que.); ceph., ×0.7 (386).

Trypaulites DELO, 1935 [**Dalmania calypso* HALL, 1861]. Cephalon semicircular, with rather broad, entire border; frontal glabellar lobe tending to be detached from central area, elliptical to subcircular bicomposite lobes *(2p+3p)* high abaxially,

[1] *Synphoria* was introduced by CLARKE (1897, p. 733) as name for a group of subgenera classed as belonging to *Dalmanites.* Because employed for an unrecognized taxonomic category intermediate between genus and subgenus, the term had no nomenclatorial status at the time of original publication but remained available for use by any author who recognized *Synphoria* in a generic or subgeneric sense. In the opinion of DELO (1940, p. 65) this author was CLARKE (1900, p. 19) when he wrote "it is very probable that the term *Synphoria,* . . . may prove of subgeneric importance." Later, CLARKE (1913, p. 148) used *Synphoria* as a "synthetic term," without thereby affecting nomenclature, because a valid name does not become invalid when it is not used for taxonomic reasons. *Synphoria* was published again and again as a generic or subgeneric name, and VOGDES (1925, p. 113) subsequently designated *S. stemmatus* as "genotype" of *Dalmanites (Synphoria).* REED (1927, p. 352) named *Synphoria* in a list of subgenera of *Dalmanites* but DELO (1935, p. 412; 1940, p. 6, 64) treated it as a genus, assigning authorship to CLARKE, 1900. Contrary to the opinion of RICHTER & RICHTER (1942, p. 175), the name *Synphoria* evidently is valid in nomenclature. The only question concerns authorship and year of original publication. Application of the Rules indicates CLARKE, 1900.

Eocorycephalus REED, 1925, is a junior objective synonym by reason of the subsequent designation (RENNIE, 1930, p. 334) of *S. stemmatus* as type species. The substitute name *Neosynphoria* PILLET, 1954, introduced because of reasoning advanced by RICHTER & RICHTER (1942) is also a junior objective synonym of *Synphoria.*



Odontocephalus

FIG. 374. **Odontocephalus selenourus* (EATON), (Dalmanitidae), L.Dev. (Onondaga Ls.), N.Y.; *a,b*, ceph., pyg., ×1 (404).

1p lobes very narrow, obsolescent; longitudinal glabellar furrows continuous with *1p* and *3p* furrows but *2p* reduced to deep adaxial pits, *1p* also with adaxial pits in some forms; eyes large to very large, high, close to glabella; short genal spines present. Thorax with very broad axis and subangular ends of pleurae. Pygidium with rather broad axis reaching posterior margin, 12 to 15 distinct rings; pleural fields with about 12 pairs of flat, broad ribs; no posterior spine. [Resemblance of *Trypaulites* to genera of the Monorakidae seems due to convergence.] *Up.L.Dev.*, N.Am.—— FIG. 371,*3*. **T. calypso* (HALL), Onondaga Ls., Ohio; *3a,b*, exoskel., hypostoma, ×1 (404).

Subfamily ZELISZKELLINAE Delo, 1935

Cephalon with margin entire; axial furrows in most genera more or less parallel adjacent to *1p* and *2p* lateral glabellar lobes, rather divergent bordering *3p* glabellar lobes and frontal lobe, glabella thus club-shaped; segmentation of glabella scarcely modified, lateral glabellar furrows more or less curved, *1p* and *2p* furrows converging outward, *1p* furrows adaxially bifurcated more or less; eyes generally small, distant or far distant from posterior border furrows. Hypostoma rather short, with narrow border, and commonly without marginal denticles. *Low.M.Ord.-U.Ord., ?M.Sil.*

In the new arrangement of dalmanitid genera the Zeliszkellinae include rather different forms, which, however, are allied especially by peculiar segmentation of the glabella and simple shape of the hypostoma. The subfamily may be divided into 2 groups that may themselves represent taxa of subfamily rank, but here they are not given more than informal status as assemblages.

ZELISZKELLA Group

Exoskeleton small. Cephalon with entire margin; border more or less distinct laterally and visible from above in front of glabella; eyes reaching close to anterolateral border furrows; no genal sulci on posterior sections of facial sutures; genal angles rounded, lacking spines. Pygidium distinctly smaller than cephalon, rather vaulted, subtriangular, consisting of few segments; no posterior spines. *M.Ord.*

The *Zeliszkella* probably is a somewhat specialized offshoot of the early dalmanitids that became extinct soon after its appearance.

Zeliszkella DELO, 1935 [**Phacops deshayesi* BARRANDE, 1846]. Cephalon with rather narrow frontal area, anterior sections of facial sutures close to frontal lobe anteriorly; eyes large, reaching far backward. Posterior thoracic pleurae curving progressively backward, their pointed ends longer than those of anterior pleurae. Pygidium elongate subtriangular with about 10 rings; pleural fields with 3 or 4 ribs. *M.Ord.*, Czech.

Z. (Zeliszkella). Cephalon with relatively wide axial furrows; *3p* lateral glabellar lobes notably below level of vaulted to somewhat inflated frontal glabellar lobe; occipital lobe prominent; palpebral lobes and furrows well developed, summit of palpebral lobes in or above level of palpebral region of fixigenae. *M.Ord.*, Czech.——FIG. 375,*1*. **Z. (Z.) deshayesi* (BARRANDE); exoskel., ×1 (3).

Z. (Mytocephala) STRUVE, 1958 [**Dalmanites oriens mytoensis* KLOUČEK, 1916]. Cephalon with distinct but very narrow axial and lateral glabellar furrows; anterior slope of glabella formed by entire scarcely vaulted frontal lobe, as well as by essential to prevailing parts of *3p* lateral glabellar lobes; central part of cephalon flattened or level; occipital lobe scarcely elevated; palpebral lobe missing or almost inappreciable, upper margins of visual areas distinctly below level of palpebral region of fixigenae. *M.Ord.*, Czech.

Ormathops DELO, 1935 [**Dalmanites atavus* BARRANDE, 1872]. Cephalon with broad frontal border, facial sutures in front distant from glabella; laterally with shallow vincular furrow; eyes small, in anterolateral corner of genae. Lateral margins of hypostoma re-entering at half length. Pygid-

ium subtriangular, with about 10 rings and 5 pairs of ribs. *M.Ord.*, Eu.——FIG. 375,*5*. **O. atavus* (BARRANDE), Czech.; *5a,b*, exoskel., hypostoma, ×1 (4).

DALMANITINA Group

Cephalon with distinct border and border furrows, but narrow or missing in front of glabella, which mostly is club-shaped; genal sulci visible or missing; short to moderately long genal spines. Pygidium subcircular to ogival in outline, generally with more numerous segments than in *Zeliszkella* group. *M.Ord.-L.Sil., ?M.Sil.*

The *Dalmanitina* group shows distinct resemblance to the Dalmanitinae in outline and increasing number of segments of the

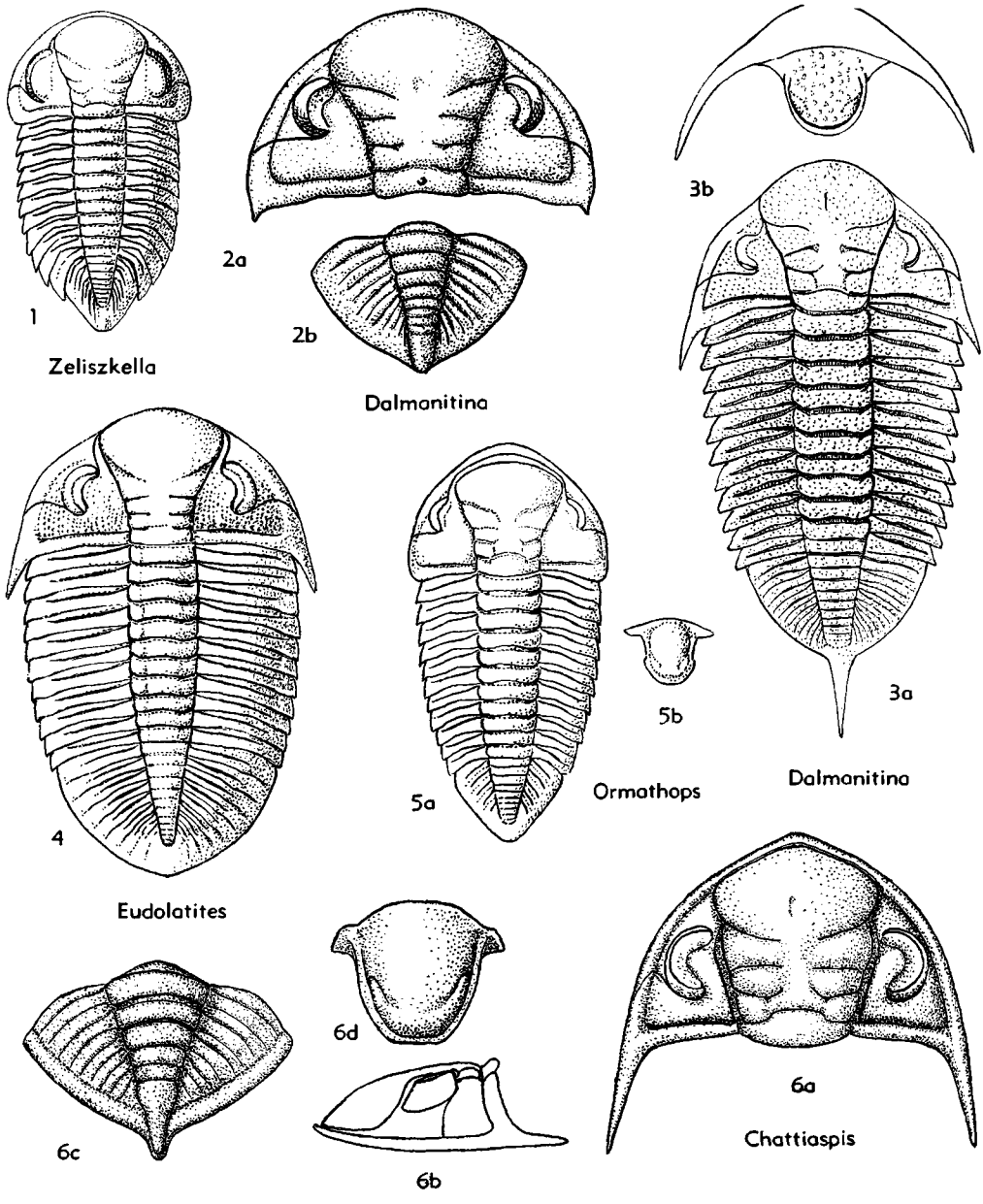


FIG. 375. Dalmanitidae (Zeliszkellinae) (p. O473-O475).

pygidium but is distinguished by segmentation of the glabella and shape of the hypostoma. Additional differences seen in typical representatives of the *Dalmanitina* group are the suppressed frontal border, club-shaped glabella, faint or missing genal sulcus, and size and position of the eyes. With little doubt, the Dalmanitinae are descendants of the *Dalmanitina* group of the Zeliszkellinae.

Dalmanitina REED, 1905 [**Phacops socialis* BARRANDE, 1846]. Cephalon with *3p* lateral glabellar furrows slightly to moderately oblique, *1p* and *2p* furrows distinctly converging outward, adaxial bifurcation of *1p* furrows generally distinct; genal spines very short to about 0.5 of glabellar length. Pygidium ogival, in some attaining considerable length; axis rather broad, with postaxial ridge, posterior spine generally present. *M.Ord.-U.Ord., ?M.Sil.,* Eu.-N.Afr.-N.Am.-E.Asia.

D. (Dalmanitina). Exoskeleton tending to considerable elongation. Cephalon with anterior border more or less completely suppressed; glabella club-shaped; eyes small, far removed from posterior border furrows. Hypostoma with lateral margins slightly convergent backward, posterior margin broadly rounded. Pygidium with 8 to 14 rings and 7 or 8 (exceptionally 5) pairs of ribs. *M.Ord.-U.Ord., ?M.Sil.,* Eu.-?N.Am.-?E.Asia. ——FIG. 375,*3*. **D. (D.) socialis* (BARRANDE), Czech.; *3a,b,* exoskel., ceph. and hypostoma from below, ×1 (3).——FIG. 375,*2*. *D. (D.) morrisiana* (BARRANDE), Czech.; *2a,* ceph., ×2; *2b,* pyg., ×1.3 (3).

D. (Chattiaspis) STRUVE, 1958 [**Dalmanitina kegeli* RICHTER & RICHTER, 1927]. Outline of cephalon subpentangular, with anterior border well developed; axial furrows nearly straight, moderately divergent, somewhat re-entrant at *3p* lateral glabellar furrows; glabella expanding forward but not distinctly swollen in front, *2p* furrows almost transverse, curving slightly backward abaxially, *2p* lobes narrowing sideward, shallow longitudinal furrows present; eyes somewhat less than 0.5 of glabellar length *(exsag.)*, closer to posterior border furrows than in *D. (Dalmanitina);* long genal spines in straight continuation of lateral cephalic margins. Hypostoma with sides distinctly converging. Pygidium transversely elongate ogival; with 8 or 9 rings and 4 or 5 pairs of ribs; border distinct; posterior spine present. *Ord.,* Ger.——FIG. 375,*6*. **D. (C.) kegeli* RICHTER & RICHTER, Kleinlinden; *6a-d,* ceph., pyg., hypostoma, ×3 (461 mod.).

Eudolatites DELO, 1935 [**Dalmanites angelini* BARRANDE, 1852]. Glabella with frontal lobe scarcely detached from central area; all glabellar furrows distinct, *3p* lateral furrows somewhat widened *(exsag.)*, abaxially, *1p* and *2p*, furrows slightly converging or transverse; genal spines present. Pygidium nearly as large as cephalon; slender axis with 11 to 15 rings and 8 to 13 pairs of ribs, without posterior spine. [Pygidial features of this genus are closer to Dalmanitinae than those of *Dalmanitina,* which it resembles closely in cephalic features. Nature of the hypostoma, now unknown, may have considerable taxonomic importance.] *M. Ord.-U.Ord., ?M.Sil.,* Eu.-?E.Asia.——FIG. 375,*4*. **E. angelini* (BARRANDE), Ord., Czech.; exoskel., ×2.5 (3).

Subfamily ACASTAVINAE Struve, 1958

Cephalon similar to that of Asteropyginae (Dalmanitidae), outline typically ogival to pentangular; axial furrows moderately diverging; lateral glabellar furrows distinct in most species, *2p* and *3p* obsolescent exceptionally, *2p* straight, transverse or slightly oblique in posterolateral direction, exceptionally a little oblique in anterolateral direction, and more or less reduced abaxially; longitudinal furrows may be developed; eyes attaining considerable size, rather close to posterior border furrows and glabella; genal angles produced into angular lappets or short spines that lie in straight continuation of lateral margins. Pygidium composed of few segments (5 or fewer pairs of ribs); axis broad; with tendency to develop protrusions of soft body inside of doublure (indicated only on internal mold) as pleural marginal indentations or minute lappets; small posterior spine may be present. *U.Sil.-L.Dev.*

The Acastavinae include such genera of the "Acastinae" (in the hitherto usual arrangement as Phacopidae) that show a distinct Asteropyginae trend. Several cephalic features may come close to those of Acastinae (restricted) but on the whole display more similarity to Dalmanitinae and Asteropyginae, especially in having genal spines of the same shape as in these subfamilies and generally quite different from those in the Calmoniidae. Of genera included in the Acastavinae, *Acastellina* is most similar to Acastinae.

Acastava RICHTER & RICHTER, 1954 [**Cryphaeus atavus* W. E. SCHMIDT, 1907]. Cephalon similar to that of *Asteropyge,* frontal border having a sharp margin; *2p* lateral glabellar lobes narrow *(sag.)*, *3p* broader; "intercalating ring" narrow; genal spines present. Pygidium with entire margin on exterior surface but on internal molds showing tendency to develop 5 lateral denticles,

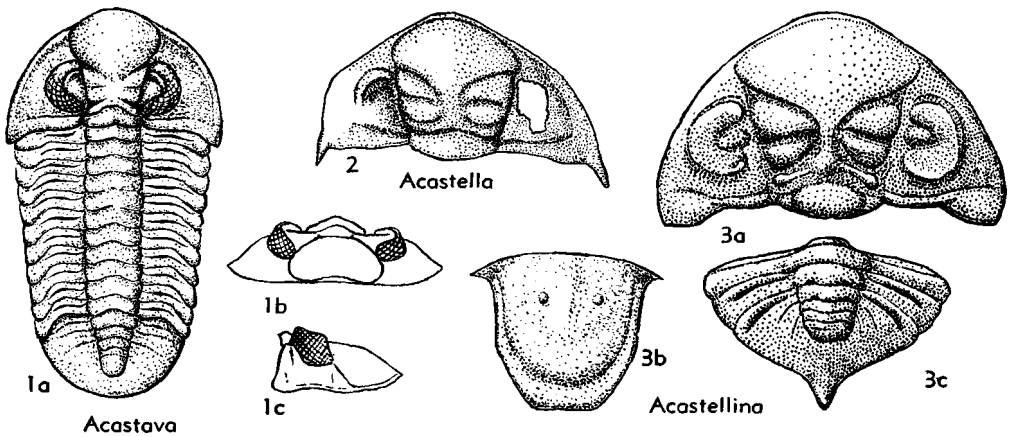


FIG. 376. Dalmanitidae (Acastavinae) (p. O475-O476).

2 posterior not always distinct, margin between 5th denticles broad, entire. *L.Dev.*, Eu.——FIG. 377,*1*. **A. atavus* (W. E. SCHMIDT), Siegenian, Ger.; *1a*, ceph., ×4 (469, 1907); *1b*, pyg., ×2.8 (255).——FIG. 376,*1*. *A.? schmidti* (RUD RICHTER), Emsian, Ger.; *1a*, exoskel., ×2; *1b,c*, ceph., ×2 (460, 1916).

Acastella REED, 1925 [**Acaste downingiae spinosa* SALTER, 1864]. Cephalic frontal margin visible from above, pointed; axial furrows only slightly diverging; *3p* lateral glabellar furrows directed backward, *1p* and *2p* deep, transverse, *1p* not continuous, curved backward, with inner ends bending forward; eyes large; genal angles with spines. Hypostoma with maculae near margin. Pygidium broadly triangular, with terminal spine, about 7 axial rings and 4 ribs; margin tending to develop interior denticles. *U.Sil.-L.Dev.*, Eu.——FIG. 376,*2*. **A. spinosa* (SALTER), Sil.(U. Ludlow), Eng.; ceph., ×2 (255).——FIG. 377,*2*. *A. tiro* RICHTER & RICHTER, L.Dev., Ger.(Ebbe); *2a,b*, ceph., pyg., internal molds showing inner denticulations on pygidium, ×4.3 (255).

Acastellina RICHTER & RICHTER, 1954 [**Acaste (Acastella) nolens* RICHTER & RICHTER, 1952]. Exoskeleton minute. Cephalon with axial furrows divergent (about 35°); lateral glabellar lobes swollen, *3p* much broader and higher than *2p*, "intercalating ring" inflated in median part as node; all glabellar furrows uniting near sagittal line; eyes very long; palpebral regions of fixigenae nodelike, visual areas low; genal angles acute but without spines. Hypostoma broad, with small maculae near sagittal line. Pygidium pointed, tending to develop a terminal spine; axis relatively short, posteriorly truncated, with 5 rings (1 to 3 distinct); pleural fields with 3 or 4 ribs. *L.Dev.*, Eu.——FIG. 376,*3*. **A. nolens* (RICHTER & RICHTER), Up.L.Dev., Ger.(Eifel); *3a*, ceph., ×8; *3b*, hypostoma (probably belonging to this species), ×9; *3c*, pyg., ×6 (254).

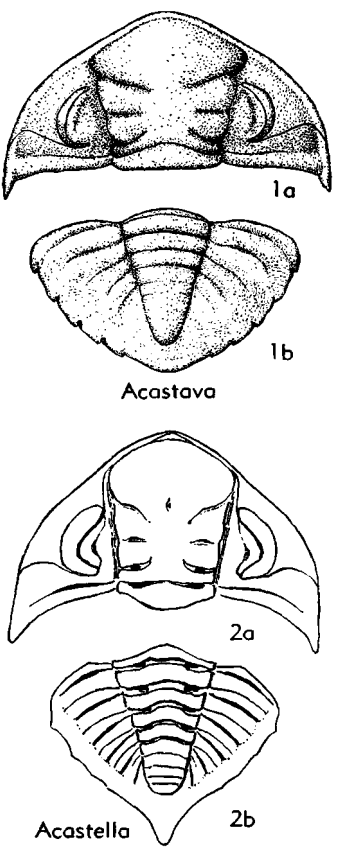


FIG. 377. Dalmanitidae (Acastavinae (p. O475-O476).

Subfamily ASTEROPYGINAE Delo, 1935

Cephalon rather closely similar to those of Dalmanitinae; *3p* lateral glabellar furrows distinct, straight, rather oblique, *2p* transverse, tending to retreat from axial furrows, *1p* deep, gently curving in anteromesial direction; eyes generally large about 0.5 of glabellar length *(exsag.)*, palpebral lobes close to glabella in front and to posterior border furrows at rear; genal sulcus may be present, genal angles acutely pointed or bearing medium-length to very long genal spines in straight continuation of lateral margins. Hypostoma short, similar to that in Zeliszkellinae and Acastinae. Thorax with rather long pleural spines or spinelike lappets. Pygidium with 7 to 15 or more axial rings (av. 10 to 12) and 5 pairs of distinct ribs (in some genera with 1 or 2 additional pairs of reduced ribs); lateral border generally with 5 pairs of lappets or spines (*Gourdonia,* 6 pairs; *Cryphina,* 7 pairs) and in most genera an unpaired posterior lappet or spine. [*Philonyx, Cryphina,* and *Gourdonia* are included in this subfamily with reservation.] *L.Dev.-U.Dev.*

In generic diagnoses 4 patterns of pleural fields (2 conservative and 2 progressive) are usefully distinguished by names derived from species that show them typically. These severally need to be described.

Conservative Types. Pleural bands equal or subequal; border with lappet-shaped processes correlated with pleurae or posterior pleural bands. (1) *Prorotundifrons pattern* (named from *Treveropyge prorotundifrons*), with anterior and posterior than posterior, interpleural furrows broadening distally to give ribs a bifurcate appearance, pleural furrows rather broad and deep, border obliterated by traversing pads (thickened tracts between ribs and processes); pleural border lappets tending to be posterior on internal molds. (2) *Boothi pattern* (from *Greenops boothi*), with anterior and posterior pleural bands subequal or anterior somewhat narrower, anterior lower than posterior bands, disappearing at border furrow or extending faintly to anteroproximal part of posteriorly adjacent border lappet, posterior pleural bands gently expanded distally, passing into traversing pads that attain size of border lappets; interpleural furrows narrow and distinct; pleural furrows moderately wide and deep; posterior border lappets tending to be pleural on exoskeleton.

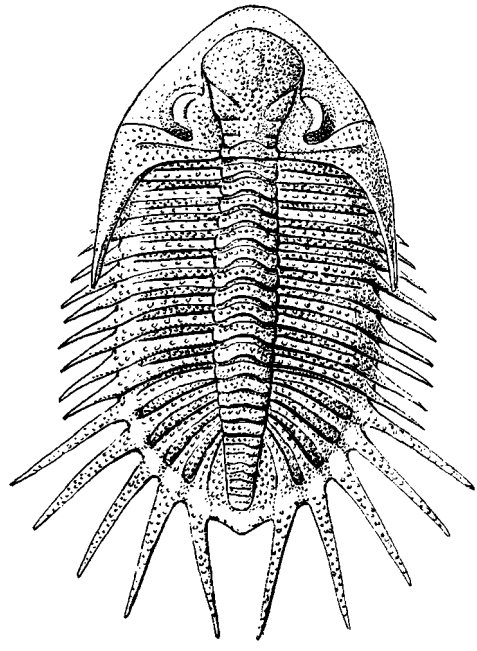


Fig. 378. **Asteropyge punctata* (Steininger) (Dalmanitidae), M.Dev., Ger.(Eifel); exoskel. (reconstr.), ×1.5 (458n).

Progressive Types. Distinct to complete lowering and reduction of anterior pleural bands; traversing pads and spinelike processes distinctly correlated with posterior pleural bands. (3) *Supradevonica pattern* (from *Asteropyge supradevonica*) with anterior pleural bands moderately to much reduced in width and depressed below posterior pleural bands, both sets of bands well separated in steplike arrangement, interpleural furrows distinct, pleural furrows deep and rather wide; furrows finally bicomposite owing to disappearance of anterior bands. (4) *Cometa pattern* (from *Comura cometa*), with anterior pleural bands increasingly narrowed and depressed well below level of posterior bands to which they appear welded without sharp boundaries, also tending to retreat from border furrow; interpleural furrows narrow to faint; pleural furrows broad and deep.

Asteropyge Hawle & Corda, 1847 [*pro Pleuracanthus* Milne Edwards, 1840 (*non* Gray, 1832; *nec*

AGASSIZ, 1837)] [**Calymene arachnoides* GOLDFUSS in HOENINGHAUS, 1835 (=**Olenus punctatus* STEININGER, 1831)]. Cephalon gently to moderately vaulted, border distinct; no median frontal process; glabellar frontal lobe sloping, fused with slightly elevated, transversely arched central area, *2p* and *3p* lateral glabellar lobes detached abaxially by longitudinal furrows, *1p* lobes considerably below level of *2p* lobes, *3p* lateral glabellar furrows only moderately oblique; occipital ring very prom-

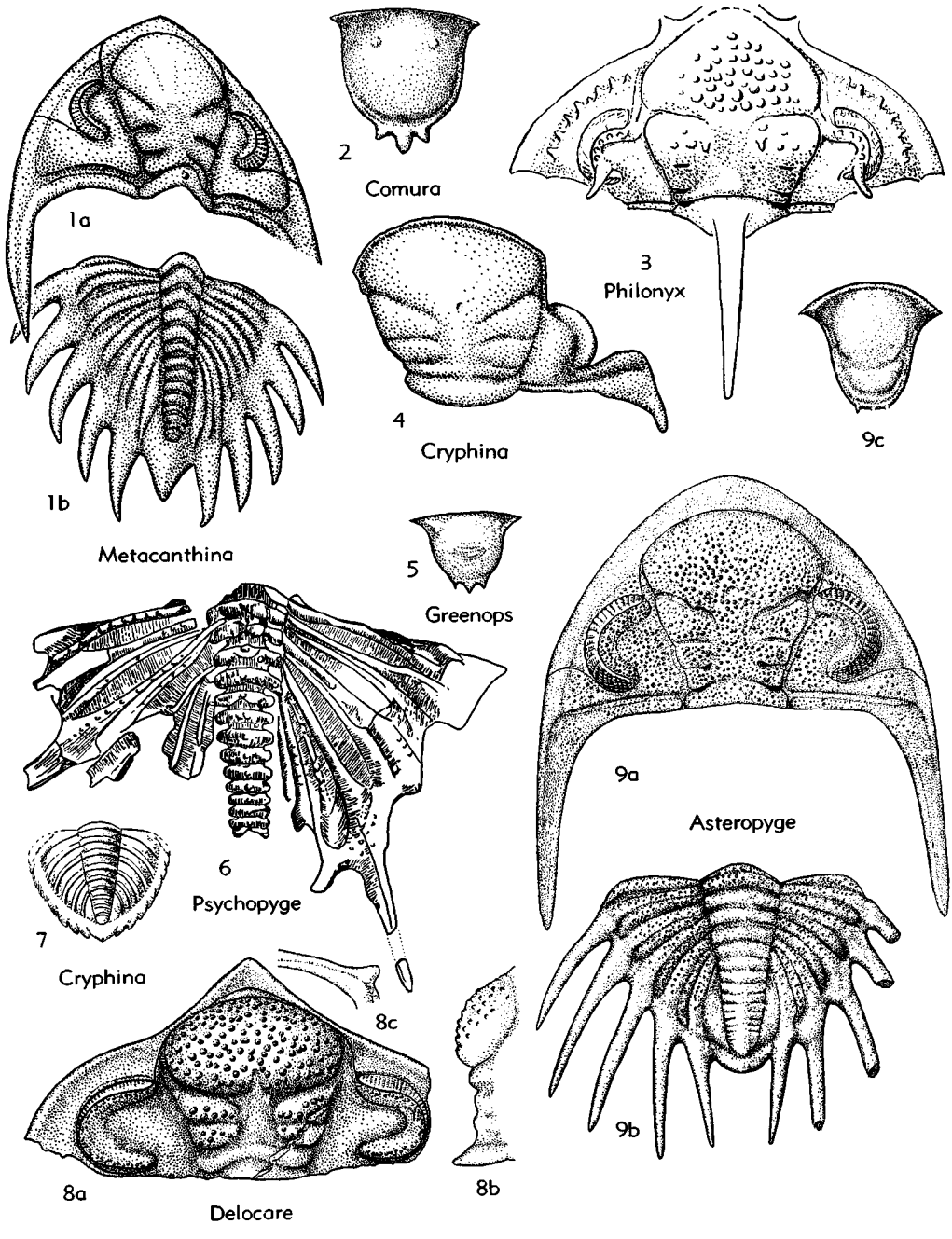


FIG. 379. Dalmanitidae (Asteropyginae) (p. O477-O483).

inent; palpebral lobes well above glabella; genal areas bordering eyes steeply sloping or even vertical, subocular ridges generally distinct; genal spines moderately to very long. Thorax with long pleural spines (type species). Pygidium with slender axis showing 10 to 15 rings, those near front bent slightly forward and near rear not bent; pleural fields with segmentation of *supradevonica* pattern showing 5 pairs of ribs (5th about as long as 1st) that are separated from axis by space for an unribbed field or 1 or 2 pairs of short ribs; border furrow, border, and traversing pads distinct in most species; 5 pairs of long, gently curved posterior pleural spines (5th distinctly shorter than 4th); posterior border produced in minute lappet or short spine. *M.Dev.-Low.U.Dev.*, Eu.——FIGS. 378; 379,*9a,b*. **A. punctata* (STEININGER), M. Dev., Ger. (Eifel); 378, exoskel. (reconstr.), ×1.5 (458n); 379,*9a,b*, ceph., pyg., ×2.7, ×1.7 (474n).——FIG. 379,*9c*. *A. supradevonica* (FRECH), Low.U.Dev., Ger. (Eifel); hypostoma, ×2.7 (474n).

Comura RICHTER & RICHTER, 1926 [**Cryphaeus cometa* RUD. RICHTER, 1909]. Cephalon transversely elongate; glabella with frontal lobe sloping peripherally on all sides, detached from central area which is depressed between *2p* and *3p* lateral glabellar lobes, lobes distinctly decreasing in size and elevation from *3p* to *1p; 3p* lateral glabellar furrows moderately oblique and *2p* tending to be reduced laterally; genal angles unknown. Pygidium with 7 to 10 axial rings bent forward near front and distinctly backward near rear, each with medial node; pleural fields with segmentation of *cometa* pattern, showing 5 pairs of ribs (5th subequal in length to 1st) and 5 pairs of long, posterior pleural spines; posterior spine or lappet present. [Under International Rules, *Comura* dates from 1926 despite the contrary opinion of RICHTER & RICHTER (1952, p. 81).] *Up.L.Dev., ?Low.M.Dev.*, Eu.

C. (Comura). Frontal glabellar lobe somewhat inflated but with broad flat top; all lobes distinctly detached from central area, *3p* lobes at about level of frontal lobe, *2p* lobes considerably smaller than *3p, 1p* lobes deep below level of glabella, very small, forming narrow "intercalating ring." Pygidium with 7 to 10 rings, near rear bent strongly backward; anterior pleural bands of pleural fields very narrow; border indistinct; traversing pads bearing short, vertical node or spine; posterior pleural spines very long, circular in cross section; posterior spine of same shape but shorter. *Up.L.Dev.*, Ger.-Sp.——FIG. 380,*3*. **C. (C.) cometa* (RUD. RICHTER), Ger. (Eifel); *3a*, cran., ×2.5 (474n); *3b*, pyg. (holotype), ×2.6 (251, 458, 474 mod.).——FIG. 379,*2*. *G. (C.) cometa?*, Ger. (Eifel); hypostoma, ×5.3 (254, 474 mod.).

C. (Delocare) STRUVE, 1958 (**Cryphaeus boopis* RUD. RICHTER, 1909). Cephalon with moderately broad convex border and broadly triangular median frontal process, border furrow wide, shallow; posterior part of glabella considerably below level of highly inflated frontal lobe, lateral glabellar lobes detached from central area, becoming low toward axial furrows; librigenae rather flat. Pygidium with 10 axial rings, bent moderately backward near rear; pleural fields with anterior pleural bands moderately reduced, posterior pleural bands bearing erect spine on geniculate bend of distal part; border furrow distinct, border moderately wide; posterior pleural spines long, vertically elongate subrectangular in cross section, 5th pair of spines longest; slightly upturned posterior lappet broadly triangular and pointed. *Up.L.Dev.*, Ger.——FIG. 379,*8a-c;* 380, *2*. **C. (D.) boopis* (RUD. RICHTER), Eifel; 379,*8a*, ceph. (lectotype); 379,*8b*, ceph. (another specimen), profile; 379,*8c*, part of 1st pygidial rib, posterior view; 380,*2*, pyg.; all ×1.65 (251, 474 mod.).

C.? (Philonyx) RICHTER & RICHTER, 1952 [**Asteropyge? (Philonyx) philonyx*]. Cephalic border distinctly convex, with conspicuous broadly subtriangular median frontal process and close to it on either side another short pointed process, border furrow distinct; glabella with frontal lobe somewhat inflated at sides, lateral glabellar lobes steeply descending in level from *3p* to *1p*, becoming low toward axial furrows; *3p* lobes fused laterally with much smaller *2p* lobes and raised considerably above frontal lobe; occipital ring with very long median spine; eyes somewhat distant from posterior border furrows and glabella, eye ridges(?) extending from posterolateral corners of frontal lobe to anterior end of palpebral lobes which bear long, erect spine on posterior end. Thorax and pygidium unknown. Surface of frontal lobe, *3p* lobes, palpebral lobes, and subocular ridges coarsely granulose. [Genus combines features of *Comura* and *Cryphaeoides;* relationships uncertain in view of lack of knowledge of pygidium.]. *Up.L.Dev.-Low.M.Dev.*, Ger.——FIG. 379,*3*. **C.? (P.) philonyx* (RICHTER & RICHTER), *Low.M.Dev.*, Harz; ceph. (holotype), ×1.3 (254).

Cryphina OEHLERT, 1889 [**C. andegavensis*]. Cephalon rather flat, with broadly rounded front margin and narrow well-marked anterior border; frontal lobe of glabella sloping gradually forward; *2p* lateral glabellar lobes slightly smaller than *3p;* "intercalating ring" narrow; occipital ring broad; eyes well behind *3p* furrows, slightly shorter than 0.5 of glabellar length *(exsag.);* genal spines short, blunt. Pygidium with prominent axis, bearing 8 to 10 distinct rings; lateral part of pleural fields sloping steeply, with subequal anterior and posterior pleural bands, interpleural furrows faint, pleural furrows rather broad, deep, 6 or 7 pairs of prominent ribs (last pair distinctly shorter than 1st); no border furrow, border distinct, with 7

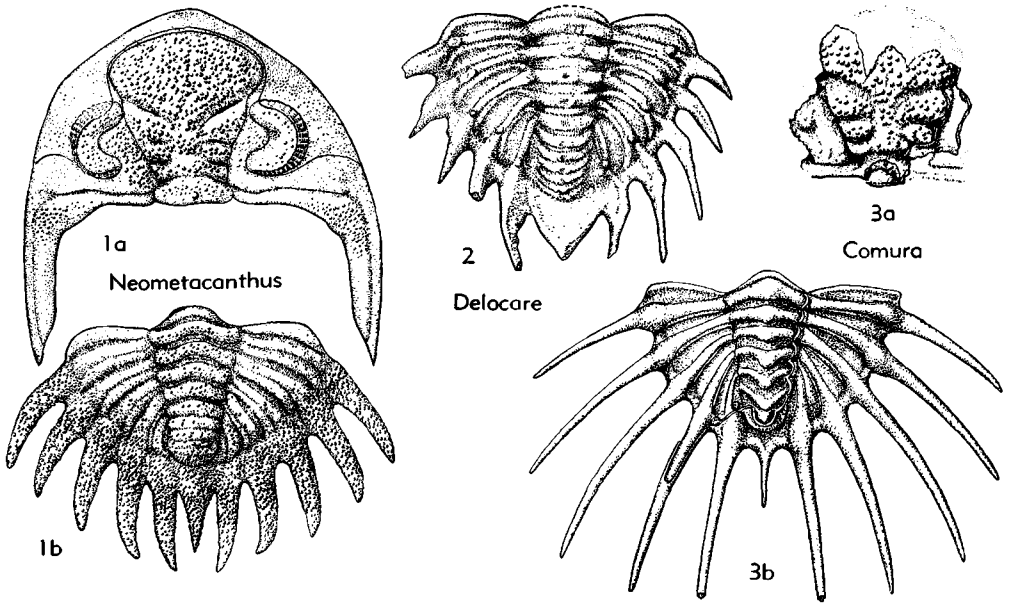


FIG. 380. Dalmanitidae (Asteropyginae) (p. O479-O480).

pairs of pleural processes and terminal process. *L. Dev.*, Gr.-Belg.-Ger.——FIG. 379,*7*. **C. andegavensis*, Fr.(St. Malo); pyg., ×0.7 (438, 458). ——FIG. 379,*4*. *C.? gdoumontensis* (ASSELBERGHS), Belg. (Weismes); cran., ×2.5 (461, 474).

Gourdonia PILLET, 1954 [**Dalmanites gourdoni* BARROIS, 1884]. Cephalon with fairly distinct border and very short angular median frontal process; frontal lobe of glabella not isolated from central area, decrease of size of lateral glabellar lobes well graded; eyes relatively small, considerably less than 0.5 of glabellar length, centrally on genae; genal spines long. Thorax with short pointed pleural lappets. Pygidium with long, slender axis containing about 12 rings (anterior 6 distinct); pleural fields with anterior pleural bands somewhat narrower than posterior bands; interpleural furrows faint proximally, broadening distally; pleural furrows broad proximally, narrowing distally; 6 pairs of ribs (6th subequal in length to 1st, close to axis), 6 pairs of short, slightly curved, pleural lappets; posterior lappet triangular, broad, long. *Dev.*, Fr.——FIG. 381,*4*. **G. gourdoni* (BARROIS), Haute Garonne; *4a*, ceph. (reconstr.), ×2.25; *4b*, pyg., ×1.5 (474).

Greenops DELO, 1935 [*pro Cryphaeus* GREEN, 1837 (*non* KLUG, 1833)] [**Cryphaeus boothi* GREEN, 1837]. Cephalon moderately convex; with border and border furrow scarcely visible, with preglabellar area but no median frontal process; frontal lobe of glabella sloping, not detached posteriorly from transversely arched forward sloping central area, *2p* lateral glabellar lobes distinctly smaller than *3p* and fused with them distally, *1p* lobes smaller than *2p*, not much depressed; lateral glabellar furrows deepening adaxially, *2p* furrows reduced abaxially to elongate pits, *1p* furrows abaxially above level of axial furrows; palpebral region of fixigenae sloping steeply toward glabella; genal spines broad, blunt, long. Pygidium with broad low axis containing 7 to 10 rings bent forward near front; pleural fields with segmentation of *boothi* pattern, with 5 pairs of ribs (5th distinctly shorter than 1st, close to axis) and 5 pairs of long, gently curved, posterior pleural lappets ranging from blunt to slender terminal lappet of similar shape, length, and breadth. [Taxonomic distinctness of subgenera doubtful.] *M.Dev., ?Low. U.Dev.*, N.Am.-Eu.

G. (Greenops). Thoracic pleural processes comprising short, blunt lappets. Pygidial ribs flat, anterior and posterior pleural bands subequal, traversing pads very broad, obliterating border; processes of lateral and posterior border developed as broad, flat lappets. *M.Dev., ?Low.U.Dev.*, N.Am.——FIG. 381,*1*. **G. (G.) boothi* (GREEN), M.Dev.(Hamilton); *1a*, ceph. (Ont.), ×3 (474, 476); *1b*, pyg. (Naples, N.Y.), ×3.75 (474). ——FIG. 379,*5*. *G. (G.?) collitelus* (GREEN), M. Dev.(Hamilton), Ont.; hypostoma, ×1.3 (54).

G. (Neometacanthus) RICHTER & RICHTER, 1948 [*pro Metacanthus* HAWLE & CORDA, 1847 (*non* COSTA, 1838)] [**Phacops stellifer* BURMEISTER, 1843]. Cephalon with palpebral lobes high above posterior part of glabella, adjacent region of fixigenae sloping steeply toward axial furrows. Thoracic pleural processes long, spinelike. Pygid-

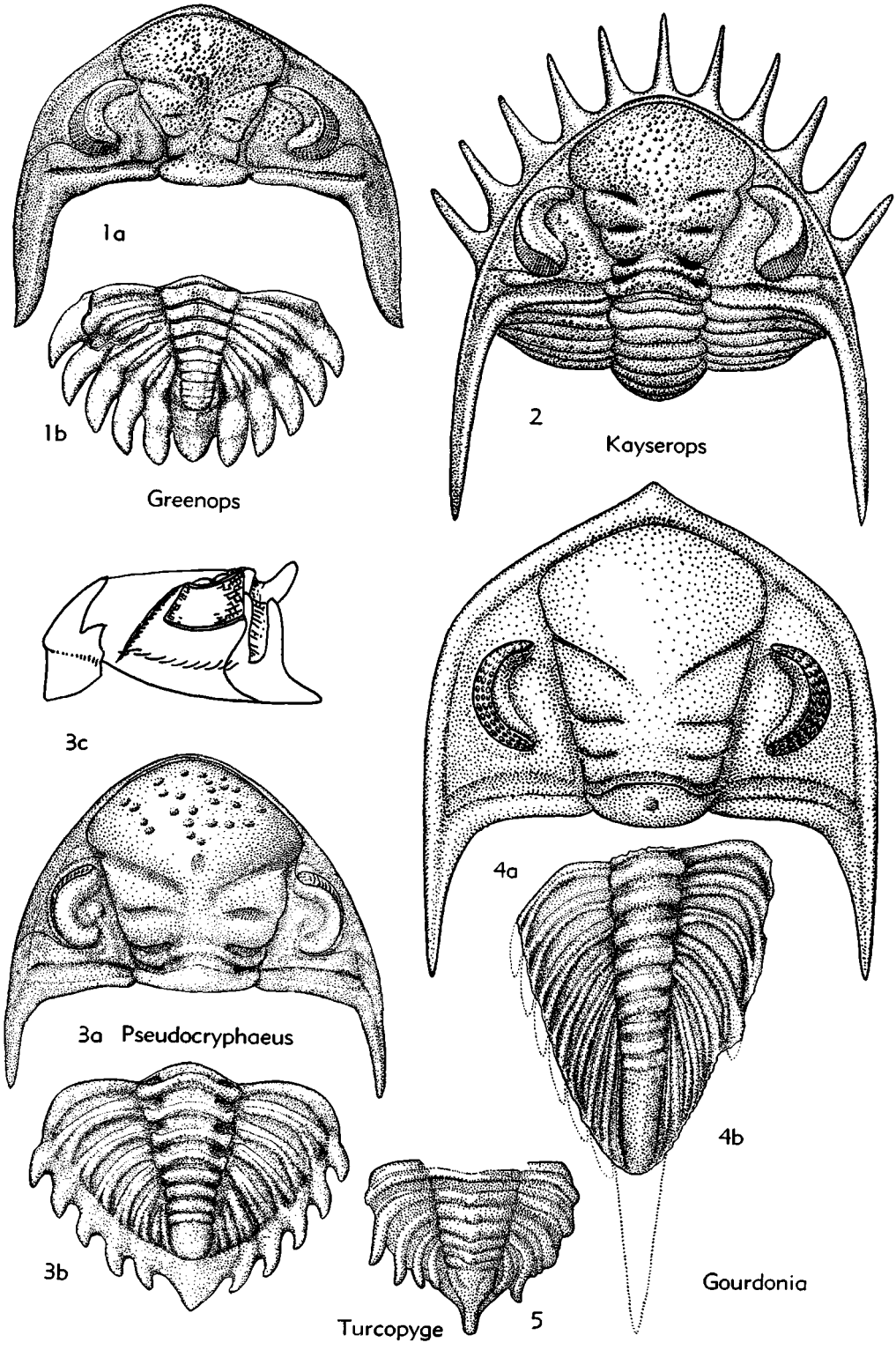


FIG. 381. Dalmanitidae (Asteropyginae) (p. O480-O482); Suborder Uncertain (*Turcopyge*, p. O495).

ium with fairly distinct border furrow and slightly inflated border that is visible between traversing pads; lateral and posterior processes of border slender. *Low.M.Dev.*, Ger.-Pol.——Fig. 380,*1*. **G. (N.) stellifer* (Burmeister), Eifel; *1a,b*, ceph., pyg., ×4.5 (474).

Kayserops Delo, 1935 [**Cryphaeus kochi* Kayser, 1883]. Cephalon high, without distinct border and median frontal process; preglabellar area very narrow; frontal lobe of glabella steeply sloping, faintly detached from central area, median and posterior parts of glabella subequal in elevation with palpebral lobes, so that central part of cephalon has a flattened appearance; *2p* and *3p* lateral glabellar lobes inflated, *1p*, depressed, decreasing in size from *3p* to *1p*; genae steeply sloping, with long genal spines. Thorax with moderately long straight pleural spines. Pygidium with rather prominent axis containing 10 to 12 rings bent gently forward near front and backward near rear; each with median node; pleural fields with segmentation of *cometa* pattern showing 5 pairs of distinct, equally long ribs; border and border furrow distinct; traversing pads well marked; 5 pairs of long, straight, posterior pleural spines; posterior spine of same shape and about equal length. *L. Dev.(Emsian)*, Ger.——Fig. 381,*2*. **K. kochi* (Kayser); exoskel., enrolled, ×3 (251, 474).

Metacanthina Pillet, 1954 [**Cryphaeus barrandei* Oehlert, 1889]. Border and border furrow of cephalon rather distinct, preglabellar area well developed; frontal lobe of glabella scarcely widened, backward decrease in size of glabellar lobes well graded, *1p* lateral glabellar lobes slightly narrower than occipital ring; eyes somewhat less than 0.5 of glabellar length *(exsag.)*, distant from lateral border furrow and distant from posterior border furrow; librigenae rather flat; long, broad genal spines. Thoracic pleural processes spinelike, straight, moderately long. Pygidium with moderately or very slender axis, 12 to 15 rings; pleural fields with segmentation of *boothi* to *prorotundifrons* pattern, 5 pairs of ribs (5th as long as 1st), 5 pairs of long, curved, pointed, pleural lappets; posterior lappet triangular, subequal to others in length but broader proximally. *L.Dev.-M.Dev.*, Fr.——Fig. 379,*1*. **M. barrandei* (Oehlert), Pt. Maillet; *1a,b*, ceph., pyg. (distorted holotype), ×1.3 (371 mod., 441 mod., 474).

Pseudocryphaeus Pillet, 1954 [**Phacops michelini* Rouault, 1851]. Cephalon considerably vaulted, with front margin narrowly rounded to subangular, cephalic border moderately distinct, narrow in front of glabella; frontal lobe rather steeply sloping forward and sideward, *2p* and *3p* lateral glabellar lobes about same in elevation and more or less fused laterally, *2p* not much smaller than *3p*, *1p* lobes depressed deeply below general level of glabella, "intercalating ring" very narrow; *2p* lateral glabellar furrows reduced distally, lacking adaxial pits, but *1p* deep, with elongate pits; genal spines broad and short. Pygidium with moderately broad high axis containing 10 rings bent somewhat forward near front; pleural fields with segmentation of *boothi* pattern showing 5 pairs of ribs (5th distinctly shorter than 1st; a 6th pair of incomplete ribs may occur); 5 pairs of short, slightly curved, posterior pleural lappets; posterior lappet of about same length, but broader proximally. *L.Dev.*, Fr.——Fig. 381,*3*. **P. michelini* (Rouault); *3a*, ceph., ×2.2 (474); *3b*, pyg., ×3.75 (474); *3c*, ceph., showing plowshare-

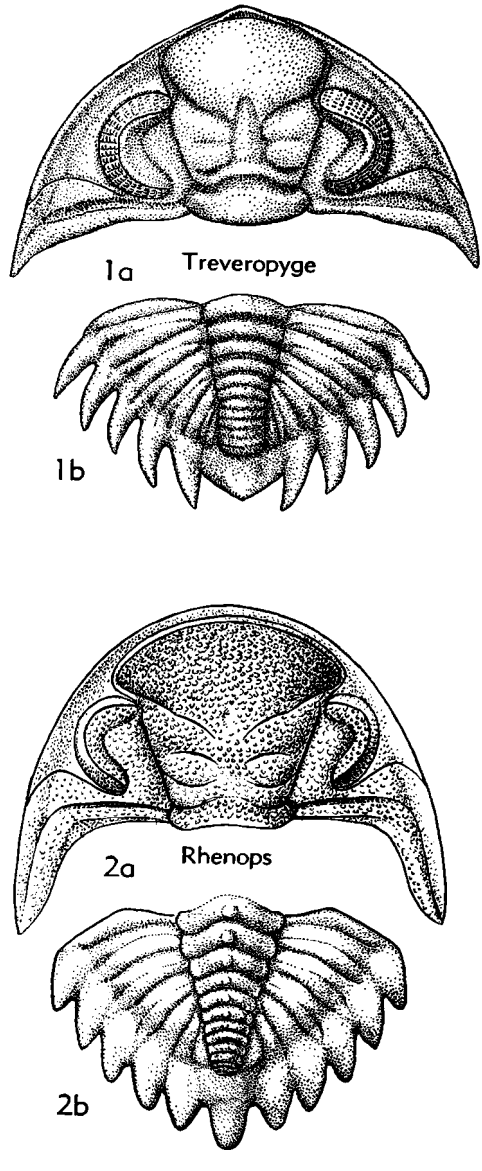


Fig. 382. Dalmanitidae (Asteropyginae (p. O483).

like process of frontal part of doublure, ×3 (460).

Psychopyge TERMIER & TERMIER, 1950 [**Psychopyge elegans*]. Cephalon and thorax unknown. Pygidium with very slender axis containing many rings (14 preserved with space for some more), posterior rings probably transverse; pleural fields with 5 pairs of distinctly biramous ribs (5th as long as 1st), broad distal endings of ribs fused with border; posterior segmental bands narrow but anterior bands still narrower; interpleural furrows narrow, deep; pleural furrows broad, deep; ?5 pairs of long, posterior pleural spines; posterior part of pygidium unknown. *L.Dev.*, Morocco.——FIG. 379,*6*. **P. elegans*; pyg. (holotype), ×1.3 (479).

Rhenops RICHTER & RICHTER, 1943 [**Cryphaeus anserinus* RICHTER & RICHTER in RUD. RICHTER, 1916]. Cephalon gently to moderately vaulted, with rounded front margin, border well developed both laterally and anteriorly, border furrow shallow, but distinct; axial furrows distinctly divergent forward; decrease in size of glabellar lobes well graded, *2p* and *3p* lateral glabellar lobes fused distally, about same in elevation as central area, middle part of "intercalating ring," and palpebral area; *3p* lateral glabellar furrows only moderately oblique; eyes large (about 0.7 of glabellar length), extending to lateral border furrow; broad, blunt, moderately long genal spines. Thoracic pleurae with long sickle-shaped processes. Pygidium with moderately broad, not very prominent axis containing up to 10 rings; pleural fields with segmentation of modified *boothi* pattern showing subequal posterior and anterior pleural bands that tend to fuse by reduction of interpleural furrows; pleural furrows narrow; 5 pairs of flat ribs (5th distinctly shorter than 1st, close to axis); border distinct; no border furrow; 5 pairs of rather short, curved, pleural to posterior pleural lappets; posterior lappet of same shape and breadth, of same length or longer. *L.Dev.*, Ger.-AsiaM.——FIG. 382,*2*. **R. anserinus* (RICHTER & RICHTER), Ger.(Eifel); *2a*, ceph., ×1.7 (251, 458); *2b*, pyg., ×3.4 (251, 474 mod.).

Treveropyge STRUVE, 1958 [**Asteropyge (Asteropyge) prorotundifrons* RICHTER & RICHTER, 1943]. Cephalon gently vaulted, much widened, with distinct subhorizontal border that is narrow anteriorly; short median frontal process; axial furrows diverging slightly forward with re-entrants at *3p* lateral glabellar furrows, frontal lobe somewhat inflated, usually above level of transversely arched, wedge-shaped central area; *2p* and *3p* lateral glabellar lobes gently sloping sideward, fused distally, more or less detached adaxially, *1p* lobes somewhat depressed, tending to fuse with *2p* lobes distally; genae sloping gently to moderately sideward, with very short genal spines pointing obliquely outward. Thorax with long, spinelike pleural lappets. Pygidium with broad, moderately high axis containing 10 to 12 rings bent gently forward near front; pleural fields with segmentation of *prorotundifrons* pattern showing 5 pairs of flat ribs (5th pair considerably shorter than 1st, distant from axis, with 6th pair of rudimentary ribs present in some) that bifurcate distinctly by distal broadening of interpleural furrows; traversing pads broad; 5 pairs of gently curved, short to moderately long, pleural lappets; posterior lappet broad, short, slightly tipped and upturned. *L.Dev.-M.Dev.*, Eu.-?N.Afr.——FIG. 382, *1*. **T. prorotundifrons* (RICHTER & RICHTER), L. Dev., Ger.(Eifel); *1a*, ceph., ×2.6; *1b*, pyg. (holotype), ×2.6 (251, 474 mod.).

Family CALMONIIDAE Delo, 1935

[*nom. transl.* STRUVE, 1958 (*ex* Calmoniinae, *nom. correct.* DELO, 1940, *pro* Calmoninae DELO, 1935)] [*Authorship.* Except for contributions by RUD. RICHTER relating to *Calmonia*, *Paracalmonia*, *Pennaia*, *Probolops*, *Schizostylus*, *Acaste*, *Acastoides*, and *Kloucekia*, all parts of the section here published on Calmoniidae are by W. STRUVE.]

Exoskeleton typically compact, in many genera with *Phacops*-like bluntness. Cephalic border (frontal processes excluded) narrow in front of glabella or not visible from above; axial furrows slightly to moderately divergent; *3p* lateral glabellar furrows simple, in none bipartite, tending to become faint and (exceptionally) obsolete, *2p* furrows moderately deep or shallow (exceptionally obsolete), in most genera not reaching axial furrows, *1p* deepest of glabellar furrows; *2p* and *3p* lateral glabellar lobes fused marginally; eyes small to moderately large (especially in Acastinae), in most genera distinctly to far distant from posterior border furrows; genal sulcus shallow if present; no vincular furrows (?except *Typhloniscus*). Hypostoma short, with maculae close to lateral borders. Pygidium short, semicircular, with moderately to very broad axis; pleural fields with 3 to 5 pairs of ribs or a few more. *Ord.-M.Dev.*

Subfamily CALMONIINAE Delo, 1935

[*nom. correct.* DELO, 1940 (*pro* Calmoninae DELO, 1935)]

Exoskeleton small to moderately large. Cephalon rounded subtriangular, with median frontal processes a common feature; *2p* and *3p* lateral glabellar furrows present in all genera but faint in many, *2p* slightly oblique in posteromesial direction, *1p* deep, exceptionally not reaching axial furrows; *1p* to *3p* lateral glabellar lobes subequal in length *(exsag.)* in most genera; eyes small, at mid-length of genae *(exsag.)*, more or less distant from glabella; anterior sections of

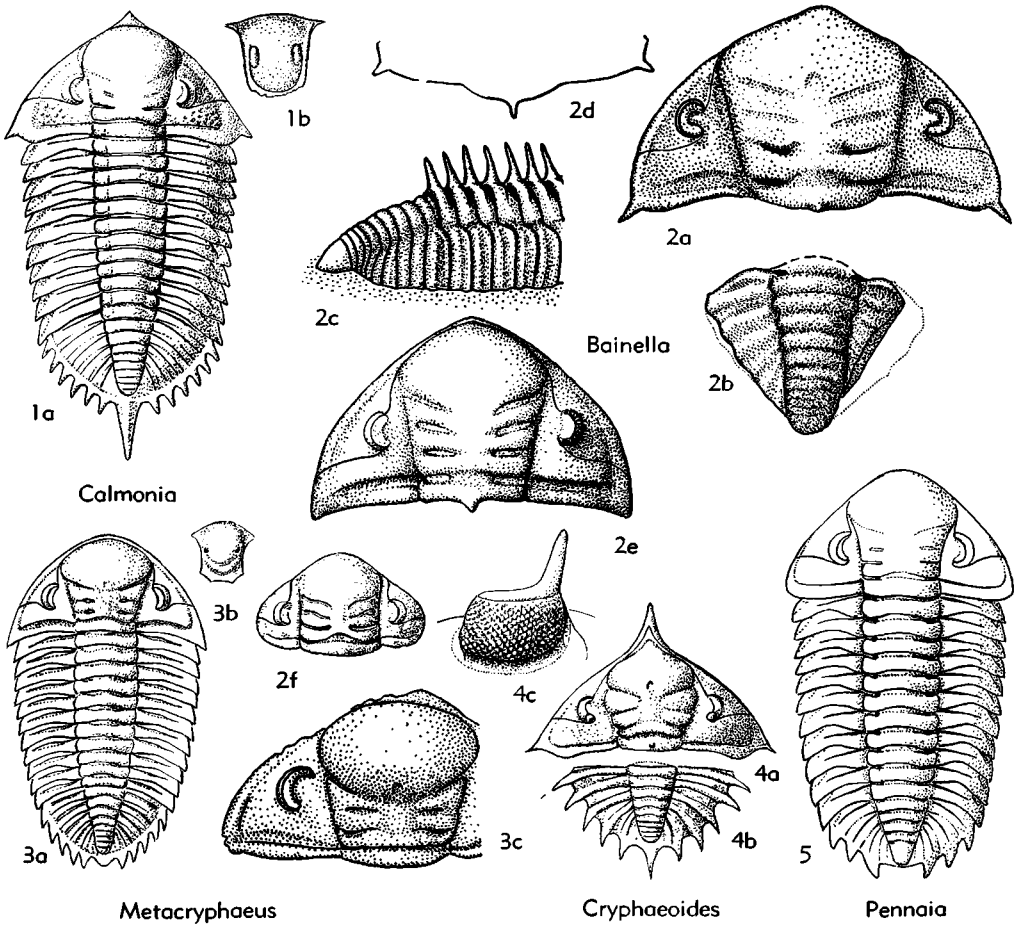


FIG. 383. Calmoniidae (Calmoniinae) (p. O484-O486).

facial sutures may cut off lateral corners of glabella; genal angles rounded or (exceptionally) angular, without true genal spines in straight continuation of lateral cephalic margins but spiniform processes (in diagnoses simply termed "spines") that originate on rounded genal angles. Thoracic pleural endings rounded, pointed angular, or bearing short spines (in several species resembling shape of genal spines). Pygidium showing tendency to develop pleural border spines or lappets; posterior lappet or spine in many genera. *Ord.-M.Dev.*

Calmonia CLARKE, 1913 [**C. signifer;* SD VOGDES, 1917]. Cephalon with short median frontal process; glabella depressed, resembling that of *Acaste;* axial furrows slightly divergent; *3p* lateral glabellar furrows shallow and *2p* reduced to elongate, shallow adaxial grooves; eyes rather small, distant from posterior border; in type species facial sutures cut lateral corners of glabella; with short genal spines. Pygidium as in Asteropyginae but with 5 pairs of ribs and 6 pairs of long pleural spines; type species with long posterior spine. *L.Dev.*, S.Hemis.——FIG. 383,*1a.* **C. signifer,* Braz.(Paraná); ×0.7 (24).——FIG. 383,*1b.* *C. subseciva* CLARKE, Braz.(Paraná); hypostoma, ×2.7 (24).

Bainella RENNIE, 1930 [**B. bokkeveldensis*] [=*Paradalmanites* PILLET, 1954]. Cephalon stout, with wide subtriangular, subpentagonal, or semi-elliptical outline; frontal border visible from above or not, without median frontal process; glabella rather uniformly vaulted, compact, subpentagonal to pear-shaped, frontal lobe of 0.5 glabellar size or considerably less, not detached from central area; all glabellar furrows more or less distinctly

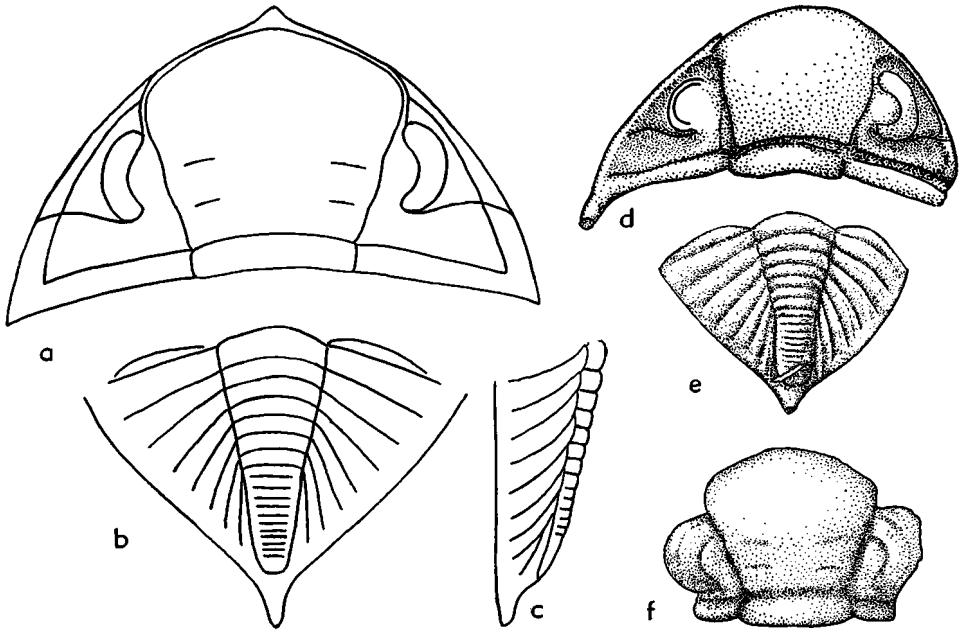


FIG. 384. *Dalmaniturus* (Calmoniidae) (p. O485).

oblique in posteromesial direction (with few exceptions) and distant from axial furrows; *3p* lateral glabellar furrows shallow, *2p* generally a little deeper, and *1p* very deep, especially adaxially; median occipital spine present; eyes small, about in center of genae; genal angles rounded, short genal spines may be present. Thoracic axis broad, with mesial spines. Pygidium highly vaulted, subtriangular, with broad, prominent axis containing 8 to 10 rings; pleural fields with 5 to 8 pairs of distinct ribs showing anterior pleural bands reduced or obsolete; posterior margin bluntly pointed or with spine. *L.Dev.;* S.Afr.-?MalvinI.-?Braz.——FIG. 383,*2a-c*. **B. bokkeveldensis,* Bokkeveld beds, S.Afr.; *2a,* ceph. (reconstr. from 2 specimens) (474); *2b,* pyg. (partly reconstr. from external mold; *2a* and *2b* preserved in same nodule), ×1.3 (474); *2c,* part of thorax and pyg., ×0.7 (456).——FIG. 383,*2d*. *B. acacia* (SCHWARZ), Bokkeveld beds, S.Afr.; posterior region of cephalon of holotype (reconstr.), ×0.7 (456). [This is the type species of *Paradalmanites,* holotype very poorly preserved (456, p. 348) but showing many features of *B. bokkeveldensis* and perhaps junior synonym. The form called *B. acacia* by CLARKE (1913) presumably does not belong to this species.]——FIG. 383,*2e*. *B.?* sp., L.Dev., Malvin I.; ceph., ×1 [=*B. acacia* (*sensu* CLARKE)].——FIG. 383,*2f*. *B.? ocellus* (LAKE), Bokkeveld beds, S.Afr.; ceph., ×0.7 (421).

Cryphaeoides DELO, 1935 [**Cryphaeus rostratus* KOZLOWSKI, 1923]. Cephalon with median frontal spine; glabella subpentagonal; frontal lobe less protruding laterally than *3p* lateral lobes, *1p* to *3p* completely separated by distinct lateral furrows, central area between *2p* and *3p* lobes slightly detached anteriorly, laterally, and posteriorly, gently arched *(tr.);* eyes with about 0.3 of glabellar length, in center of genae; long erect spines on posterior ends of palpebral lobes; anterior sections of facial sutures meet at half length *(sag.)* of dorsal surface of frontal spine; short genal spines present. Pygidium with 10 distinct rings and 5 pairs of ribs, anterior pleural bands subequal in width to posterior bands and below their level; no distinct border; 5 pairs of long posterior pleural spines and long posterior spine present. *M.Dev.,* Bol.——FIG. 383,*4*. **C. rostratus* (KOZLOWSKI), Sicasica; *4a,b,* ceph., pyg., ×0.7; *4c,* side view of eye, ×2 (111).

[Contrary to previous usage *Cryphaeoides* here is included in the Calmoniinae because the genal spines and small eyes are in a typical position for the subfamily. The segmentation of the glabella is comparable to that of *Schizostylus*. The course of anterior sections of the facial sutures is intermediate between *Calmonia* and *Schizostylus*. The genal angles are as in *Calmonia*. The similarities with *Comura? (Philonyx)* probably are due to convergence (see Asteropygiinae), solution of this question depending on discovery of complete specimens of *Philonyx*.]

Dalmaniturus CHERNYCHEVA, 1937 [**D. weberi*]. Cephalon rather flat; with small median frontal process; axial furrows narrow; glabella subpentangular in outline; *1p* and *2p* lateral glabellar furrows faintly visible but not reaching axial furrows; eyes distant from posterior border furrows, very prominent, embraced by a shallow depres-

sion; anterior sections of facial sutures in marginal position anteriorly; genal angles pointed. Pygidium triangular, with slender axis, 16 to 20 rings; pleural regions with 7 or 8 pairs of ribs separated by narrow furrows, 8th pair of ribs parallel and close to axis; without distinct border; posterior spine present. [This genus displays mingled calmoniid (cephalon) and dalmanitid (pygidium) features, being related seemingly to *Phacopidina.*] *Sil.*, C.Asia.——Fig. 384,*a-e*. **D. weberi*, W.Mongol.; *a*, ceph., ×4; *b-c*, pyg., ×4.8; *d*, ceph. (holotype); *e*, pyg., ×3.2 (all 384).——Fig. 384,*f*. *D.* sp. cf. *D. weberi*, Tuva; cran., ×3.2 (384).

Metacryphaeus Reed, 1907 [**Phacops (Cryphaeus) cafer* Salter, 1856; SD Rennie, 1930 (*non Phacops ocellus* Lake, 1904; SD Richter & Richter, 1942)] [=*Hadrorachus* Delo, 1935; *Hadrorakos* Delo, 1940 *(nom. van.)*]. Cephalon moderately vaulted in most species, lateral cephalic border and border furrows faintly distinct, anterior margin rounded or produced in short median frontal process; axial furrows straight, moderately divergent; frontal lobe of glabella gently to considerably inflated and distinctly detached from lower posterior part of glabella, central area tending to be gently arched *(tr.)*; *3p* lateral glabellar furrows well defined, *2p* reduced distally, somewhat transverse, *1p* deepest furrows, reaching axial furrows or not, more or less transverse; *2p* and *3p* (even *1p*) lateral glabellar lobes fused; eyes about 0.3 of glabellar length *(exsag.)*, near center of genae; genal angles subangular or bluntly pointed. Thoracic axis broad; anterior pleurae with subangular to pointed ends, approaching shape of pygidial pleural lappets in posterior pleurae. Pygidium with 9 to 11 rings and 5 pairs of ribs (6th incomplete); pleural furrows deep, interpleural furrows narrow, faint; 5 pairs of moderately long, slightly curved, pointed (exceptionally rounded) pleural lappets; posterior lappet short, rather broad. *L.Dev.*, Braz.-Bol.-Falkland I.-S.Afr.——Fig. 383,*3c*. **M. cafer* (Salter), Bokkeveld beds, S.Afr.; ceph., part, ×1 (452).——Fig. 383,*3a,b*. *M. australis* (Clarke) [type species of *Hadrorachus* Delo, 1935], L.Dev., Braz.(Paraná); *3a,b*, exoskel., hypostoma, ×0.7 (24).

[This genus usually is included in the Asteropyginae (Dalmanitidae) because of its pygidial features. The eyes, however, are very small for this subfamily and in a typical Calmoniinae position. Special weight on shape of the genal spines (not clearly shown by available figures) is warranted and comparison of these structures belonging to *M. australis* and *Asteropyge*, for example, shows significant differences.]

Paracalmonia Struve, 1958 [*pro Proboloides* Clarke, 1913 (*non* Valle, 1893; *nec* Morley, 1903)] [**Proboloides cuspidatus* Clarke, 1913; SD Vogdes, 1917]. Cephalon with long median frontal spine, separated from glabella by facial sutures surrounding frontal lobe closely; *2p* glabellar furrows short, not reaching axial furrows; fixigenal and prolibrigenal spines short. Pygidium presumably with long terminal spine. [Very similar to *Calmonia* in segmentation of glabella, course of anterior sections of facial suture, eyes, and genal spines.] *L.Dev.*, Braz.——Fig. 385,*2*. **P. cuspidata* (Clarke); ceph., ×1 (24).

Pennaia Clarke, 1913 [**P. pauliana*]. Cephalon similar to that of *Calmonia*, without median frontal process or genal spines. Thoracic axis very broad. Pygidium short, as in Asteropyginae, with moderately long pleural lappets (but only 3 pairs) and 3 pairs of ribs; posterior margin between lappets broadly rounded. *L.Dev.*, S.Hemis.——Fig. 383,*5*. **P. pauliana*, Braz.(Paraná); exoskel., ×1.3 (24).

Phacopidina Bancroft, 1949 [**Phacopidina harnagensis*]. Cephalon subpentangular, resembling that of *Kloucekia*, with narrow angular anterior border; axial furrows straight, moderately divergent; lateral glabellar furrows increasingly deep from *3p* to *1p*, all gently oblique in posteromesial direction, separating subequal glabellar lobes, *1p* furrows bifurcated adaxially; eyes moderately large, considerably distant from posterior border furrows; short genal spines. Pygidium subtriangular; with about 6 rings and 5 pairs of ribs; postaxial ridge continued into an upturned posterior spine. *Ord.*, Br.I.——Fig. 385,*4a,b*. **P. harnagensis*, Harnage Sh., Eng.(Shrops.); *4a,b*, ceph., pyg., ×2.7 (369).——Fig. 385,*4c,d*. *P.? solitaria* (Barrande), Czech.; *4c,d*, ceph., ×1.3 (3).

[*Phacopidina* resembles Acastinae *(Kloucekia)* and Zeliszkellinae in showing presence of all glabellar furrows, bifurcation of *1p* furrows, and eyes in anterolateral position, but seems to be closer to the Calmoniinae trend, as indicated by direction of the *2p* glabellar furrows, all glabellar lobes of about same size, and shape of genal spines (if imperfect figure of the type species by Bancroft is interpreted correctly).]

Probolops Delo, 1935 [**Proboloides glabellirostris* Kozlowski, 1923]. Frontal lobe of glabella produced into a forward-directed spine; anterior sections of facial sutures border frontal lobe and meet beneath the spine; posterior margin of cephalon with a sharp angularity or rudimentary metafixigenal spine on either side, halfway between axial furrows and genal spines. Pygidium unknown. [Comparable with *Schizostylus* and *Paracalmonia*, and in glabellar segmentation with *Calmonia*; angularity of the posterior margins suggests *Cryphaeoides.*]. *L.Dev.*, Bol.——Fig. 386,*1*. **P. glabellirostris* (Kozlowski), Padilla; ceph., ×1 (111).

Tibagya Struve, 1958 [*pro Schizopyge* Clarke, 1913 (*non* Heckel in Russegger, 1847)] [**Homalonotus (Schizopyge) parana* Clarke, 1913; SD Vogdes, 1925]. Cephalon and thorax unknown. Pygidium with broad, flat axis containing 9 rings; pleural fields with 4 pairs of broad ribs continued into 4 pairs of curved, rounded pleural pygidial lappets; posterior degenerated ribs embrace end of axis; posterior end bluntly pointed, upturned; no border. [Re-

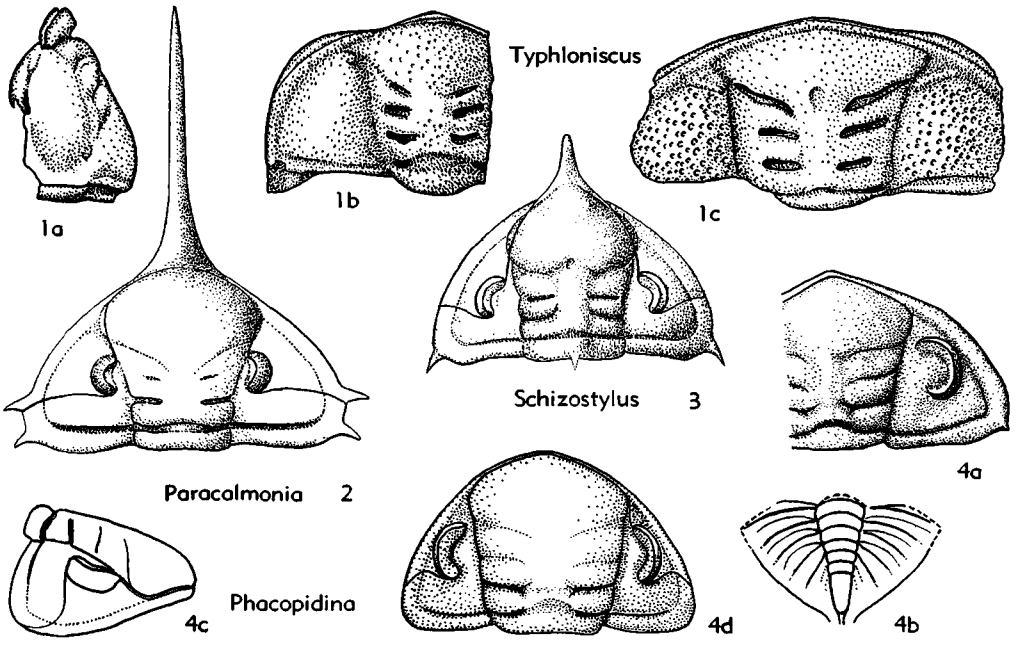


FIG. 385. Calmoniidae (Calmoniinae) (p. O486-O487).

sembles pygidium of *Pennaia.*] *L.Dev.*, Braz.——FIG. 386,*2*. **T. parana* (CLARKE), Tibagy; pyg., ×1 (24).

Schizostylus DELO, 1935 [**Dalmanites brevicaudatus* KOZLOWSKI, 1923]. Cephalon with strong median frontal process; facial sutures cut off lateral corners of glabellar frontal lobe, anteriorly being in marginal position, dividing process into a dorsal convex half (prolongation of cephalic border) and ventral concave half (continuation of doublure); axial furrows subparallel; *1p* to *3p* lateral glabellar furrows distinct, *2p* fading away distally, *1p* not transglabellar; eyes distant from glabella; median occipital spine ?invariably present; short genal spines. Pygidium very small, rounded; with 5 or 6 rings and 3 or 4 pairs of ribs. *M. Dev.*, Bol.——FIG. 385,*3*. **S. brevicaudatus* KOZLOWSKI), Letanias; ceph., ×0.7 (111).

[The glabellar segmentation shows more resemblance to Dalmanitinae than to typical Calmoniinae, but outline of the cephalon, genal angles, median frontal process, smallness and position of eyes, and lateral corners of frontal lobe cut off by facial sutures correspond to features of *Calmonia, Paracalmonia, Pennaia,* and *Probolops*. The short pygidium would be unusual for Dalmanitinae.]

Typhloniscus SALTER, 1856 [**Typhloniscus bainii*]. Cephalon wide, roughly subpentagonal, with distinct border and broad, shallow border furrows; axial furrows also broad, shallow; frontal glabellar lobe gently vaulted, lateral ends pointed; *3p* lateral glabellar furrows shallow, *2p* and *1p* deep, rather short, somewhat distant from dorsal furrows, and slightly oblique in posteromesial direction; genae swollen, subtriangular; eyes possibly represented by swellings at anterior ends of genae; facial sutures may be represented by groove that runs along upper side of rounded border, becoming inframarginal toward genal angles, which are slightly produced; vincular furrow ?present anteriorly and anterolaterally. Surface of cephalon covered with scattered pits which are particularly coarse on genae. Thorax strongly tapering posteriorly; with prominent, rather narrow axis and pleural ends pointed. Pygidium comparatively small, rounded, with entire margin; axis very prominent, not becoming narrower and lower backward but abruptly truncate and slightly overhanging posteriorly; 4 (+1 indistinct) rings; pleural lobes depressed; 3 (+1 reduced) pairs of very prominent ribs. [Systematic position of *Typhloniscus* is uncertain; despite peculiar features it seems most similar to *Bainella,* as in glabellar segmentation and pitted ornamentation of the genae.] *L.Dev.*, S.Afr.——FIG. 385,*1*. **T. bainii,* Bokkeveld beds, Gamka Poort; *1a-c,* cephala, ×1.3 (456).

Subfamily ACASTINAE Delo, 1935

Exoskeleton small. Cephalon semicircular to rounded subtriangular, without frontal processes; *3p* lateral glabellar furrows undulating in many species, *2p* typically transverse, slightly convex forward or straight; *2p* and *3p* lateral glabellar lobes generally fused distally; in some species entire glabella

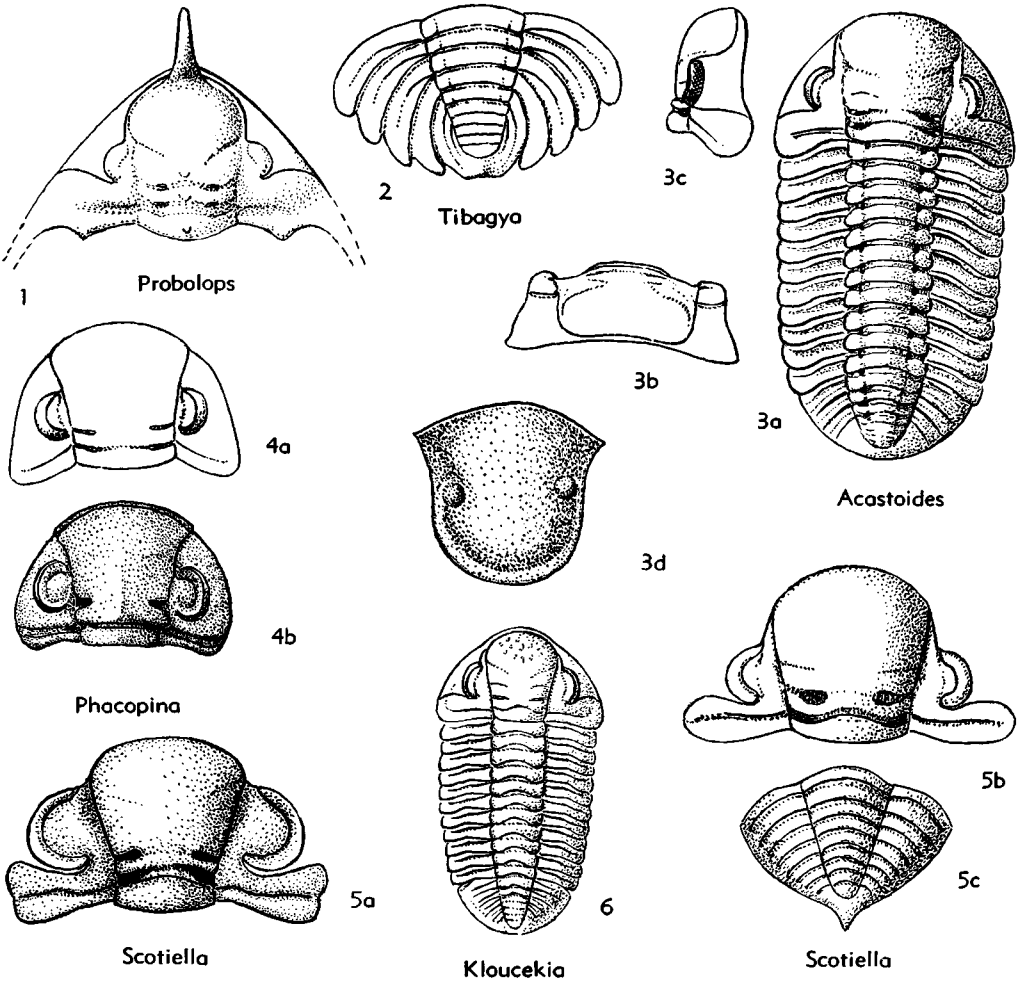


FIG. 386. Calmoniidae (Calmoniinae, Acastinae) (p. O486-O489).

in front of *1p* furrows may form a uniform, unsegmented lobe; *2p* and *3p* lobes about equal in size exsagittally, *1p* commonly much narrower *(exsag.);* eyes of moderate or considerable size; genal angles rounded or angular, may be produced into lobes, in some species slightly pointed but without true genal spines. Thorax with pleural endings blunt, rounded, or angular. Pygidium with entire margin; short posterior spine present. *Ord.-L.Dev.*

Acaste GOLDFUSS, 1843 [**Calymene? downingiae* MURCHISON, 1839; SD BURMEISTER, 1843] [=*Acastina* REED, 1927 *(nom. van.)*]. Cephalon with convex border, in side view projecting without edge; glabella gently sloping anteriorly; glabellar lobes differing little in size; *1p* lateral glabellar furrows deepest; genae gently sloping laterally; genal angles without spines, at most slightly pointed. Hypostoma with maculae near margin. Pygidium relatively long, rounded, tending to become triangular; margin without interior denticles; axis anteriorly narrow, scarcely tapering. *Sil.,* Eu.-N.Am.——FIG. 387. **A. downingiae* (MURCHISON), Wenlock., Eng.(Dudley); *a,* exoskel.; *b,* cephalic doublure and hypostoma; *c,d,* cephala, showing pointed genae; all ×2 (*a,b,* 266; *c,d,* 255).

Acastoides DELO, 1935 [**Acaste henni* RUD. RICHTER, 1916]. Cephalon short, stout, frontal margin rounded, not visible from above; glabella high, abruptly sloping anteriorly; axial furrows nearly parallel; frontal glabellar lobe short, scarcely protruding sideward; genae abruptly sloping laterally, frontal view of cephalon rectangular; eyes very

small, visual areas high above genae, narrow, with 4 lenses at most in vertical rows; genal angles rounded. Hypostoma with maculae near margin. Pygidium steeply sloping laterally, with entire, rounded margin; only on doublure 6 spine-like tubercles may occur, directed downward, segmental, but different from marginal denticles of *Acastella, Acastellina, Acastava;* axis flat, in transverse section scarcely interrupting outline of pygidium, anteriorly very broad, tapering rapidly, its posterior end passing over into general surface, only 3 rings distinct, without interruption continuing across the indistinct axial furrows into the faint ribs, following rings coalesced; 3 to 5 ribs, only anterior ones distinct. *L.Dev.,* Eu.-Bol. ——FIG. 386,*3*. **A. henni* (RUD. RICHTER), Ger.; *3a-c,* exoskel., ceph. front and side, ×2; *3d,* hypostoma, ×7 (460, 1916).

Kloucekia DELO, 1935 [**Phacops phillipsi* BARRANDE, 1846]. Frontal border a narrow rounded ridge; axial furrows straight, diverging slightly; *3p* lateral glabellar furrows faint, *1p* distinct, narrow, short; eyes large; surface of genae behind them almost vertical. Pygidium small, rounded; axis narrow, with 3 to 5 rings; pleural fields with 3 to 6 ribs. *Ord.,* Czech.——FIG. 386,*6*. **K. phillipsi* (BARRANDE); exoskel., ×2 (3).

Phacopina CLARKE, 1913 [**Phacops braziliensis* CLARKE, 1890; SD VOGDES, 1925]. Cephalon with axial furrows subparallel or slightly diverging; glabella moderately convex, roughly rectangular to trapezoidal; *2p* and *3p* lateral glabellar furrows faint or obsolete, *1p* and *2p* not converging outward, *1p* deep, faintly transglabellar or not connected; distal ends of occipital furrow deep, middle part moderately deep or shallow; genal angles rounded in general (less commonly angular; short genal spines recorded exceptionally). Surface smooth. *Ord.-L.Dev.,* N.Am.-S.Am.-Eu.

P. (Phacopina). Exoskeleton small. Cephalon with moderately deep axial furrows, swinging slightly outward; glabella subrectangular to subtrapezoidal; frontal glabellar lobe broadly rounded anteriorly; *2p* and *3p* lateral glabellar furrows obsolete; occipital ring scarcely broadened medially; eyes moderately large. Pygidium blunt, convex. *L.Dev.,* N.S.Am.-E.N.Am.——FIG. 386,*4a*. **P. (P.) braziliensis* (CLARKE), Braz.(Pará); ceph., ×3 (386).——FIG. 386,*4b*. *P. (P.) anceps* (CLARKE), Onondaga Ls., Ont.(Cayuga); ceph., ×3.5 (386).

P. (Scotiella) DELO, 1935 [**Dalmania logani* HALL, 1860]. Cephalon moderately vaulted, with straight, deep axial furrows; glabella subrectangular, subtrapezoidal, or subpentangular; *2p* and *3p* lateral glabellar furrows indistinct or obsolete, *3p* oblique, *2p* transverse; occipital furrow curved gently forward mesially, so that middle part of occipital ring is somewhat broadened; eyes large. Pygidium moderately vaulted; with 3 to 8 rings and 3 to 6 pairs of furrowed or unfurrowed ribs distinct; short posterior spine may be present. *Ord.-Sil.,* N.Am.?Eu.——FIG. 386,*5*. *P. (S.) logani* (HALL), Sil. (Stonehouse F.), N.Scotia (Arisaig); *5a,b,* cran. (*5a,* reconstr.), ×2.5 (403, 427); *5c,* pyg., ×2.5 (403).

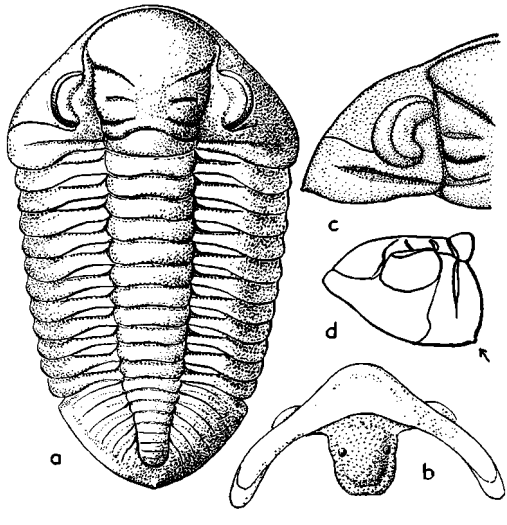


FIG. 387. **Acaste downingiae* (MURCHISON) (Calmoniidae), M.Sil., Eng.; *a,* exoskel.; *b,* cephalic doublure and hypostoma; *c,d,* cephala; all ×3 (*a,b,* 266; *c,d,* 255).

Family PTERYGOMETOPIDAE Reed, 1905

[*nom. transl.* PILLET, 1954 (*ex* Pterygometopinae REED, 1905)] [*Authorship.* Selection of genera for assignment to this family, their arrangement in subfamilies, and description of genera are by W. STRUVE, except for contributions by RUD. RICHTER on *Josephulus.*]

Exoskeleton highly vaulted (with some exceptions). Glabella with frontal lobe more or less hypertrophic, especially in transverse direction, *3p* lateral glabellar lobes slightly to strongly hypertrophic at cost of *2p* (and even *1p*) lobes, *1p* lobes narrow, tending to become detached from central area; *2p* lateral glabellar furrows slightly to very oblique in anteromesial direction; posterior sections of facial sutures may be in distinct genal sulcus; genal spines present or absent. Pygidium subequal to cephalon in size, without posterior spine. *M.Ord.-U.Ord.*

Subfamily PTERYGOMETOPINAE Reed, 1905

[Includes Eomonoracheinae PILLET, 1954]

Glabella with frontal lobe protruding sideward slightly more than *3p* lateral glabellar lobes or much beyond them, lateral corners of frontal lobe tending to become

alate by coalescence with adjacent parts of genal region *(Pterygometopus);* slight to considerable hypertrophy of *3p* lobes, impinging on *2p* lobes and reducing their size, *1p* lobes narrow, depressed, more or less detached from central area so as to form small rounded bodies; generally all furrows distinct, *2p* lateral glabellar furrows directed somewhat obliquely in anteromesial direction, in some genera reduced distally in manner causing *2p* and *3p* lobes to coalesce, *1p* furrows subparallel to *2p* furrows; longitudinal furrows may be developed; eyes (with some exceptions) moderately large to very large, close to posterior border furrows or at moderate distance from them. Pygidium triangular or semicircular. *M.Ord.-U. Ord.*

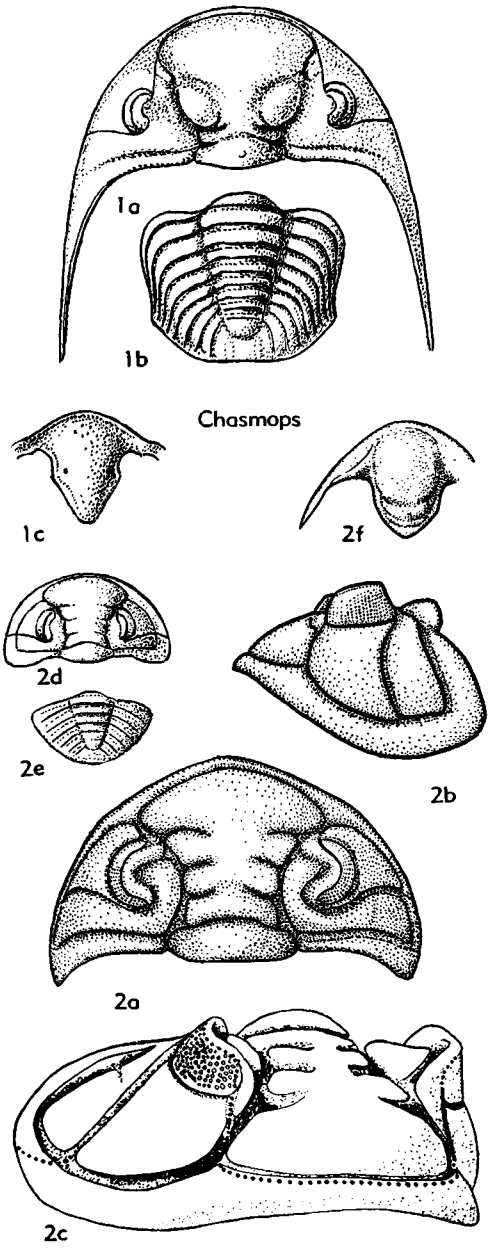


FIG. 388. Pterygometopidae (Pterygometopinae, Chasmopinae) (p. O490-O493).

Pterygometopus FR. SCHMIDT, 1881 [**Calymene sclerops* DALMAN, 1827]. Cephalon broadly rounded or elongate ogival *(tr.* or *sag.);* border distinct, narrowed in front of glabella in several; frontal glabellar lobe may fuse with swellings of adjacent parts of genal region (*cf. Ductina*) so as to become alate (e.g., as compared with *Calyptaulax*) (1) by broadening, re-entering, and swelling of border at contact with lateral corners of proper frontal lobe, (2) by formation of swellings of genae that may remain detached from proper frontal lobe, or cut off coalesced parts to produce short to very long processes between cephalic border and remainder of genae, or exceptionally (3) by entire coalescence of frontal lobe with border; anterior sections of facial sutures cutting off or running around lateral corners of proper frontal lobe, or cutting off coalesced parts of genal region from proper frontal lobe; *1p* and *2p* lateral glabellar furrows slightly to moderately oblique in anteromesial direction (with few exceptions); eyes elevated or highly conical, generally small to large and distant from posterior border furrows. Pygidium semicircular to triangular, in many species truncate posteriorly; border narrow to moderately wide, not distinctly detached; axis long, slender to moderately broad, with 5 to 13 rings; pleural regions with 6 to 13 pairs of furrowed ribs. [Recognized subgenera are so closely related that diagnoses are applicable to only a few species in each, others being classified in the genus *sensu lato.*] *Ord.,* N.Eu.-Br.I.-NE.N. Am.

P. (Pterygometopus). Cephalon semicircular to transversely elongate; cephalic border broadening toward axial furrows, slightly elevated at contact with lateral corners of frontal lobe which are distinctly limited; lateral glabellar lobes slightly decreasing in size from *3p* to *1p;* eyes relatively small, somewhat distant from posterior border furrows; genal angles rounded or subangular. *Ord.,* N.Eu.-Br.I.——FIG. 388,*2*. **P. (P.) sclerops* (DALMAN), Expansus Ls., Swed. (Östergötland); *2a-c,* ceph. (holotype), dorsal, lateral, anterolateral, ×2, ×2, ×3 (474, 496); *2d,e,*

ceph., pyg., ×1 (269, 458); *2f*, hypostoma, ×2 (474, 496).

P. (Achatella) DELO, 1935 [**Dalmanites achates* BILLINGS, 1860]. Exoskeleton rather flat. Cephalon semicircular to transversely subrectangular; axial furrows divergent; frontal lobe of glabella transversely elongate elliptical, *3p* lateral glabellar lobes larger than *1p* and *2p* lobes, which are subequal in size; occipital ring broad, elevated; eyes relatively small, highly elevated, near center of genae; genal spines well developed. Pygidium triangular to subtriangular; with 9 to 13 rings and 8 to 13 pairs of ribs distinct. *M.Ord.-U.Ord.*, N.Am.-Br.I.——FIG. 389,*4*. **Achatella achates* (BILLINGS), M.Ord. (Trenton.), N.Y.; ceph. (reconstr.), ×1.5 (33).

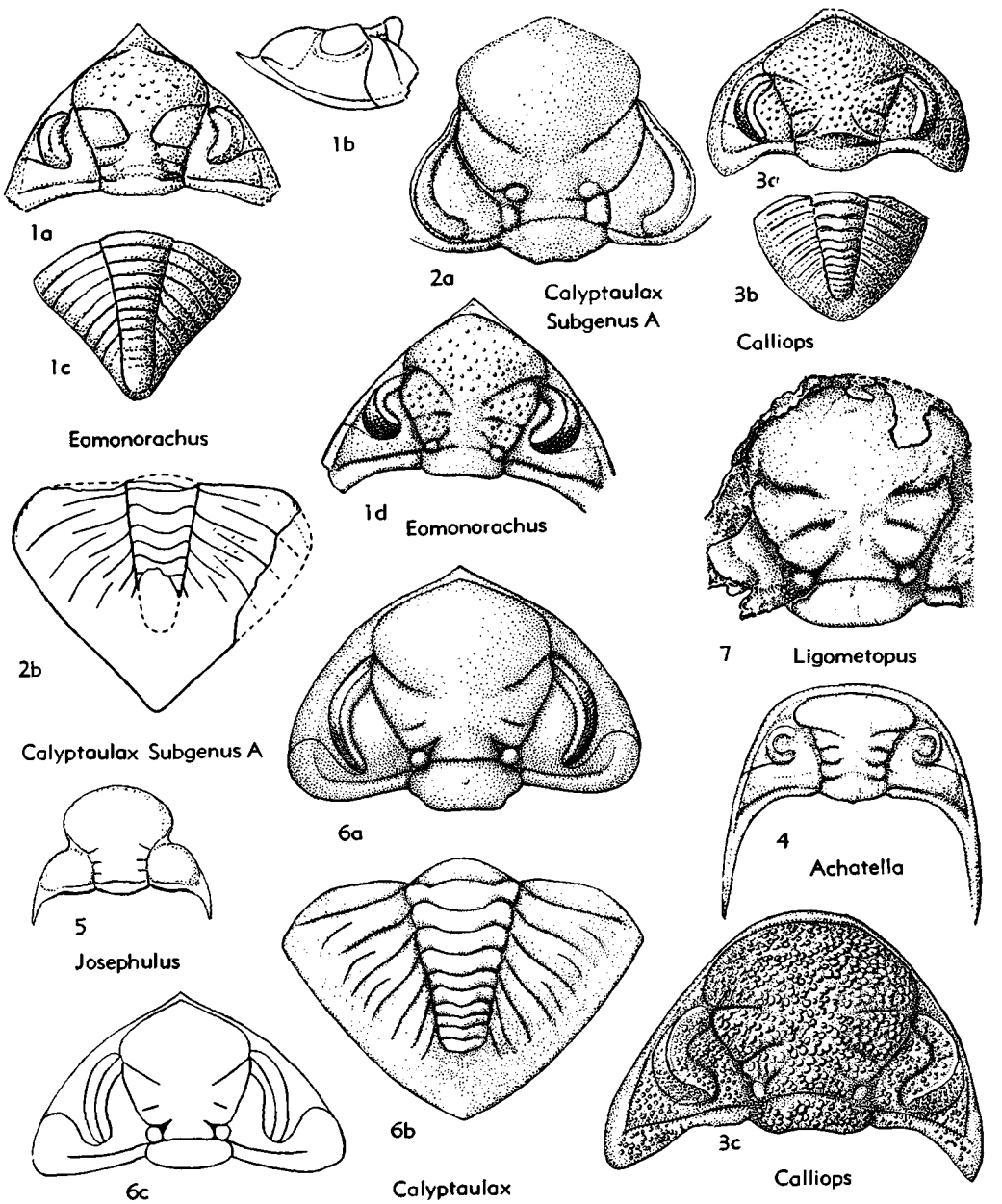


FIG. 389. Pterygometopidae (Pterygometopinae) (p. O491-O492).

Calyptaulax G. A. Cooper, 1930 [**Calyptaulax glabella*]. Cephalon highly vaulted; frontal lobe of glabella may be prolonged sideward in sickle-shaped elevations of genae that embrace eyes anteriorly and laterally and are cut off from frontal lobe by facial sutures; *3p* lateral glabellar lobes distinctly triangular, large, protruding sideward a little less than frontal lobe, *2p* lobes smaller than in *Eomonorachus;* central area more or less arched, never depressed; longitudinal furrows may be present; *2p* lateral glabellar furrows distinctly oblique in anteromesial direction, *1p* furrows subparallel to *2p* furrows; genal spines present or absent. Pygidium highly vaulted, generally subtriangular; posterior margins of rings undulating (narrow curve laterally, flat broad curve mesially). *M.Ord.-U.Ord.,* N.Am.-Eu. [Authorship of genus should be cited as G. A. Cooper in Cooper & Schuchert, 1930.]

C. (Calyptaulax). Glabella with *2p* and *3p* lateral lobes coalesced by abaxial reduction of shallow *2p* lateral glabellar furrows, which do not reach axial furrows; *1p* lobes distinctly detached; eyes in most species very large, close to glabella and posterior border furrows. Pygidium with 5 to 12 rings and 3 to 12 pairs of distinct ribs, pleural furrows distinct, interpleural furrows fairly well marked distally. *M.Ord.-U.Ord.,* N.Am.-Eu. ——Fig. 389,*6*. **C. (C.) glabella,* U.Ord., Que. (Percé); *6a,b,* ceph., pyg., ×3 (33 mod., 474); *6c,* ceph., ×2 (391 mod., 474).

C. (Calliops) Delo, 1935 [**Phacops callicephalus* Hall, 1847]. Glabella with *1p* lateral lobes detached; *2p* lateral glabellar furrows narrower and shallower than *1p* and *3p* furrows but reaching axial furrows; eyes very large, close to glabella and posterior border furrows. Pygidium with 8 to 11 axial rings and 4 to 8 pairs of ribs, pleural furrows distinct, interpleural furrows distinct or obsolescent. *M.Ord.-U.Ord.,* N.Am.——Fig. 389,*3*. **C. (C.) callicephalus* (Hall), M.Ord.; *3a,b,* ceph., pyg., (Galena Dol., Minn.), ×1.5 (386, 458); *3c,* ceph. (Trenton., N.Y.), ×3 (26 mod., 33 mod., 474).

C. (Ligometopus) Ulrich & Delo, in Delo, 1940 [**L. typus*]. Cephalon closely resembling that of *C. (Calliops),* glabella with subelliptical frontal lobe, not alate; *2p* lateral glabellar lobes smaller than *3p,* these lobes fused laterally and separated from gently arched central area by shallow longitudinal furrows; *1p* lobes distinctly detached; *2p* furrows very shallow abaxially, deep elongate pits adaxially; eyes moderately large, close to glabella and posterior border furrows. Pygidium strongly vaulted, broadly rounded posteriorly; with about 10 axial rings and 7 or 8 pairs of broad, furrowed ribs. *M.Ord.,* USA.—— Fig. 389,*7*. **C. (L.) typus* (Ulrich & Delo), Va.; ceph. (holotype), ×3 (26, 33).

C. (Subgen. A) [=*Homalops* Remelé, 1885 (*non* Motschulsky, 1850)]. Cranidium flattened; frontal glabellar lobe subpentagonal, somewhat wider than long, large (more than twice length of central area, *sag.*); *3p* lateral glabellar lobes very hypertrophic, especially in anterolateral direction; *2p* lobes reduced to small, detached, rounded bodies; *1p* lobes also detached; subquadrate in outline; eyes large (about 0.7 of glabellar length), extremities close to glabella and posterior border furrows. Pygidium with faint furrows on pleural lobes and very slender axis. *Ord.,* NW.Eu.——Fig. 389,*2a*. *C. (subgen. A) altumii* (Remelé), ?U.Ord. (Pleist. erratic), Ger. [type species of *Homalops*]; ceph. (holotype), ×3 (455, 474).——Fig. 389,*2b*. *C. (subgenus A)* cf. *altumii* (Remelé), *U.Ord.* (Slandron Ls.), Swed.; pyg., ×6 (414, 1953).

Eomonarachus Delo, 1935 [**Dalmanites intermedius* Walcott, 1877]. Cephalon vaulted; glabella with large subrhombic frontal lobe, *3p* lateral lobes subtriangular, protruding laterally less than frontal lobe, *2p* lobes smaller than *3p* lobes, *1p* lobes well detached, small, round tubercles; narrow *2p* lateral glabellar furrows slightly oblique in anteromesial direction, shallow, deeper adaxially but complete, central area depressed; eyes moderately large, close to glabella, somewhat distant from posterior border furrows; genal spines slender, rather long. Pygidium distinctly triangular, strongly vaulted; axis slender, almost reaching posterior margin; with 8 clearly defined rings distinct and some indistinct; pleural regions with 7 or 8 pairs of broadly rounded, unfurrowed ribs. *M.Ord.,* USA.——Fig. 389,*1*. **E. intermedius* (Walcott), Minn.; *1a,b,* ceph., dorsal, lateral (Blackriv.), ×2 (386, 458); *1c,* pyg. (Blackriv.), ×2 (386, 458); *1d,* ceph. (Decorah), ×2 (33 mod., 474).

Josephulus Warburg, 1925 [**J. gracilis*]. Only cranidium known; axial furrows curved anterolaterally, well impressed; glabella strongly convex, with frontal lobe twice as broad *(tr.)* as posterior part of glabella; *1p* to *3p* lateral glabellar furrows short, equally developed; fixigenae swollen; eye lobes apparently small; anterior sections of facial sutures not intersecting lateral corners of frontal lobe, posterior sections reaching margin near base of genal spines. *U.Ord.,* Swed.——Fig. 389,*5*. **J. gracilis,* Leptaena Ls., Dalarne; ×2 (323).

Subfamily CHASMOPINAE Pillet, 1954

[*nom. correct.* Struve, herein (*pro* "Sous-famille des Chasmopsidae," Pillet, 1954, *laps. cal.*]

Glabella with frontal lobe and *3p* lateral glabellar lobes extremely hypertrophic (except in primitive forms), *2p* lobes much reduced or obsolete, *1p* lobes tending to be slightly detached from central area. Pygidium more or less elongate *(sag.),* with distinct segmentation, axial rings and pleurae

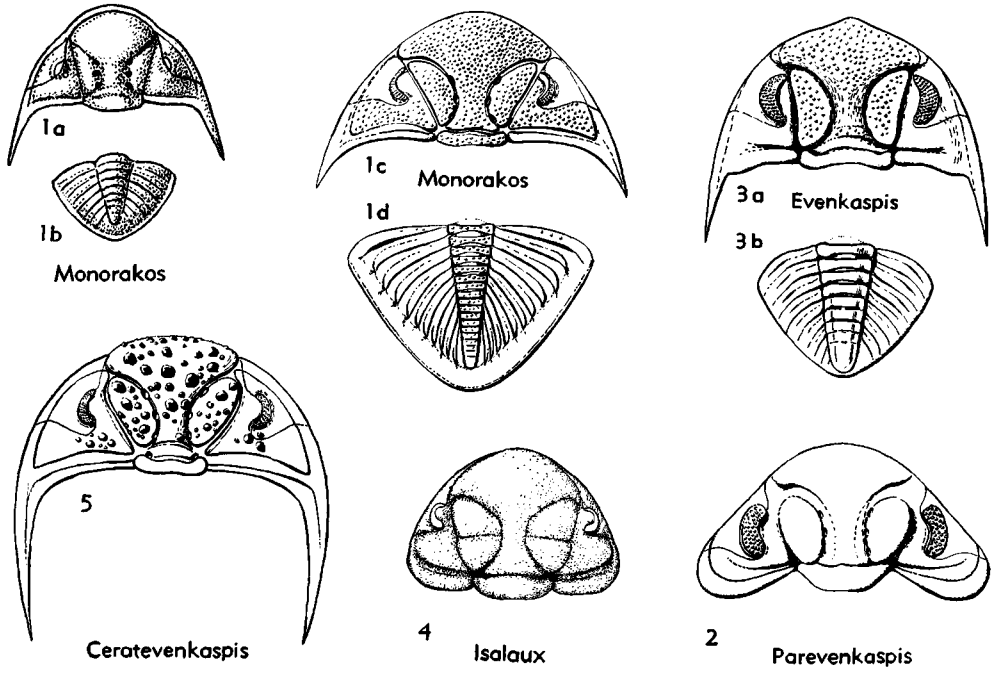


FIG. 390. Monorakidae (p. O494-O495).

generally numerous, ribs reaching margin or terminating close to it. *Ord.*

Chasmops M'COY, 1849 [**Calymene odini* EICHWALD, 1840]. Cephalon semicircular, ogival, transversely subrectangular or subpentangular; glabella with frontal lobe inflated, not alate as in *Pterygometopus,* anterior slope steep or overhanging, posterior part fused with central area; *3p* lateral glabellar lobes triangular, less commonly rounded, detached from central area or not, anterior corners tending to indent posterior margin of frontal lobe, posterior part reaching far backward so as to compress remnants of *2p* lobes and even *1p* lobes toward sagittal line of glabella (*cf. Calyptaulax* subgen. A), *1p* lobes complete or somewhat reduced abaxially; "intercalating ring" may be distinct; eyes moderately to very high and ranging from small to large; genal spines generally present and very long. Pygidium with long axis containing 6 to 20 rings; distal parts of pleural lobes steeply sloping or vertical with 6 to 20 pairs of ribs; border indistinctly marked, may be indicated by bending backward of distal ends of ribs; posterior margin rounded, acute, or truncated, in many species arched (vert.). *Ord.*, N.Eu.-Br.I.-N.Am. —— FIG. 388,*1*. **C. odini* (EICHWALD), Est. (Kukruse); *1a-c,* ceph., pyg., hypostoma, ×1.5 (458).

Family MONORAKIDAE Kramarenko, 1952

[*nom. correct.* STRUVE, herein (*pro* Monorakeidae, *nom. transl.* PILLET, 1954, *ex* Monorakeinae KRAMARENKO, 1952)] [*Authorship.* All contributions on this family here published are by W. STRUVE.]

Glabella with *2p* lateral lobes hypertrophic in backward direction, fused with *3p* lobes to form a single pair of large, bicomposite lobes, *1p* lobes very narrow or completely suppressed; *1p* and *3p* lateral glabellar furrows connected by generally deep longitudinal furrows, *2p* furrows reduced to adaxial pits (except in *Isalaux*); eyes small to large (0.2 to nearly 0.5 of glabellar length), distant from posterior border furrows; with or without genal spines. Pygidium little shorter than cephalon; with 10 to 15 rings and 7 or more pairs of ribs, no posterior spine. *M. Ord.-U.Ord.*

The tendency to form a single pair of lobes in the place normally occupied by *2p* and *3p* lateral glabellar lobes combined with reduction of *1p* lobes, is also displayed by *Chasmops* and several genera of the Pterygometopinae. In these latter genera, however, such trends are combined with

recession and reduction of the *2p* lobes. The final stage of evolution leads to very similar glabellar features in both families (also *Trypaulites* in Dalmanitinae). It seems appropriate to recognize the Monorakidae as a family. *Trypaulites* and the Coronurinae (*Coronura, Anchiopella, Corycephalus, Malladaia,* and *Odontocephalus*), assigned by PILLET (1954, p. 835) to the Monorakidae, seem to be true Dalmanitinae.

Monorakos FR. SCHMIDT, 1886 [**Phacops (Monorakos) lopatini;* SD VOGDES, 1925] [=*Monorhachis* VOGDES, 1925 *(nom. van.); Monorachus* CLARKE, 1897 *(nom. van.)*]. Cephalon with straight axial furrows, anterior cephalic border more or less visible from above; glabella with frontal lobe transversely expanded, subrhombic in outline, *3p* lateral glabellar furrows nearly straight, longitudinal furrows shallow to very deep; bicomposite lobes *(3p+2p)* moderately to very elongate, *1p* lobes reduced to small, wedge-shaped lappets; genal spines present. *U.Ord.,* Sib. (Podkamennaja Tunguska).

M. (Monorakos). Cephalon wide crescent-shaped, gently convex; axial furrows considerably divergent forward in most species; frontal lobe of glabella transversely much expanded, bicomposite lateral glabellar lobes slender, slightly elevated; genal spines of moderate length. Pygidium gently convex, subtriangular, with broad border. Surface finely granulose or smooth. *U.Ord.,* Sib.——FIG. 390,*1a,b.* **M. (M.) lopatini* (FR. SCHMIDT); ceph., pyg., ×1 (468).——FIG. 390,*1c,d. M. (M.) magnus* KRAMARENKO; ceph., pyg., ×1.5 (112).

M. (Ceratevenkaspis) KRAMARENKO, 1952 [**Ceratevenkaspis armata*]. Cephalon horseshoe-shaped, frontal border not visible from above; axial furrows strongly divergent forward, glabella inflated, with frontal lobe subtriangular in outline, overhanging frontal margin, central area narrow *(tr.),* depressed (except posterior part); *1p* and *3p* glabellar furrows and longitudinal furrows deep; bicomposite lobes inflated, highly elevated; glabella (except depressed part of central area) coarsely granulated; genal spines long. Thorax and pygidium unknown. *U.Ord.,* Sib.——FIG. 390,*5.* **M. (C.) armatus* (KRAMARENKO); ceph., ×1.9 (112).

M. (Evenkaspis) KRAMARENKO, 1952 [**Evenkaspis marina*]. Cephalon semicircular, subangular, anteriorly; axial furrows moderately divergent; frontal lobe moderately wide, subrhombic to elliptical, more or less inflated, but not overhanging frontal margin; central area depressed (except posterior part); *1p* and *3p* lateral glabellar furrows and longitudinal furrows deep; bicomposite glabellar lobes strongly elevated; genal spines moderately long. Surface may be finely granulose (except in central area). Pygidium lacking border. *U.Ord.,* Sib.——FIG. 390,*3.* **M. (E.) marinus* (KRAMARENKO); *3a,b,* cran., pyg., ×1.3 (112).

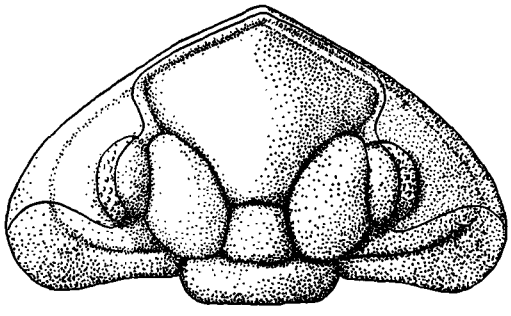


FIG. 391. **Elasmaspis speciosa* KRAMARENKO (Monorakidae), U.Ord., Sib.; ceph., ×4 (112).

Elasmaspis KRAMARENKO, 1956 [**Elasmaspis speciosa*]. Cephalon wide subogival, cephalic border very broad posterolaterally, narrow anteriorly, visible from above in front of glabella; axial furrows pushed outward by bicomposite glabellar lobes, returning toward *3p* lateral furrows; glabella slightly broadened forward; frontal lobe large, nearly rhombic in outline; bicomposite lobes large, roughly egg-shaped; *3p* and longitudinal furrows very narrow and deep; transglabellar furrow deeply incised; *1p* lateral glabellar lobes entirely suppressed; genal angles well rounded, lacking spines. *U.Ord.,* Sib.——FIG. 391. **E. speciosa,* Podkamennaja Tunguska; ceph., ×4 (420, 1956).

Isalaux FREDERICKSON & POLLACK, 1952 [**I. cañonensis*]. Cephalon rather vaulted, with rounded anterior margin; glabella broadening forward, frontal lobe sloping forward steeply, fused with central area to form a single mushroom-shaped lobe similar to *Parevenkaspis; 2p* and *3p* lateral glabellar lobes detached from central area by longitudinal furrows, *2p* lobes very hypertrophic at expense of *1p* lobes, which are reduced to short wedge-shaped lappets; *1p* to *3p* lateral glabellar furrows distinct; eyes small with visual surface curved in semicircle; lateral parts of genae steeply sloping; genal angles subangular, without spines. Pygidium rounded triangular with axis reaching posterior margin; about 11 rings; pleural fields steeply sloping, with about 7 pairs of ribs distinct. [Except *2p* furrows, the glabellar features of *Isalaux* are very like those of *Parevenkaspis.* Despite some similarities to *Eomonorachus* and closely related forms, *Isalaux* is more advanced in the trend toward typical Monorakidae. The name *Isalaux* presumably is a misspelling of *Isaulax* (Gr., *is*+*aulax,* equal furrow) but if so, under the Rules it is not correctable.] *M.Ord.,* C. USA.——FIG. 390,*4.* **I. canonensis,* Harding F. Colo.; ceph., ×2.5 (400).

Parevenkaspis KRAMARENKO, 1952 [**Parevenkaspis egloni*]. Cephalon wide semiparaboloid; axial furrows convex outward; glabella roughly circular in outline, with segmentation like that of *Isalaux*, frontal lobe inflated, bicomposite lobes subelliptically bulbous; *2p* lateral glabellar furrows completely reduced to adaxial pits, *3p* and longitudinal furrows deep and wide; eyes strongly elevated, visual areas nearly horizontal; genal angles rounded, without spines. *U.Ord.*, Sib.——FIG. 390, *2*. **P. egloni*, Podkamennaja Tunguska; ceph., ×3.4 (112).

Suborder UNCERTAIN

Turcopyge RICHTER & RICHTER, 1939 [**T. eduardi*]. Cephalon and thorax unknown. Pygidium with very broad axis, 5 or 6 rings with medial nodes, posterior part of axis not annulated, passing over into a posterior process; pleural fields with at least 5 pairs of geniculate to curved ribs, ending in cylindrical lateral (?posterior) processes that become shorter toward posterior extremity. *L.Dev.*, Thrace-?Morocco.——FIG. 381,*5*. **T. eduardi*, Thrace; pyg., ×1.5 (386). [Contributed by W. STRUVE.]

Order LICHIDA Moore, nov.

[=Superfamily Lichacea KOBAYASHI, 1935; Lichadacea PHLEGER, 1936; Lichadoidae HUPÉ, 1953 (attributed to KOBAYASHI, 1935); Lichacea TRIPP, 1957] [Type—*Lichas* DALMAN, 1827].

Medium-sized to exceptionally large trilobites chiefly characterized by distinctive cephalic and pygidial features. Glabella broad, extending to anterior border, which may be ill defined; with pair of lateral glabellar furrows longitudinally elongated; lateral glabellar and occipital lobes tending to fuse with one another and with other parts of the cranidium; facial sutures opisthoparian. Pygidium large; pleural regions usually flattened, and composed of 3 pairs of pleurae that commonly exhibit leaflike or strongly spinose form. Dorsal surface almost invariably tuberculate. *L.Ord.-U.Dev.*

Family LICHIDAE Hawle & Corda, 1847

[*nom. correct.* ANGELIN, 1854 (*ex* Lichades HAWLE & CORDA, 1847, *nom. imperf.*)] [=Lichasidae PICTET, 1854; Lichadae SALTER, 1864; Lichadidae BEECHER, 1897] [According to the opinion of a British specialist in classical languages, Professor L. W. GRENSTED, who is ICZN adviser, the name *Lichas* ought to be treated as masculine in gender, with genitive *Lichae*. That makes the family name Lichidae. Lichas is the name of the squire of Herakles.]

Cranidium usually moderately convex, but ranging from flattened to extremely convex; glabella broad and subrectangular; median lobe expanded anteriorly, basal area tending to become depressed; foremost pair of lateral glabellar furrows extended backward to form longitudinal furrows, which may reach occipital furrow; middle lateral furrows obsolete or represented by notches on longitudinal furrows; basal lateral furrows may be complete (bicomposite lobes then usually circumscribed), or incomplete (bicomposite lobes then partially defined), or lacking (lateral lobes then tricomposite); axial furrows tend to die out or to be diverted posteriorly; circumscribed occipital lobes present (*Lichas* and other genera) but commonly fused with posterior lateral glabellar lobes; occipital ring broad; glabellar lobes vary greatly in definition and inflation, in some genera becoming bulbous; preglabellar field absent; anterior border may be ill defined or strongly developed and projecting at an angle; fixigenae subtriangular; palpebral lobes marked off by furrows; anterior sections of facial sutures converging forward, running parallel and close to axial furrows; posterior sections curving backward-outward to cross posterior borders; eyes of moderate size, pedunculate in some species, usually situated behind mid-length of glabella and close to it; librigenae usually broadly falciform but may develop broad subgenal notch inside librigenal spine. Rostral plate usually subtrapezoidal, transversely elongate, bounded laterally by connective sutures continuous with facial sutures; flattened or convex; produced anteriorly beneath cranidial projection in some species. Hypostoma subquadrate; posterior margin transverse or indented; middle body swollen, circumscribed or undefined at rear; posterior lateral lobes of middle body varying in size and definition; lateral borders moderately broad to broad, anterior wings more or less strongly developed; surface tuberculate, pitted, and with anastomosing raised lines. Thorax composed of 11 segments in species with 3 pairs of pleurae in pygidium (one species has 10 segments in thorax and 4 pairs of pleurae in pygidium); axis broad, arched transversely; articulating half-rings short; axial furrows shallow; pleurae horizontal and transverse proximally, bent downward and backward at fulcra, terminating in short free points; submedial pleural furrows usually present. Pygidium with axis extending part or whole of length, wide anteriorly, tapering or flaring posteriorly; with 1 to 5 axial rings; posterior pair of pleurae may be unfurrowed; pleurae

usually end in free points, but margin of posterior pair may be rounded or produced into a posterior spine, of great length in some species; pygidium modified in certain Devonian ceratarginids. Doublure broad, particularly on pygidium, carrying usual terrace lines, spaced far apart. Apodemes not developed. Dorsal surface characteristically marked by scattered large tubercles with smaller tubercles between them but may be smooth or punctate; some forms, especially among Devonian genera, tend to develop spines or skeletal outgrowths on parts of dorsal exoskeleton. Most species medium-sized but some are exceptionally large. *L. Ord.-U.Dev.*

Subfamily LICHINAE Hawle & Corda, 1847

[*nom. transl.* Gürich, 1901 (*ex* Lichades Hawle & Corda, 1847)]

Bicomposite, basal and occipital lobes defined except in *Arctinurus* and Devonian genera. Hypostoma with posterior margin strongly indented; middle body undefined posteriorly, except in *Uralichas* and *Metopolichas;* posterior lateral lobes of middle body large, shaped like cat's ears. Pygidium with axis flaring or tapering; posterior pair of pleurae usually furrowed; posterior margin indented, unindented, or with long posterior spine. [*"Lichas" kloučeki* Růžička, Tremadoc., Boh., probably belongs in this subfamily.] *L.Ord.-M.Dev.*

Lichas Dalman, 1827 [**Entomostracites laciniatus* Wahlenberg, 1821] [=*Autolichas* Reed, 1923]. Characteristically, longitudinal furrows do not extend beyond bicomposite lobes, but they may be produced to occipital furrow. Axis of pygidium widening at back; 3 pairs of furrowed pleurae, posterior margin of 3rd rounded or sublanceolate. *U.Ord.-M.Sil.,* Eu.-N.Am.——Fig. 392,*3*. **L. laciniatus* (Wahlenberg), Dalmanites Sh., Swed.; *3a,b,* cran., dorsal, lateral, ×1.25; *3c,* hypostoma probably belonging to this species, ×2.1; *3d,* pyg., ×1.25 (324).——Fig. 393,*3*. Pathological pygidium possibly belonging to *L. laciniatus,* locality and horizon unknown, ×2 (486n).

Metopolichas Gürich, 1901 [*pro Metopias* Eichwald, 1842 (*non* Gory, 1832)] [**Metopias hübneri* Eichwald, 1842; SD Reed, 1902] [=*Macroterolichas* Phleger, 1937]. Longitudinal furrows do not extend beyond bicomposite lateral lobes. Middle body of hypostoma circumscribed, with relatively small posterior lateral lobes; lateral borders broad. Axis of pygidium widening at back; 3 pairs of furrowed pleurae, posterior margin of 3rd pair rounded or indented. *L.Ord.-M. Ord.,* N.Eu.-Asia.——Fig. 392,*1a,b,d*. **M. huebneri* (Eichwald), Tallinna Ls., Est.; *1a,b,* cran., dorsal, lateral, ×0.85; *1d,* pyg., ×0.85 (468).——Fig. 392,*1c*. *M. verrucosus* (Eichwald), Vaginatum Ls., Swed.; hypostoma, ×0.85 (489).——Fig. 393,*1*. *Metopolichas?* sp., Limbata or Planilimbata Ls., Swed.; pyg., ×1.8 (453n).

Uralichas Delgado, 1892 [**Lichas (Uralichas) ribeiroi* Delgado, 1892] [=*Platopolichas* Gürich, 1901]. Longitudinal furrows not extending beyond bicomposite lateral lobes; axial furrows faint posteriorly. Middle body of hypostoma faintly defined posteriorly; lateral borders narrow. Pygidium with relatively broad axis, narrowing slightly toward back; 3 or 4 pairs of pleurae, posterior pair ending in short free points or produced into long posterior spine. Type species estimated to have attained length of 70 cm. to tip of posterior spine. *M.Ord.,* Eu.——Fig. 394,*3*. **U. ribeiroi* (Delgado), M.Ord. Port.; *3a,* ceph., ×0.25; *3b,* hypostoma, ×0.4; *3c,* pyg., ×0.25 (394).——Fig. 393,*2*. *U. avus* (Barrande) (type species of *Platopolichas*), Sárka beds, Boh.; *2a,* cran., ×1.3; *2b,* pyg., ×1.3 (486n).

Leiolichas Schmidt, 1885 [**Platymetopus illaenoides* Nieszkowski, 1857]. Longitudinal furrows faintly connected to occipital furrow; posterior lateral glabellar furrows lightly impressed on some internal molds; glabellar lobes with little independent convexity. Hypostoma unknown. Pygidium with lateral and posterior margin rounded; dorsal surface smooth; internal molds show tapering axis and 3 pairs of furrowed pleurae. *M.Ord.-U.Ord.,* N.Eu. ——Fig. 394,*1*. **L. illaenoides* (Nieszkowski), Keila Ls., Est.; *1a,b,* cran., dorsal, lateral, ×0.85; *1c,* pyg. (left, external cast; right, internal mold), ×0.85 (468).

Dicranopeltis Hawle & Corda, 1847 [**Lichas scabra* Beyrich, 1845; SD Reed, 1902] [=*Trachylichas* Gürich, 1901 (obj.); *Dicranopeltoides, Makromuktis* Phleger, 1936; *?Raymondarges* Phleger, 1937]. Bicomposite lateral lobes usually circumscribed; longitudinal furrows may be connected to occipital furrow by depressions; occipital lobes commonly ill defined. Axis of pygidium long, narrowing toward back; 3 pairs of furrowed pleurae ending in free points. *U.Ord.-U.Sil.,* Eu.-N.Am.——Figs. 392,*5*, 393,*5*. **D. scabra* (Beyrich), Motol beds, Boh.; 392,*5a,* exoskel., ×0.85; 392,*5b,* 393,*5,* hypostoma, ×0.9, ×2.7 (486n).

Arctinurus Castelnau, 1843 [*pro Platynotus* Conrad, 1838 (*non* Fabricius, 1801)] [**Paradoxus (laps. cal.* for *Paradoxides) boltoni* Bigsby, 1825] [=*Oncholichas* Schmidt, 1885 (obj.); *Pterolichas* Gürich, 1901 (obj.); *Pseudotupolichas, Arctinuroides, Trimerolichas* Phleger, 1936]. Longitudinal furrows extending more or less distinctly to occipital furrow; occipital lobes may be present; occipital ring and axis of thorax wide. Pygidium with long axis widening posteriorly; 3 pairs of furrowed pleurae ending in free points. *L.Sil.-M.Sil.,* N.Eu.-N.Am.——Fig. 392,*4*. **A. boltoni* (Bigsby), Lock-

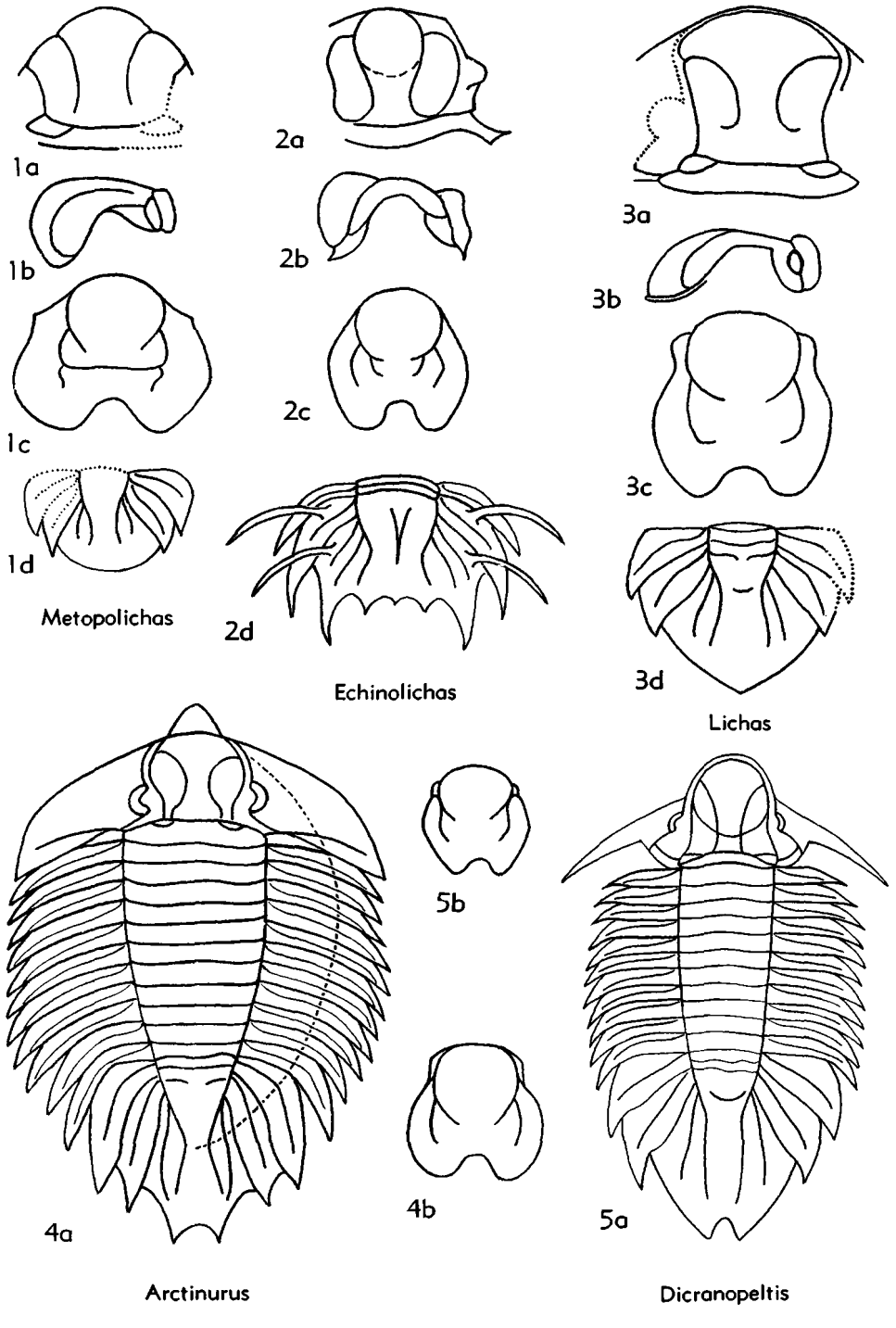


FIG. 392. Lichidae (Lichinae) (p. O496-O498).

port Sh., N.Am.; *4a*, exoskel., ×0.5 (167); *4b*, hypostoma, ×0.6 (486n).——Fig. 393,*4*. *A. marginatus* (Lindström) (type species of *Trimerolichas*), Gotlandian, Swed.; *4a,b*, syntype cranidia, ×2.7 (486n).

Gaspelichas Clarke, 1907 [**Lichas (Gaspelichas) forillonia*]. Cranidium elongate and strongly spinose; cranidial furrows almost obsolete. *L.Dev.*, Can.——Fig. 394,*4*. **G. forillonia* (Clarke), Grande Grêve Ls., Can.(E.Que.); *4a,b*, cran., dorsal, lateral, ×0.55 (386).

Echinolichas Gürich, 1901 [**Lichas eriopis* Hall, 1863; SD Reed, 1902]. Longitudinal furrows extend to occipital furrow; frontal area of glabella strongly swollen; occipital lobes fused with tricomposite lateral lobes. Pygidium with 4 pairs of free points, or more. *L.Dev.-M.Dev.*, N.Am.——Fig. 392,*2a,b,d*. **E. eriopis* (Hall), Onondaga Ls., N.Am.(N.Y.); *2a,b*, cran., dorsal, lateral, ×1.2; *2d*, pyg., ×1.2 (404).——Fig. 392,*2c*. *E. bigsbyi* (Hall), New Scotland Ls., N.Am.(N.Y.); hypostoma, ×0.85 (403).

Ceratolichas Hall & Clarke, 1888 [**Lichas (Ceratolichas) gryps*; SD Reed, 1902]. Differs from *Echinolichas* in possessing glabellar and occipital spines. Cranidia only known. *M.Dev.*, N. Am.——Fig. 394,*5*. **C. gryps* (Hall & Clarke), Onondaga Ls., N.Am.(N.Y.); *5a,b*, cran., dorsal, lateral, ×1.2 (404).

Terataspis Hall, 1863 [**Lichas grandis* Hall, 1861] [=*Deuterolichas* Reed, 1902]. Like *Echinolichas* but with frontal lobe of glabella bulbous and constricted round base; neck of median lobe depressed. Pygidium with 4 pairs of long barbed spines. One of the largest trilobites known, almost 70 cm. in length. *Up.L.Dev.*, N.Am.——Fig. 394, *2*. **T. grandis* (Hall), Onondaga Ls., N.Am. (N.Y.); *2a*, exoskel. (reconstr.), ×0.1 (454); *2b*, hypostoma, ×0.3 (494).

Subfamily HOMOLICHINAE Phleger, 1936

[*nom. correct.* Tripp, 1957 (*pro* Homolichadinae Phleger, 1936)]

Lateral glabellar lobes tricomposite but modified in some species of *Platylichas;* occipital lobes well defined. Hypostoma with posterior margin strongly indented; middle body circumscribed, with small posterior lateral lobes. Pygidium with axis flaring; posterior pair of pleurae usually furrowed, with free points or short posterior spine. *L.Ord.-M.Sil.*

Conolichas Dames, 1877 [**Lichas aequiloba* Steinhardt, 1874; SD Vogdes, 1890] [=*Homolichas* Schmidt, 1885; *Cypholichas* Phleger, 1936]. Occipital ring simple. Pygidium with 3 pairs of furrowed pleurae; posterior margin usually indented. *L.Ord.-U.Ord.*, N.Eu.-?Asia.——Fig. 395, *6a-c*. **C. aequilobus* (Steinhardt), Keila Ls., Est.; *6a,b*, cran., dorsal, lateral, ×1; *6c*, pyg., ×0.8 (468).——Fig. 395,*6d*. *C. triconicus*, Idavere beds, Est.; hypostoma, ×1 (468).

Hoplolichas Dames, 1877 [**Lichas tricuspidata* Beyrich, 1846 (=**Lichas dissidens* Beyrich, 1845); SD Vogdes, 1890] [=*Hoplolichoides, Cyranolichas* Phleger, 1936]. Occipital ring with single or bifurcated median spine. Pygidium with 3rd pair of pleurae unfurrowed or with short furrows situated far back; posterior margin with median point or 2 short projecting free points. *L.Ord.-M.Ord.*, N.Eu.——Fig. 395,*5a-c*. **H. dissidens* (Beyrich), M.Ord.; *5a,b*, cran., dorsal, lateral, ×0.8 (Schroeteri Ls., Swed.) (12); *5c*, pyg., ×0.6 (Echinospaerites Ls., Est.) (22).——Fig. 395,*5d*. *H. furcifer* (Schmidt), Aseri Ls., Est.; hypostoma, ×1.5 (468).

Platylichas Gürich, 1901 [**Lichas margaritifer* Nieszkowski, 1857] [=*Metalichas* Reed, 1902; *Autoloxolichas, Linguecephalichas* Phleger, 1936]. Axial furrows joining longitudinal furrows at occipital furrow in stratigraphically lower species, becoming modified and joining longitudinal furrows well in front of occipital furrow in later species, or dying out posteriorly. Pygidium with 3 pairs of furrowed pleurae ending in free points. *M.Ord.-M.Sil.*, N.Eu.-N.Am.——Fig. 396,*1*. **P. margaritifer* (Nieszkowski), Porkuni Ls., Est.; *1a,b*, cran., dorsal, lateral, ×1.5; *1c*, hypostoma, ×2.25; *1d*, pyg., ×1.25 (468).——Fig. 393,*7a*. *P. grayi* (Fletcher), Wenlock Ls., Eng.; ceph., ×1.5 (486n).——Fig. 393,*7b*. *P. halli* (Foerste), Maysville Sh., N.Am.; hypostoma, ×2.4 (486n).

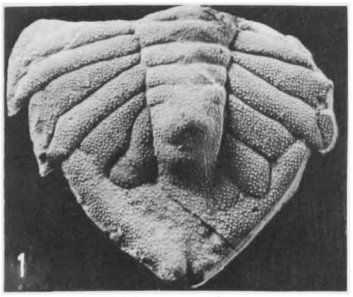
Subfamily TETRALICHINAE Phleger, 1936

[*nom. correct.* Tripp, 1957 (*pro* Tetralichadinae Phleger, 1936)]

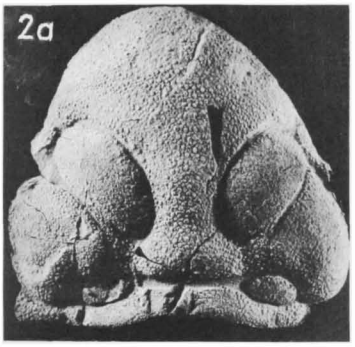
Lateral glabellar lobes tricomposite and completely fused with occipital lobes. Hypostoma with posterior margin strongly indented; middle body circumscribed, with small posterior lateral lobes. *M.Ord.-U.Ord.*

Amphilichas Raymond, 1905 [*pro Paralichas* Reed, 1902 (*non* White, 1859), *pro Platymetopus* Angelin, 1854 (*non* Dejean, 1829)] [**Platymetopus lineatus* Angelin, 1854] [=*Acrolichas* Foerste, 1919; *Tetralichas, Kerakephalichas, Probolichas* Phleger, 1936]. Longitudinal furrows short (in type species) but mostly reaching occipital furrow. Pygidium usually with pointed axis reaching posterior margin, and unfurrowed 3rd pleurae with single free points. *M.Ord.-U.Ord.*, N.Eu.-N.Am.-Asia.——Fig. 395,*1a,b*. **A. lineatus* (Angelin), U.Ord.; *1a*, cran., ×1.2 (Boda Ls., Swed.) (489); *1b*, hypostoma, ×1.6 (Lyckholm Ls., Est.) (468).——Fig. 395,*1c*. *A. cucullus* (Meek & Worthen) (type species of *Acrolichas*), Kimmswick Ls., N.Am.; pyg., ×1.5 (45).——Fig. 393,*6*. *A. hibernicus* (Portlock), Bardahessiagh beds(U.Ord.), N.Ire.; pyg., ×1.5 (468n).

Lyralichas Weber, 1948 [**Lichas (Amphilichas)*



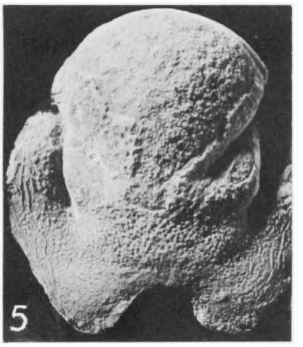
?Metopolichas



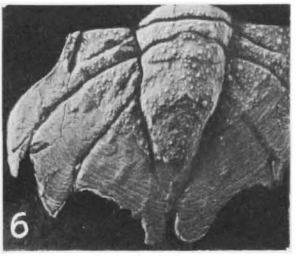
Uralichas

Lichas

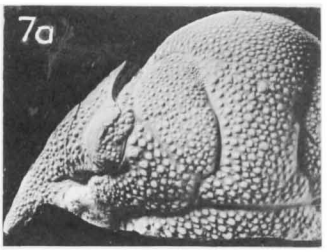
Arctinurus

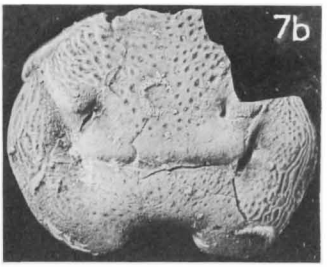


Dicranopeltis

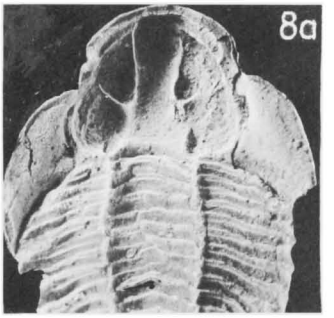


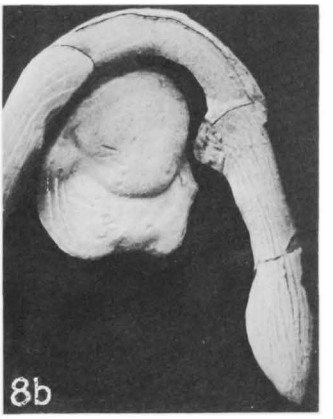
Amphilichas





Platylichas





Hemiarges

FIG. 393. Lichidae (Lichinae, Homolichinae, Tetralichinae, Ceratarginae) (p. O496-O498, O503).

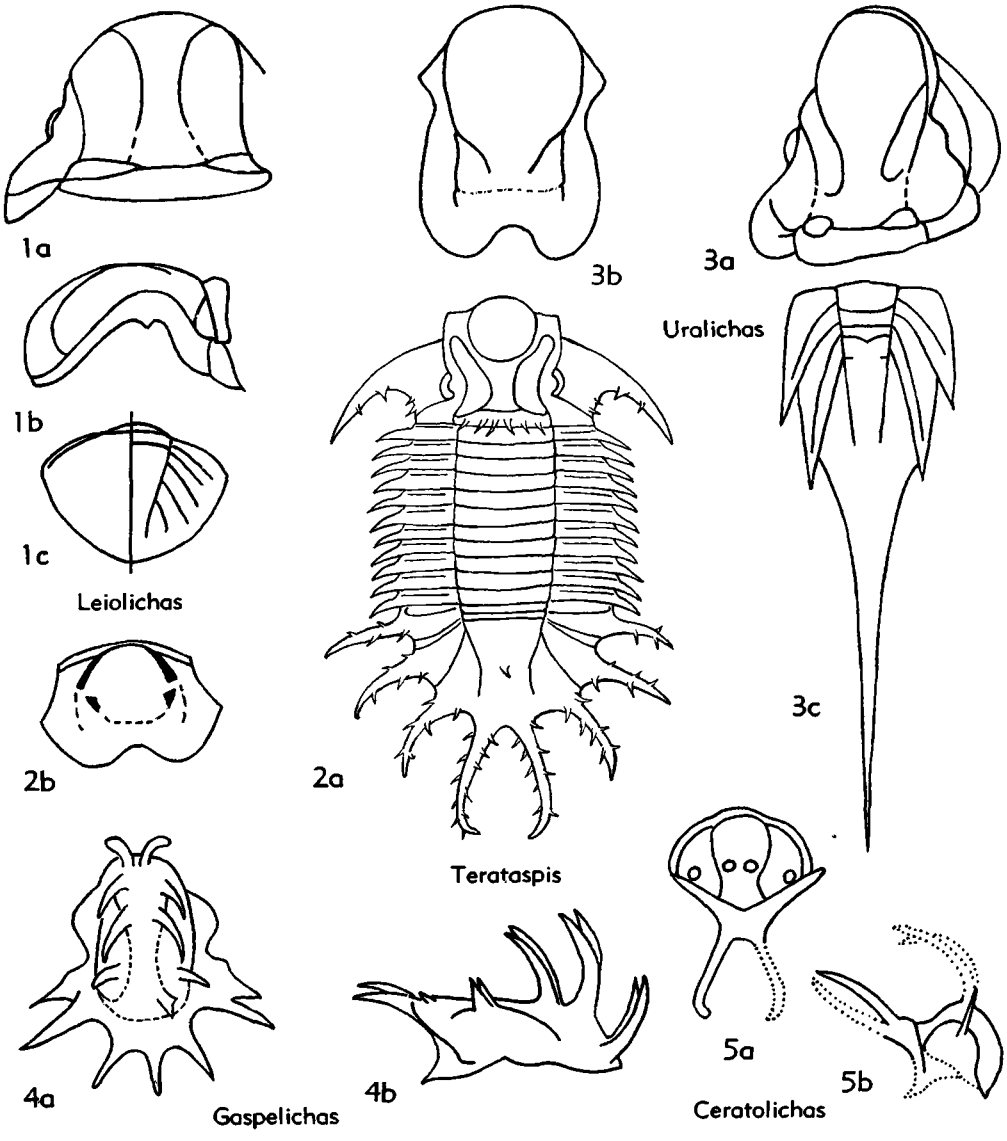


FIG. 394. Lichidae (Lichinae, Homolichinae) (p. O496-O498).

bronnikovi WEBER, 1932]. Longitudinal furrows not reaching occipital furrow. Pygidium with short axis narrowing posteriorly; 4 pairs of furrowed pleurae ending in short free points. *M.Ord.* (=*Chazy.*), Turkestan.——FIG. 396,*3*. **L. bronnikovi* (WEBER); *3a,b*, cran., dorsal, lateral, ×1.5; *1c*, hypostoma, ×1.8; *1d*, pyg., ×1.5 (490).

Subfamily CERATARGINAE Tripp, 1957

[*pro* Argetinae GÜRICH, 1901, *nom. neg.*]

Bicomposite lateral glabellar lobes bounded at back by posterior lateral furrows (except in some species of *Hemiarges*); axial furrows usually obsolete behind bicomposite lobes; occipital lobes fused with basal lateral glabellar lobes (except in *Trochurus* and *Dicranogmus*). Hypostoma with posterior margin not markedly indented; middle body circumscribed, with small posterior lateral lobes. Pygidium with axis extended to posterior border or margin by narrow ridge; posterior bands of 1st and 2nd pleurae narrower and more swollen than anterior bands; posterior pair of pleurae unfur-

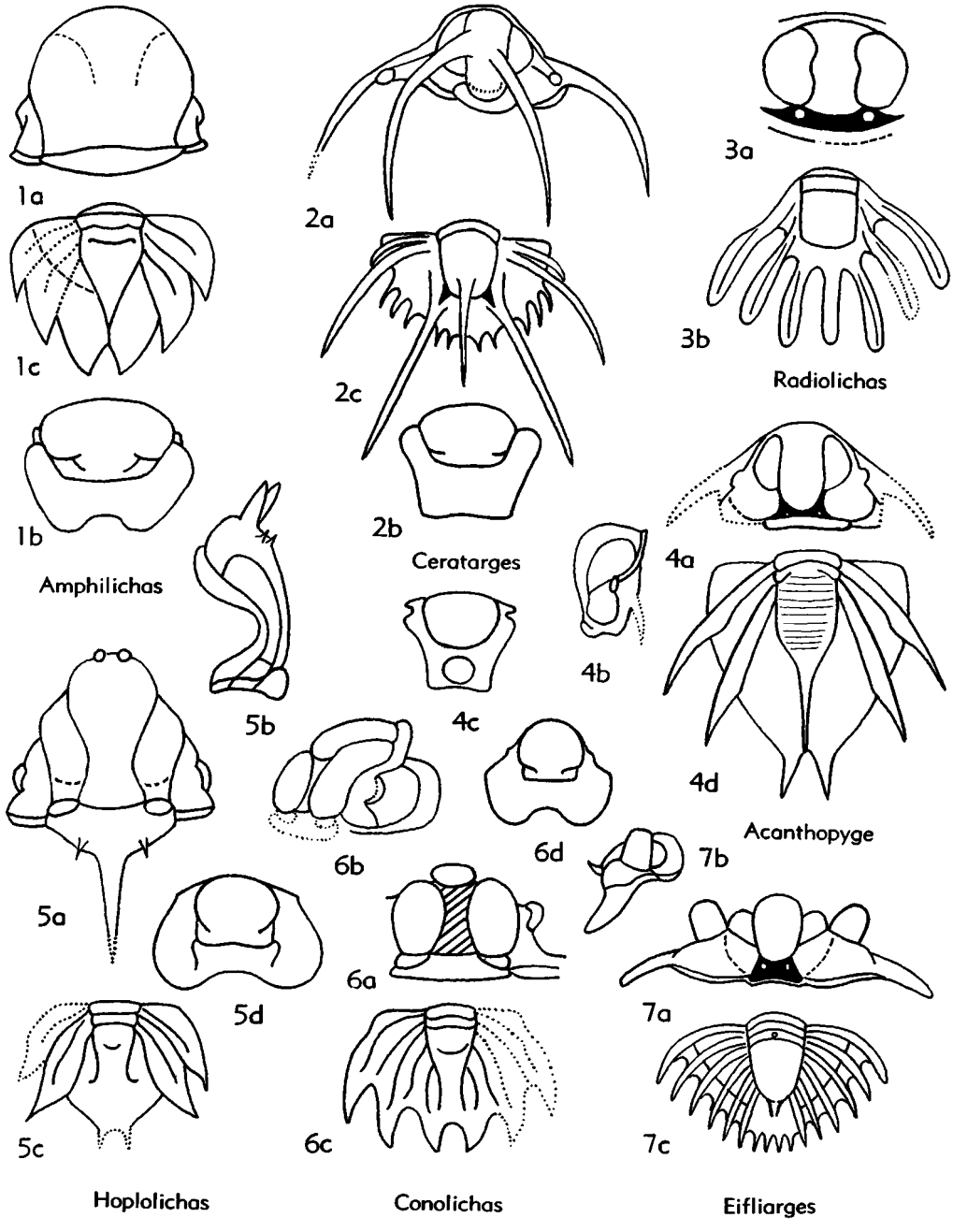


FIG. 395. Lichidae (Homolichinae, Tetralichinae, Ceratarginae) (p. O498-O503).

rowed; pygidium modified in certain Devonian genera. *M.Ord.-U.Dev.*

Ceratarges GÜRICH, 1901 [*pro Arges* GOLDFUSS, 1839 (*non* DEHAAN, 1833)] [**Arges armatus* GOLDFUSS, 1839]. Glabellar furrows faintly impressed; librigenal spines long and slender, forwardly placed. Long spines curving upward and backward on frontal lobe of glabella and pygidium; marginal spines on pygidium. *M.Dev.*, Eu. ——FIG. 395,*2*. **C. armatus* (GOLDFUSS), U. Cal-

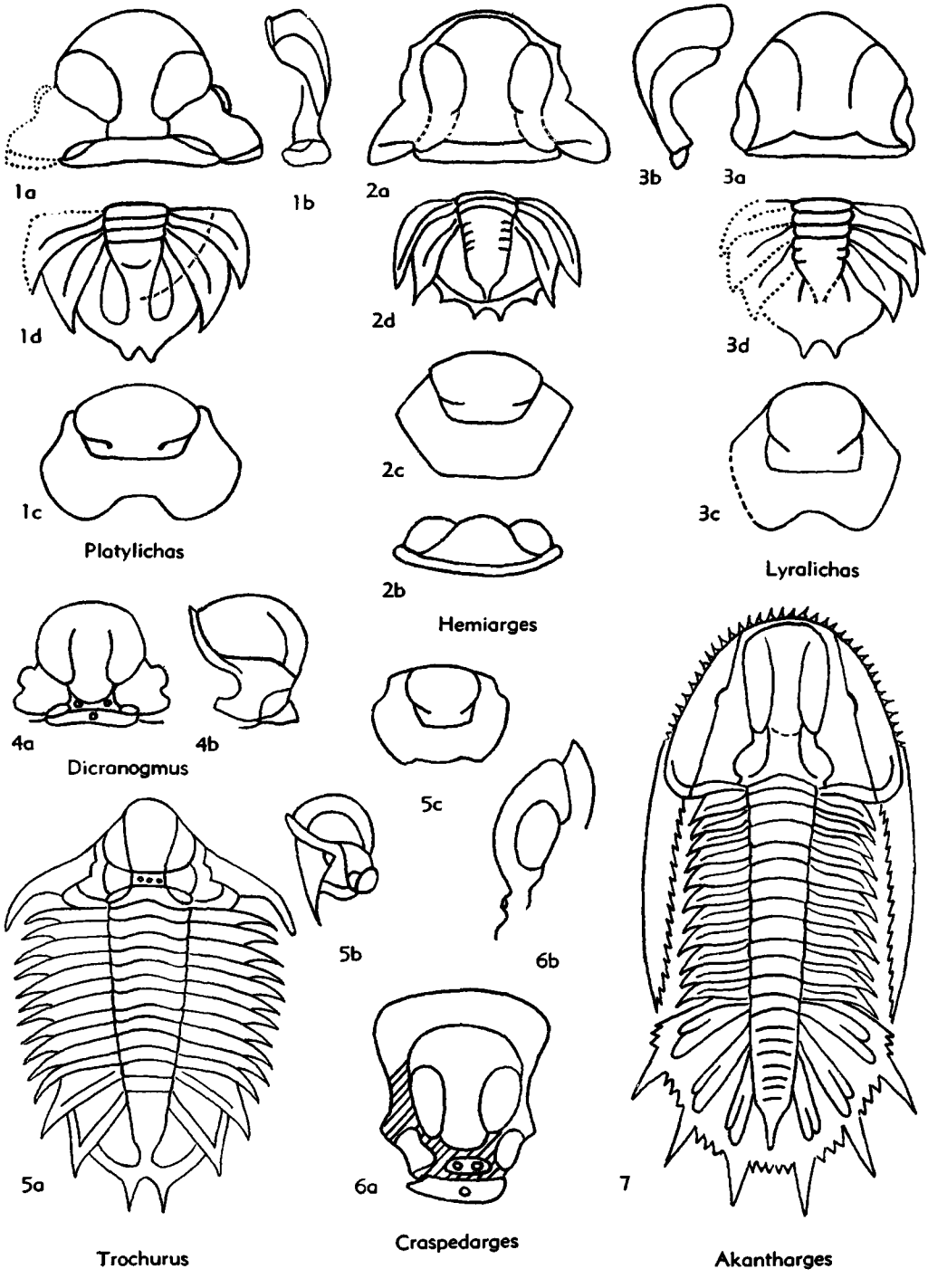


FIG. 396. Lichidae (Homolichinae, Tetralichinae, Ceratarginae) (p. O498-O503).

ceola Ls., Ger.; *2a*, ceph., ×0.9 (461); *2b*, hypostoma, ×1.2 (401); *2c*, pyg., ×0.9 (461).

Hemiarges GÜRICH, 1901 [**Lichas wesenbergensis* SCHMIDT, 1885; SD REED, 1902] [=*Richterarges, Choneilobarges* PHLEGER, 1936]. Bicomposite and basal lateral glabellar lobes partially confluent (in typical species); genal angles produced in stout, broad-based spines. *M.Ord.-U.Sil.*, Eu.-N.Am.——FIG. 396,*2a,b,d*. **H. wesenbergensis* (SCHMIDT), Rakvere Ls., Est.; *2a,b*, cran., dorsal, anterior, ×3.75; *2d*, pyg., ×3.75 (468).——FIG. 396,*2c*. *H. antelucanus* TRIPP, Craighead Ls., Scot.; hypostoma, ×7.5 (486).——FIG. 393,*8a*. *H. maccullochi* (REED) (type species of *Choneilobarges*), Drummuck Ls., Scot.; ceph., thoracic segments, ×2 (486n).——FIG. 393,*8b*. *H. scutalis* (SALTER), Wenlock Ls., Eng.; ceph., ventral, showing doublures of librigenae, rostral plate and hypostoma, ×2.67 (486n).

Trochurus BEYRICH, 1845 [**T. speciosus*] [=*Corydocephalus* HAWLE & CORDA, 1847; *Plusiarges* GÜRICH, 1901; *Protolichas* REED, 1902]. Glabellar lobes with strong independent convexity; area at base of median lobe depressed; axial furrows extending to occipital furrow (in type species); occipital lobes circumscribed. *U.Ord.-M.Sil.*, Eu.-N.Am.——FIG. 396,*5*. **T. speciosus*, Motol beds, Boh.; *5a*, exoskel. (reconstr.), ×1; *5b*, ceph., lateral, ×1; *5c*, hypostoma, ×1.5 (370).

Dicranogmus HAWLE & CORDA, 1847 [**D. pustulatus* (=**Lichas simplex* BARRANDE, 1846] [=*Liparges* GÜRICH, 1901 (obj.)]. Glabellar lobes with little independent convexity; longitudinal furrows dying out or becoming shallow anteriorly; occipital lobes circumscribed. Cranidia only known. *U.Ord.-U.Sil.*, Eu.-Austral.——FIG. 396,*4*. **D. simplex* (BARRANDE), Budňany Ls., Boh.; *4a,b*, cran., dorsal, lateral, ×1 (370).

Acanthopyge HAWLE & CORDA, 1847 [**A. leuchtenbergii* (=**Lichas haueri* BARRANDE, 1846); SD REED, 1902] [=*Euarges* GÜRICH, 1901 (obj.); *Mephiarges* RICHTER & RICHTER, 1930; *Diplolichas* PHLEGER, 1936; *Lobopyge, Nitidulopyge* PŘIBYL & ERBEN, 1952]. Area at base of median glabellar lobe strongly depressed. Librigenal spines slender, forwardly placed; deep subgenal notches in genae. *M.Sil.-M.Dev.*, Eu.-N.Am.-S.Am.-Asia-Austral.——FIG. 395,*4*. **A. haueri* (BARRANDE), Koněprusy Ls., Boh.; *4a,b*, ceph., dorsal, lateral, ×0.8; *4c*, hypostoma, ×1; *4d*, pyg., ×0.8 (370).

Eifliarges RICHTER & RICHTER, 1917 [**Lichas (Eifliarges) caudimirus*]. Cephalon differing from *Acanthopyge* in strong convexity of glabellar lobes and short subgenal notches. Pygidium with 6 pairs of ribs ending in spines, with 4 marginal spines on the postaxial area. *M.Dev.*, Ger.——FIG. 395,*7*. **E. caudimirus* (RICHTER & RICHTER), U.Calceola Ls.; *7a,b*, ceph., dorsal, lateral, ×4; *7c*, pyg., ×3 (461).

Radiolichas REED, 1923 [**Lichas aranea* HOLZAPFEL, 1895 (=**R. araneiformis* TRIPP, 1957, ICZN pend.)]. Bicomposite lateral glabellar lobes extending to occipital furrow. Emaciated pygidium with 3 pairs of pleurae modified to form long, narrow, furrowed bands, with postaxial unfurrowed band. *M.Dev.*, Ger.——FIG. 395,*3*. **R. araneiformis* TRIPP; *3a*, cran., ×1.2; *3b*, pyg., ×1.8 (185).

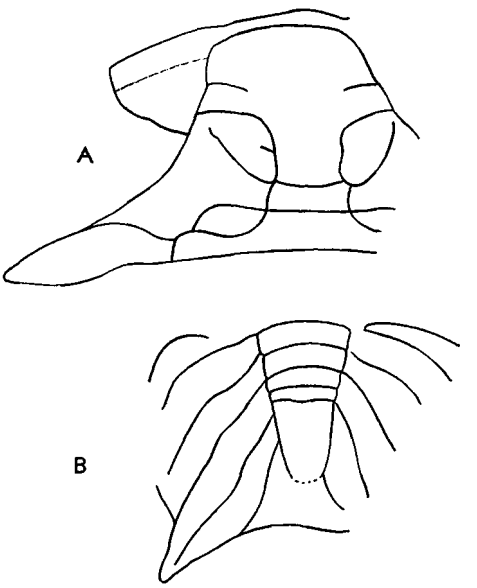


FIG. 397. **Lichakephalus erbeni* SDZUY (Lichakephalidae), L.Ord.(Tremadoc.), Ger.; *A*, cran., ×4; *B*, pyg., ×1 (272).

Akantharges PHLEGER, 1936 [**Lichas gourdoni* BARROIS, 1886]. Cephalon elongate; longitudinal furrows dying out anteriorly; axial furrows reaching occipital furrow. Genal angles produced backward into long, straight spines. Margin of cephalon and pygidium spinose. *M.Dev.*, Fr.——FIG. 396,*7*. **A. gourdoni* (BARROIS); exoskel. (reconstr.), ×1 (371).

Craspedarges GÜRICH, 1901 [**C. wilcanniae*]. Cranidium differing from *Acanthopyge* in long *(sag.)* anterior border. Pygidium with numerous subequal marginal spines. *U.Dev.*, Austral.——FIG. 396,*6*. **C. wilcanniae; 6a,b*, cran., dorsal, lateral, ×2.5 (52).

Family LICHAKEPHALIDAE Tripp, 1957

Cranidium rather flat; glabella narrowing forward, with pair of short furrows anterior to elongated pair that reach occipital furrow; "middle" lateral glabellar lobes large, possibly bicomposite, bounded except at anterior lateral angles; basal lateral furrows connected across median lobe; axial furrows

obsolete posteriorly; occipital ring broad; occipital lobes large and well defined, not projecting in front of occipital ring; anterior border moderately long; anterior sections of facial sutures strongly divergent, outlining broad anterior areas of fixigenae; posterior sections divergent cutting long posterior borders at low angles. Pygidium broad; axis narrow, relatively short, tapering toward back; with 4 axial rings; apparently 3 pairs of furrowed pleurae, posterior margin exceptionally broad and gently indented. Dorsal surface finely tuberculate. *L.Ord.(L. Tremadoc.).*

Lichakephalus SDZUY, 1955 [**L. erbeni*]. Characters of family. *L.Ord.(L.Tremadoc.),* Ger.—— FIG. 397. **L. erbeni; A,* cran., ×4; *B,* pyg., ×1 (272).

Order ODONTOPLEURIDA Whittington, nov.

[Superfamily Odontopleuracea PRANTL & PŘIBYL, 1949; Odontopleuroidae HUPÉ, 1953 (attributed to PRANTL & PŘIBYL, 1949)] [*emend.* WHITTINGTON, herein] [Type—*Odontopleura* EMMRICH, 1839]

Cephalon convex, posteromedian region high above anterolateral margin; glabella with maximum width generally at occipital ring, subparallel-sided or tapering forward; occipital ring may be elongated behind adjacent part of genal regions and bear lateral lobes, with median or paired spines or tubercles characteristic; 2 or 3 pairs of lateral glabellar lobes present; genal regions convex, inner posterior corners merging with anterolateral parts of occipital ring; eye lobes prominent, situated centrally on genal regions or may be inside and behind this point, eye ridges curving forward to merge with anterolateral margins of frontal glabellar lobe; anterior sections of facial sutures running forward-inward, posterior sections outward-backward, sutural ridges characteristic; usually stout librigenal spines present, base merging into posterolateral cephalic borders; row of shorter spines arising from outer edge of borders of librigenae, progressively shorter anteriorly; notches in borders of librigenae adjacent to anterior sections of sutures. Rostral plate short *(sag., exsag.)* and wide *(tr.).* Width and length of hypostoma subequal or width greater than length, posterolateral margins rounded; with convex middle body, faint middle furrows running backward and slightly inward from depression at anterolateral corners of middle body; lateral and posterior borders moderately wide; small anterior wing, no wing process, posterior wing small or absent. Thorax with 8 to 10 segments; axis convex; pleurae horizontal, with or without pleural furrow dividing them into 2 convex bands, with short anterior pleural spine or spines, long posterior pleural spine directed horizontally outward and progressively more backward toward rear. Pygidium short, subtriangular in outline; axis with 2 or 3 rings (3rd faint); pleural regions horizontal; paired spines on border, with or without median posterior spine (one pair of border spines may be larger than others and directed horizontally or upward, or large pair of spines may arise from pleural region), large spine connected by raised ridge to 1st axial ring. External surface rarely smooth, generally with thornlike spines or tubercles, granules between them, arrangement of larger spines or tubercles may be symmetrical (39, 176). *Up.M.Cam.-U.Dev.*

Family ODONTOPLEURIDAE Burmeister, 1843

[=Mastigopleuridae ANGELIN, 1854 (invalid, not based on a generic name); Acidaspidae SALTER, 1864; Ceratocephalidae RICHTER & RICHTER, 1925]

Characters of order. *L.Ord.(U.Canad.)-U.Dev.*

Subfamily ODONTOPLEURINAE Burmeister, 1843

[*nom. transl.* WHITTINGTON, herein (*ex* Odontopleuridae BURMEISTER, 1843)]

Glabella tapering forward slightly or moderately; occipital ring usually elongate, with median or paired tubercles or spines; eye lobes far back and at variable distance outward from glabella on genal regions, external angle between anterior and posterior sections of sutures adjacent to eye lobes 90 to 120 degrees. Hypostoma wider than long, with shallow lateral notches and sharp shoulders. Thoracic pleurae with broad *(exsag.),* convex posterior band and stout posterior pleural spine, each directed outward and successively more strongly backward. Pygidium with prominent pair of border spines wtih 1 or 2 pairs of small spines between them. *M.Ord.-U.Dev.*

Odontopleura EMMRICH, 1839 [**O. ovata*]. Glabella with relatively large lateral lobes; median part of occipital ring elevated and produced into long pair of occipital spines, also with faint occi-

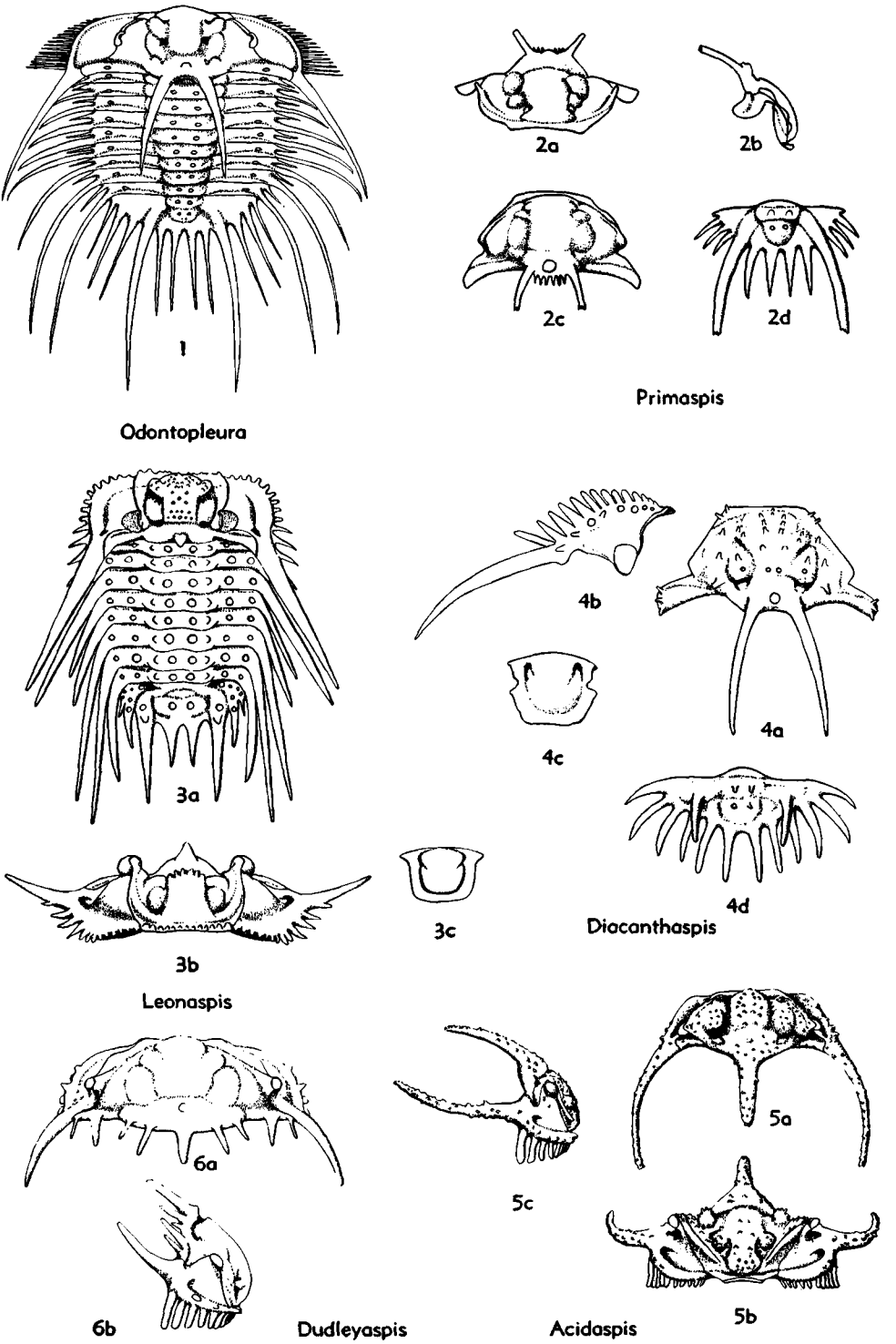


FIG. 398. Odontopleuridae (Odontopleurinae) (p. O504-O506).

pital lobes; small eye lobes situated opposite basal glabellar furrows, angle between anterior and posterior sections of facial sutures 120 degrees, slender librigenal and posterior pleural spines, long anterior pleural spines. Pygidium relatively wide, posterior part with long horizontal pair of major border spines. *M.Sil.*, Eu.——Fig. 398,*1*. **O. ovata*, Boh.; exoskel. (reconstr.), ×1 (496*).

Acidaspis Murchison, 1839 [**A. brightii*] [=*Pseudomonaspis* Richter & Richter, 1917 (obj.)]. Glabella tapering forward from basal lateral lobes; with 3 pairs of lateral lobes; occipital ring with lateral lobes, inflated and prolonged backward into thick, long median spine; eye lobes close to posterior border and situated at about half-width of genal regions, eye lobes and sutural ridges prominent; lateral cephalic border spines directed vertically, librigenal spines thick, long. Thorax with 10 segments; posterior pleural bands strongly convex, inflated at fulcra. Pygidium with 7 pairs of border spines, 5th thicker and more elongate than others. Surface tuberculate. *M.Ord.-M.Dev.*, Eu.-N.Am.——Fig. 398,*5*. **A. brightii*, M.Sil., Eng.; *5a-c*, ceph., dorsal, anterior, right lateral, ×1 (496*, 1956).

Diacanthaspis Whittington, 1941 [**D. cooperi*]. Glabella widest across occipital ring and basal lateral lobes, length *(sag.)* greater than maximum width; with 2 pairs of lateral glabellar lobes; occipital ring not greatly elongate, small lateral lobes, short median spine and commonly long paired spines; eye lobes on inner part of genal regions opposite basal glabellar lobes; librigenal spines long, slender. Number of thoracic segments unknown; posterior pleural bands not inflated at fulcra. Pygidium with 3 axial rings and 6 or 7 pairs of horizontal border spines, large spine on pleural region directed upward-backward. Surface bearing symmetrically arranged thornlike spines, with granules between them (347). *M.Ord.*, N. Am.-Scot.——Fig. 398,*4*. **D. cooperi*, Va.; *4a-d*, cran., librigena, hypostoma, pyg., ×3 (496*).

Dudleyaspis Prantl & Přibyl, 1949 [**Acidaspis quinquespinosa* Lake, 1896]. Like *Acidaspis* but occipital ring without lateral lobes, bearing median and 2 pairs of spines on posterior margin and 2 pairs of spines on posterior cephalic border, all directed backward and slightly upward; librigenal spines slender, short. *M.Sil.*, Eu.-N.Am.——Fig. 398,*6*. **D. quinquespinosa* (Lake), Eng.; *6a,b*, ceph., dorsal, lateral, ×2 (496*, 1956).

Leonaspis Richter & Richter, 1917 [**Odontopleura leonhardi* Barrande, 1846] [=*Acanthaloma* Conrad, 1840 (suppressed, ICZN Opinion 498); *Acantholoma* Castelnau, 1843, *L. (Acanthomina)* Prantl & Přibyl, 1949]. Distinguished from *Odontopleura* by smaller, lower, lateral glabellar lobes, occipital ring with median tubercle or spine and lacking occipital lobes, larger eye lobes situated in inner, posterior corners of genal regions, stouter librigenal and posterior pleural spines, latter more backwardly directed, narrower *(tr.)* pygidium. *L.Sil.-L.Dev.*, Eu.-N.Am.-Bol.

L. (Leonaspis). All thoracic segments with backward-directed pleural spines. *L.Sil.-L.Dev.*, Eu.-N.Am.-Bol.——Fig. 398,*3*. *L. (L.) williamsi* Whittington, L.Dev., Okla.; *3a*, exoskel. (reconstr.); *3b*, ceph., anterior; *3c*, hypostoma; all ×1.5 (496*).

L. (Kettneraspis) Prantl & Přibyl, 1949 [**Acidaspis pigra* Barrande, 1872]. First 2 thoracic segments faceted and having short posterior pleural spines. *M.Sil.-M.Dev.*, Boh.-Ger.

Primaspis Richter & Richter, 1917 [**Odontopleura primordialis* Barrande, 1846]. Glabella with small *3p* lateral lobes; occipital ring not greatly lengthened or inflated, median tubercle or small paired occipital spines, small occipital lobes, eye lobes opposite basal glabellar lobes and about halfway across genal regions; librigenal spines broad at base, adjoining short lateral cephalic spines. Thorax with 10 segments; posterior pleural bands inflated at fulcra, stout posterior pleural spines, small anterior pleural spines. *M.Ord.-U.Ord.*, *?Sil.*, Eu.-N.Am.——Fig. 398,*2*. **P. primordialis* (Barrande), *M.Ord.*, Boh.; *2a-c*, cran., anterior, right lateral, dorsal; *2d*, pyg.; all ×2 (496*).

Radiaspis Richter & Richter, 1917 [*Arges radiatus* Goldfuss, 1843]. Like *Acidaspis* but inflated median part of occipital ring prolonged into paired spines. Thorax with 9 segments. Pygidium with posterior part of axis bilobed, 8 pairs of subequal border spines. *L.Dev.-U.Dev.*, Ger.-Boh.

Subfamily MIRASPIDINAE Richter & Richter, 1917

[=Ceratocephalidae Prantl & Přibyl, 1949]

Glabella wide; occipital ring long *(sag., exsag.)*, convex, with prominent paired spines; median glabellar lobe subparallel-sided; small 3rd lateral lobes usually present; genal regions subrectangular in outline, librigenal spines arising from upper surface of border and directed upward-outward; sections of sutures form obtuse angle. Hypostoma wider than long, middle furrow forming triangular depression in anterolateral corners of middle body; shallow median posterior notch. Thoracic pleurae may lack pleural furrow; anterior pleural spine bladelike, with lateral barbs; 1st 2 or 3 posterior pleural spines directed outward and slightly forward, successively more posterior pleural spines directed outward and more strongly backward. *M.Ord.-M.Dev.*

Miraspis Richter & Richter, 1917 [**Odontopleura mira* Barrande, 1846]. Occipital ring with posterior band; eye lobes opposite basal glabellar lobes, pedunculate; long, slender spines on lat-

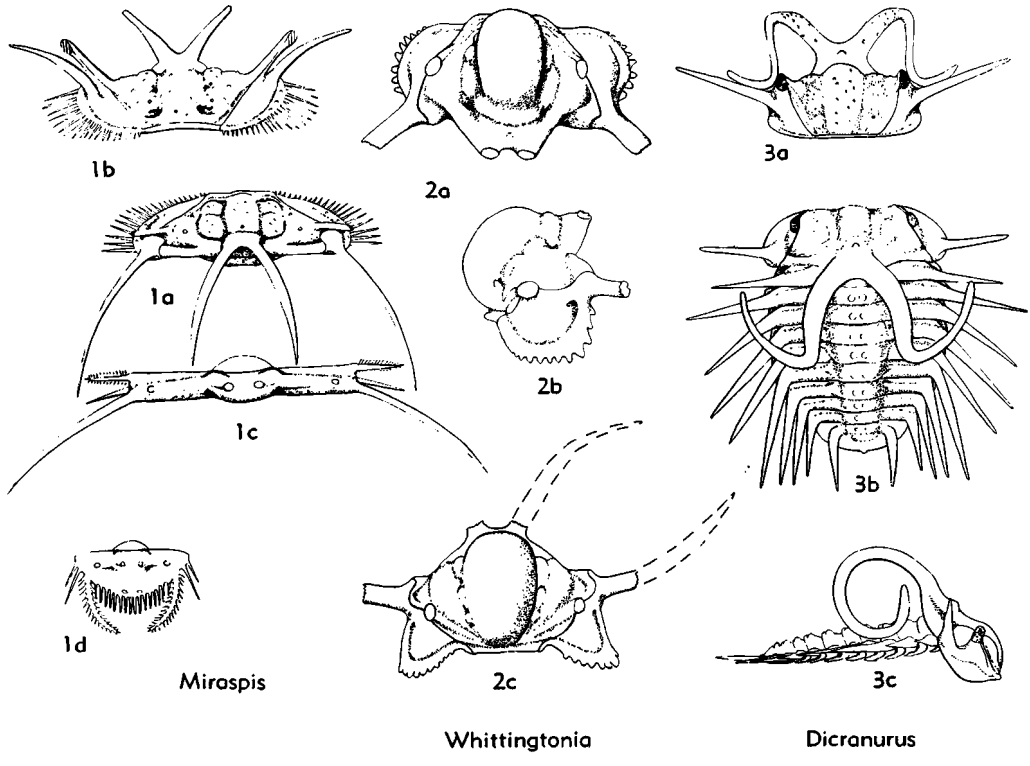


FIG. 399. Odontopleuridae (Miraspidinae) (p. O506-O508).

eral cephalic border. Thorax with 9 segments bearing deep pleural furrows; slender pleural spines between anterior and posterior spines. Pygidium with 11 pairs of border spines, 3rd pair thick, long, others slim and short; ridge on pleural region running out transversely from 1st axial ring, then turning abruptly back to base of large 3rd border spine. *M.Sil.*, Eu.——FIG. 399,*1*. **M. mira* (BARRANDE); *1a,b*, ceph., dorsal, anterior; *1c*, thoracic segment; *1d*, pyg., all ×1 (496*).

Ceratocephala WARDER, 1838 [**C. goniata*] [=*Trapelocera* HAWLE & CORDA, 1847; =*Onchaspis* RAYMOND, 1925]. Occipital ring with posterior band; eye lobes opposite *1p* lateral glabellar furrows and halfway across genal regions, not pedunculate; lateral cephalic spines short. Thorax with 10 segments, pleural furrows faint or absent, anterior pleural spines almost vertically directed. Pygidium short, with 1 to 3 pairs of border spines and median posterior spine, none conspicuously longer than others (360). *M.Ord.-M.Dev.*, Eurasia-Austral.-N.Am.

C. (Ceratocephala). *M.Ord.-M.Dev.*, Eurasia-Austral.-N.Am.——FIG. 400. *C. laciniata* WHITTINGTON & EVITT, *M.Ord.*, Va.; *a,b*, exoskel. (reconstr.), number of thoracic segments unknown, dorsal and left lateral views, ×3 (360*).

C. (Ceratocephalina) WHITTINGTON, 1956 [**Ceratocephala (Ceratocephalina) tridens*]. *M.Ord.*, USA(Va.).

Ceratonurus PRANTL & PŘIBYL, 1949 [**Acidaspis krejčii* NOVÁK, 1883]. Inadequately known, cephalon as in *Ceratocephala;* 9 thoracic segments, convex posterior pleural band and long spines like those of *Dicranurus;* pygidium like that of *Miraspis* (38). *L.Dev.-M.Dev.*, Boh.-Ger.

Dicranurus CONRAD, 1840 [**Acidaspis hamata* HALL, 1859]. Massive paired occipital spines recurved over thorax, small 3rd lateral glabellar lobes; eye lobes opposite basal glabellar lobes, high on genal regions; no lateral cephalic spines. Thorax with 9 segments; convex posterior pleural band running outward in curve gently convex forward; short, curved anterior pleural spines. Pygidium with single pair of border spines. *L.Dev.-M.Dev.*, Eu.-N.Am.-Austral.——FIG. 399,*3*. *D. monstrosus* BARRANDE, M.Dev., Boh.; *3a*, ceph., anterior; *3b,c*, exoskel., dorsal, right lateral; all ×0.75 (496*, 1956).

Koneprusia PRANTL & PŘIBYL, 1949 [**Acidaspis fuscina* NOVÁK, 1883]. Inadequately known, seemingly like *Ceratocephala;* with 10 thoracic segments; pygidium with single long pair of border spines and median spine. *L.Dev.-M.Dev.*, Boh.

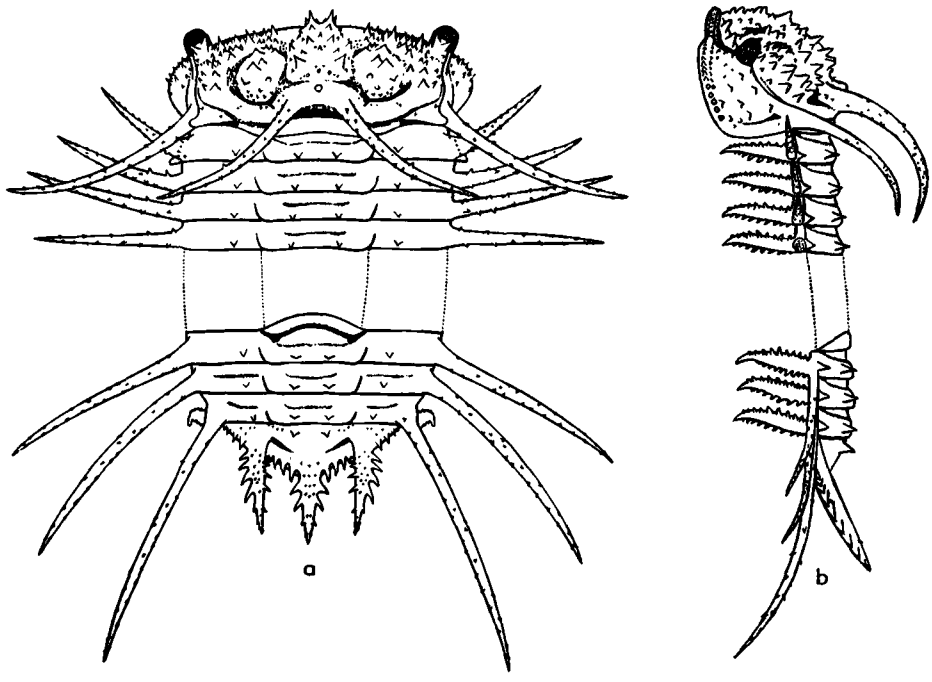


FIG. 400. **Ceratocephala laciniata* WHITTINGTON (Odontopleuridae), M.Ord., Va.; *a,b*, incomple. exoskel. (reconstr.), dorsal and lateral views, ×3 (360*).

Orphanaspis PRANTL & PŘIBYL, 1949 [**Trilobites orphana* BARRANDE, 1852]. Few thoracic segments known. Pygidium with short axis, 3 axial rings, usually raised border on pleural regions, one pair of border spines (38). *M.Sil.-M.Dev.*, Boh.-Ger.

Proceratocephala PRANTL & PŘIBYL, 1949 [**Acidaspis terribilis* REED, 1914] [=*Drummuckaspis* PRANTL & PŘIBYL, 1949]. Like *Ceratocephala;* position of eye lobes uncertain; lateral lobes and long paired spines on occipital and axial rings; 9 thoracic segments, deep pleural furrows; pygidium with horizontal long pair, and short median, border spines. *U.Ord.*, Scot.

Selenopeltoides PRANTL & PŘIBYL, 1949 [**Acidaspis hawlei* BARRANDE, 1852]. Like *Ceratocephala* but eye lobes opposite and close to basal part of posterior glabellar lobes. Thorax with 9 segments, pleurae with furrow and posterior band. Axis of pygidium with 2 rings, pleural regions traversed by ridge running from 1st axial ring to base of paired border spines. *M.Sil.*, Boh.

Whittingtonia PRANTL & PŘIBYL, 1949 [**Acidaspis bispinosus* M'COY, 1846]. Only cephalon known; frontomedian glabellar lobe strongly convex, overhanging anterior border, convex band across base; with 3 pairs of narrow *(tr.)* lateral glabellar lobes; eye lobes centrally situated on genal regions; lateral cephalic spines short. *U.Ord.*, Ire.-Swed.—— FIG. 399,2. **W. bispinosa* (M'COY); *2a-c*, ceph., dorsal, left lateral, anterior, ×2 (496*).

Subfamily SELENOPELTINAE Hawle & Corda, 1847

[*nom. transl.* WHITTINGTON, herein (*ex* Selenopeltidae, *nom. correct.* PRANTL & PŘIBYL, 1949, *pro* Selenopeltides HAWLE & CORDA, 1847)]

Characters of *Selenopeltis. M.Ord.-U.Ord.*

Selenopeltis HAWLE & CORDA, 1847 [**Odontopleura buchii* BARRANDE, 1846] [=*Polyeres* ROUAULT, 1847). Cephalon transversely subrectangular in outline; glabella gently convex, narrowing slightly forward; occipital ring short *(sag.)*, with median tubercle; frontomedian lobe wide *(tr.)* narrow *(sag.)*, gently convex band across base; apparently 3 lateral glabellar lobes, basal furrow shallow, at inner end turning back into deep furrow that becomes shallow as it meets furrow defining band at base of median lobe; basal lateral glabellar lobes divided subequally by shallow transverse furrow, posterior part divided again by shallow longitudinal furrow; *2p* lateral furrows diagonal, deepest at inner end, *2p* lobes gently convex, *3p* lobes small; crescentic eye lobes situated about centrally on genal regions, sections of sutures at obtuse angle; narrow anterolateral cephalic border; librigenal spines long, arising from upper surface of border at genal angles. Hypostoma wider than long, with broad lateral and posterior borders, shallow median posterior notch; middle furrow shallow. Thorax with 9 segments; rings with convex lateral lobe; pleurae with narrow posterior

pleural ridge running outward in curve convex forward; short, curved anterior pleural spine, long backwardly directed posterior pleural spine. Pygidium with short axis, faint 3rd ring, pleural regions crossed by strong ridges continuous with base of single border spine. Surface tuberculate or granulose. *L.Ord.-U.Ord.*, Eu.-N.Afr.——FIG. 401. **S. buchii* (BARRANDE), M.Ord.-U.Ord., Boh.; *a*, ceph., anterior; *b*, hypostoma; *c*, exoskel. (reconstr.); all ×0.5 (496n).

Subfamily APIANURINAE Whittington, 1956

Glabella narrowing forward; median lobe well defined, parallel-sided, 2 pairs of lateral glabellar lobes fused; occipital ring long *(sag.)*, convex, with long paired spines and median tubercle; eye lobes situated far back and about midway across genae, 2 sections of sutures forming straight line inclined inward-forward to sagittal line; librigenae narrow, with genal spines arising about midway along lateral border and curving back. Hypostoma shield-shaped, middle furrow arising at anterolateral corners of middle body and running inward-backward, with small, pointed shoulders and shallow lateral notch. Thorax of unknown number of segments, pleurae convex *(exsag.)*, single large pleural spine. Pygidium with paired border spines and unpaired median border spine in some, also long major spine directed upward. *M.Ord.-U.Ord.*

Apianurus WHITTINGTON, 1956 [**A. barbatus*]. Occipital spines long, diverging at angle of 60 to 80 degrees; fused lateral lobes kidney-shaped; large eye lobes opposite basal glabellar lobe. Hypostoma widest anteriorly, convex middle body divided into triangular anterior and crescentic posterior lobe; small anterior, tiny posterior, wings. Pygidium with 6 or 7 pairs of border spines, flat pleural fields bearing centrally situated upright major spine. Long spines (except occipital) with thornlike lateral spines, remainder of exoskeleton tuberculate or spinose. *M.Ord.-U.Ord.*, Eu.-USA (Va.).

Calipernurus WHITTINGTON, 1956 [**C. insolitus*]. *M.Ord.*, USA(Va.).

Subfamily UNCERTAIN

Ancyropyge CLARKE, 1892 [**Acidaspis romingeri* HALL & CLARKE, 1888]. Pygidium only known; axis little longer than wide, including anterior ring and subhemispherical rear part; pleural regions comprising merely bases of 6 pairs of long spines that curve outward-backward. *M.Dev.*, Mich.

Bounyongia ETHERIDGE & MITCHELL, 1917 [**B. bowningensis*]. Based on 2 poorly preserved cephala, inadequate for diagnosis. *Sil.*, Austral.

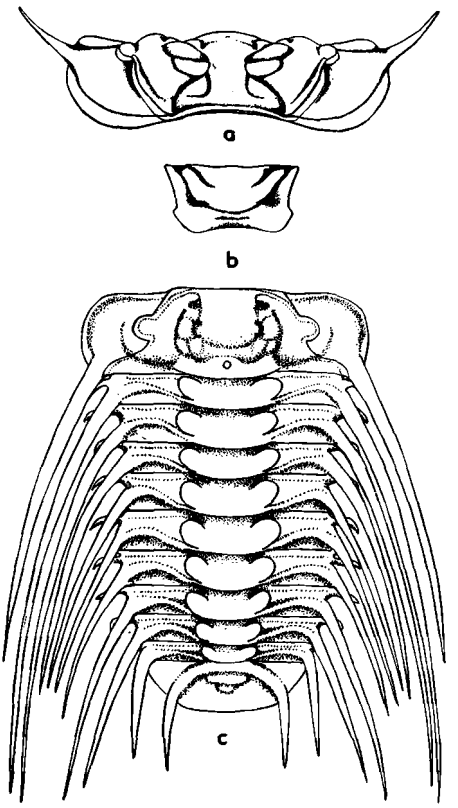


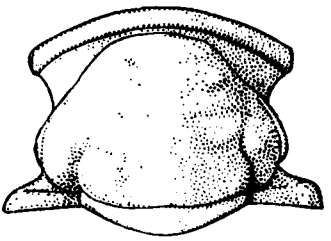
FIG. 401. **Selenopeltis buchii* (BARRANDE) (Odontopleuridae), Ord., Boh.; *a*, ceph., anterior; *b*, hypostoma; *c*, exoskel. (reconstr.); all ×0.5 (496).

Globulaspis REED, 1931 [**Acidaspis (Globulaspis) prominens*]. Based on internal mold of incomplete cranidium; strongly convex glabella with small basal lateral lobes, fixigenae strongly convex posteriorly. *L.Sil.*, Scot.

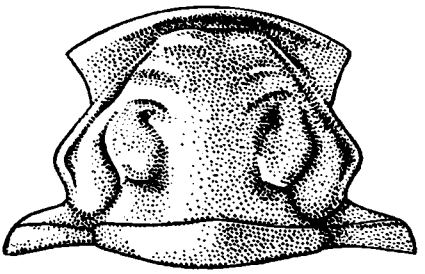
Family EOACIDASPIDIDAE Poletaeva, 1957

[*nom. correct.* JAANUSSON, herein (*ex* Eoacidaspidae POLETAEVA, 1957)]

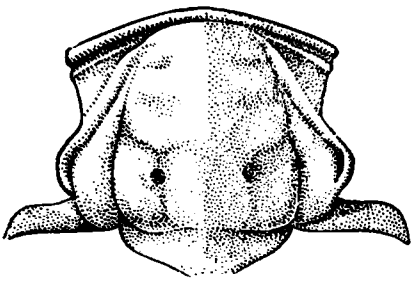
Apparently primitive odontopleuraceans with facial sutures conspicuously divergent in front of eyes. Cranidium with prominent anterior border separated from glabella by distinct furrow; glabella long, more or less trapezoidal, with lateral glabellar furrows well defined to almost obsolete, posterior or middle *(Eoacidaspis)* lateral glabellar lobes large; eye ridges well developed, like those of other odontopleuraceans; librigenae, rostral shield, hypostoma, and number of thoracic segments unknown, details of thoracic



1 Belovia



2 Eoacidaspis



3 Acidaspides

FIG. 402. Eoacidaspididae (p. O510).

segments poorly known. Pygidium (known only in *Acidaspides*) with 3 pairs of prominent, posteriorly directed spines of subequal length and width. *Up.M.Cam.-U.Cam.*

Eoacidaspis POLETAEVA, 1956 [**E. salairica*]. Lateral glabellar furrows well defined, middle lobes *(2p)* large, separated from remainder of glabella by distinct furrows. Posterior (preoccipital) glabellar lobes *(1p)* shorter *(exsag.)* than middle lobes, poorly defined. *U.Cam.*, Sib.——FIG. 402,*2*. **E. salairica;* cran., ×? (443).

Acidaspides LERMONTOVA, 1951 [**A. precurrens*]. Posterior lateral glabellar lobes *(1p)* large, separated from remainder of glabella by distinct furrow, middle lateral glabellar lobes *(2p)* shorter *(exsag.)* than posterior lobes, well defined. *Up.M. Cam.-U.Cam.*, Sib.-Kazakhstan.——FIG. 402,*3*. *A. lermontovae* CHERNYSHEVA; cran., ×? (443).

Belovia POLETAEVA, 1956 [**B. calva* CHERNYSHEVA, 1956]. Lateral glabellar lobes and furrows generally as in *Acidaspides*, but poorly defined, lateral glabellar furrows faint to obsolete; eye ridges comparatively faint. *U.Cam.*, Sib.——FIG. 402,*1*. **B. calva* (CHERNYSHEVA); cran., ×? (443).

Order UNCERTAIN

Family MISSISQUOIIDAE Hupé, 1953

Exoskeleton gonatoparian, subisopygous. Glabella parallel-sided to tapering, with 3 to 4 pairs of glabellar furrows; eye ridges faint or obsolete; palpebral furrows shallow; palpebral rims, occipital and axial furrows deep; eyes of medium size, position probably variable; preglabellar area probably absent in all; fixigenae upsloping, with straplike posterior areas and rounded genal angles; librigenae small, quadrate, steeply inclined. Thorax with 5 or more segments; axis convex, about same in width *(tr.)* as pleurae, ends of pleurae pointed. Pygidium subtriangular; axis convex, extending nearly full length; pleural fields about same in width, without border furrow or border, pleurae continuing directly to margin; marginal and terminal axial spines may be present. *L.Ord.(Tremadoc.)*.

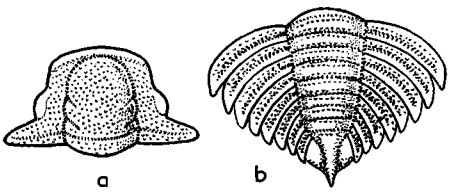


FIG. 403. **Missisquoia typicalis* SHAW (Missisquoiidae), L.Ord.(Tremadoc.), USA(Vt.); *a,b*, ceph., pyg., ×6 (471).

Missisquoia SHAW, 1951 [**M. typicalis*]. Glabella parallel-sided to tapering, front broadly rounded, with median notch and 3 or 4 pairs of short deep lateral furrows at sides; eyes slightly below medium size, opposite center of glabella; no preglabellar field, curved anterior border furrow meeting preglabellar furrow, anterior border narrow; fixigenae with palpebral areas a little less than 0.5 of glabellar width, posterior areas about 0.7 of length *(tr.)* of occipital ring. Pygidium with axis showing 7 or 8 axial rings and terminal continued into median terminal spine; pleurae 6, separated by narrow shallow interpleural grooves and crossed by broad deep pleural furrows to

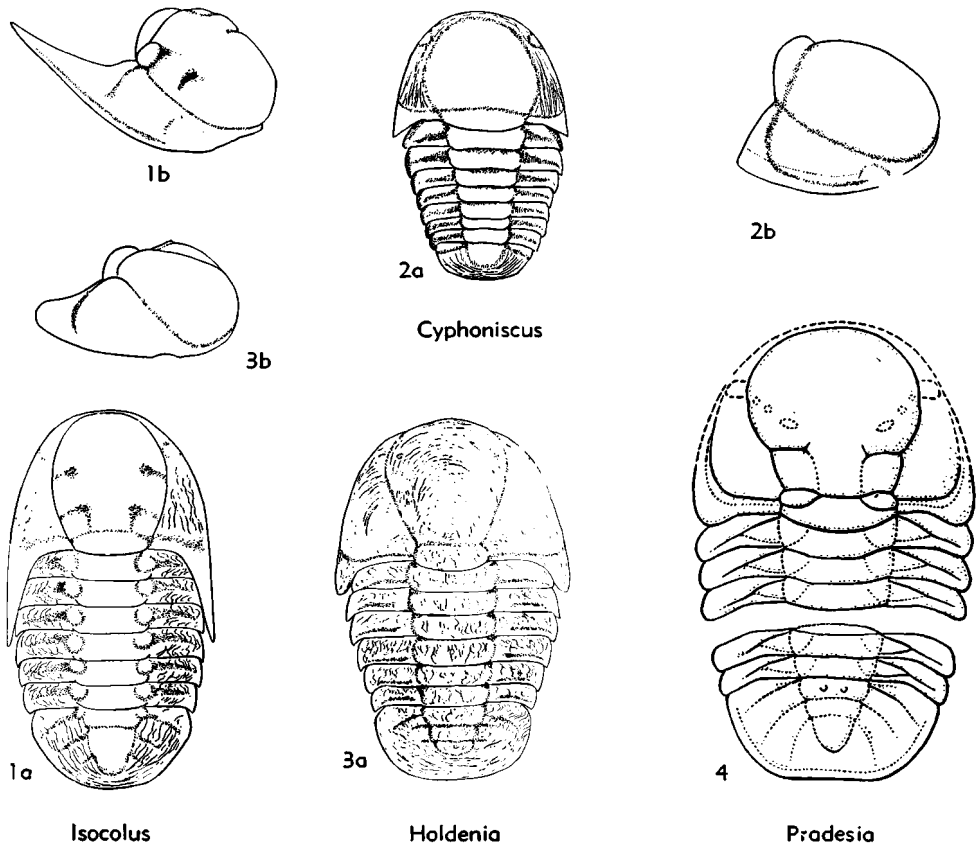


FIG. 404. Isocolidae (p. O511-O512).

margin, terminating in short marginal spines. Outer surface finely granulose. *L.Ord.(Tremadoc.)*, E.N.Am.——FIG. 403. **M. typicalis*, Vt.; *a,b*, ceph., pyg., ×6 (471).

Family ISOCOLIDAE Angelin, 1854

Exoskeleton 1 or 2 cm. in length. Convex cephalon, glabella ovate, outlined by deep axial and preglabellar furrows, greatest width at or in front of mid-length, deep occipital furrow, with or without 3 pairs of lateral glabellar furrows; genal regions and frontal area confluent, descending vertically distally, posterior and lateral borders gently convex, defined by furrows, long genal spines may occur; eye lobes (if present) gently convex, situated adjacent to axial furrows on anterolateral parts of genae, seemingly combined with eye ridges; eye facets absent; facial sutures opisthoparian, posterior sections curving across distal part of posterior borders, anterior sections confluent along margin of frontal area. Anterior cephalic doublure and hypostoma unknown. Thorax with 6 or 7 segments; axis about 0.3 of width; small anterolateral lobes may be present on rings; inner part of pleurae horizontal, outer part bent steeply down, with deep pleural furrow. Pygidium with bluntly terminated axis not reaching posterior margin, 1 to 3 rings, convex pleural regions crossed by one or more pleural furrows. External surface with raised, anastomosing lines running subparallel to margins, except in furrows (78, 79, 358). *?L. Ord., M.Ord.-U.Ord.*

Isocolus ANGELIN, 1854 [**I. sjögreni*]. Maximum width of glabella at mid-length and less than length *(sag.)*, with 2 pairs of short, deep lateral furrows directed transversely, inner end of basal furrow expanding into pit and connected by

shallow furrow to occipital furrow, thus isolating small, subcircular basal lobe; eye lobes ovate in outline, transversely directed; genal spines extending back close to thorax and reaching 3rd segment. Thorax with 6 segments with small axial rings bearing isolated anterolateral lobes, pleural furrows running in curves gently convex forward. Pygidial axis with faint 1st ring furrow, pleural regions with 3 pleural furrows, progressively shorter and fainter posteriorly (323). *U.Ord.*, Swed.-?C.Asia.——Fig. 404,*1*. **I. sjoegreni*, Swed.; *1a,b*, exoskel., ceph. (anterolateral), ×12 (358*).

Cyphoniscus Salter, 1853 [**C. socialis*]. Glabella subcircular in outline, lateral furrows not impressed, posterior border widening *(exsag.)* distally, continuous with convex lateral border; apparently without genal spines; low eye lobes. Thorax with 7 segments; axial rings with faint anterolateral lobes; pleurae with deep diagonal pleural furrows. Pygidium without ring furrows on axis; only 1st pleural furrows present, extending to margin (266). *U.Ord.*, Eng.——Fig. 404,*2*. **C. socialis*, Eire; *2a,b*, exoskel., ceph. (anterolateral), ×5 (358*).

Holdenia Cooper, 1953 [**H. typa*]. Glabella pear-shaped, widest near front; basal and median lateral furrows represented by smooth areas, anterior laterals by small pits; librigenae unknown; emarginations in anterolateral parts of cranidium indicate position of eyes but no lobes present; posterior border furrows deep. Thorax with 6 segments; pleurae with pleural furrows close to posterior margins, deepening outward. Pygidial axis with 3 ring furrows; pleural regions with inner ends of 1st 2 interpleural grooves, 1st pleural furrows distinct, 2nd furrows faint (26). *M.Ord.*, Va.——Fig. 404,*3*. **H. typa; 3a,b*, exoskel., cran. (anterolateral), ×2.5 (358*).

?Pradesia Thoral, 1935 [**P. martyi*]. Like *Holdenia*, but basal lateral glabellar furrows deep, curving back and shallowing toward occipital furrow; three further glabellar furrows indicated by shallow depressions. Convex lobe in anterolateral part of occipital ring. Eye lobe and lateral cephalic border unknown. Doublure broad *(sag.)* anteriorly, no median suture. Number of thoracic segments unknown, but not less than 6; convex anterolateral lobes on axial rings, pleural furrow diagonal. Pleural regions of pygidium with 3 shallow pleural furrows. *L.Ord.(Tremadoc.)*, Fr.——Fig. 404,*4*. **P. martyi*, incomplete exoskel., ×5 (79).

Family MYINDIDAE Hupé, 1955

Cephalon approximately semicircular, slightly convex, with narrow, prominent border; glabella short, convex, parallel-sided, rounded anteriorly, 3 pairs of short lateral glabellar furrows; eye ridges short, distinct; preglabellar field long, crossed by well-marked median ridge; suture apparently marginal (287). *L.Ord.(Tremadoc.)*.

Myinda Stubblefield in Stubblefield & Bulman, 1927 [**M. uriconii*]. Characters of family. *L.Ord. (Tremadoc.)*, Eng.——Fig. 405,*3*. **M. uriconii*; ceph., ×7.5 (287).

Family GRANULARIIDAE Poletaeva, ?1936

[*nom. correct.* Henningsmoen, herein (*ex* Granularidae Poletaeva, ?1936)]

Cranidium proparian, with pyriform glabella and preglabellar field. Pygidium isopygous, with many segments and relatively narrow axis. Surface densely granulose. *Up. L.Cam.*

Granularia Poletaeva, ?1936 [**G. obrutchevi*]. Characters of family. *Up.L.Cam.*, USSR.

Family SARKIIDAE Hupé, 1953

[*nom. correct.* Henningsmoen, herein (*pro* Sarkiaiidae Hupé, 1953)]

Cephalon without facial sutures and with stout posterolateral spines; glabella with parallel sides and 3 pairs of short lateral furrows; eyes absent. Cephalic border furrows pitted. Thorax with at least 10 segments. Pygidium small, transverse, and with 3 or 4 axial rings. *M.Ord.(Llandeil.)*.

Sarkia Kloučeк, 1916 [**S. bohemica*]. Characters of family. *M.Ord.(Llandeil.)*, Boh.——Fig. 405,*1*. **S. bohemica; 1a,b*, ceph.; *1c*, hypostoma; all ×2.2 (411).

Order and Family UNCERTAIN

LOWER CAMBRIAN GENERA

[Authorship of text is indicated by code letters given at the end of each section; these letters are explained on page O160]

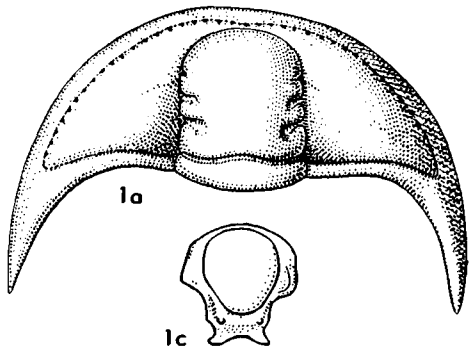
Aguaraya Rusconi, 1955 [**A. acutispina*]. *Up.L. Cam.*, Arg. (Mendoza) (LB).

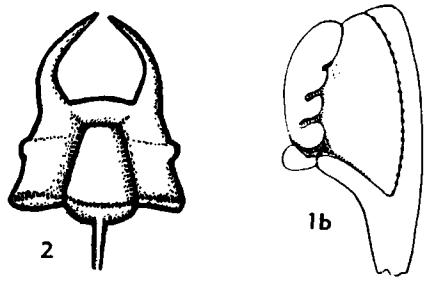
Avalonia Walcott, 1891 [**A. manuelensis*]. Cranidium trapezoidal; glabella parallel-sided, extended to anterior border; occipital ring rounded; eye ridges conspicuous; palpebral lobes small; facial sutures almost straight from anterior to posterior margin; posterior areas large, deeply furrowed. May belong to Corynexochidae. *L.Cam.*, N.Am. (Acad.-Balt. prov.).——Fig. 406,*4*. **A. manuelensis*, Newf.; cran., ×2.25 (448n) (RA).

Binodaspis Lermontova, 1951 [**B. spinosa*]. Resembles Ptychopariidae. *Up.L.Cam.*, E.Sib. (HE).

Giordanella; Bornemann, 1891 [**Illaenus meneghinii* Bornemann, 1883; SD Vogdes, 1925]. *Up.L.Cam.*, Sard. (LB).

Jakutus Lermontova, 1951 [**Dorypyge quadriceps* Rjonsnitsky]. Glabella only slightly tapering forward and with 5 pairs of lateral furrows; no preglabellar field; wide anterior border; eye lobes





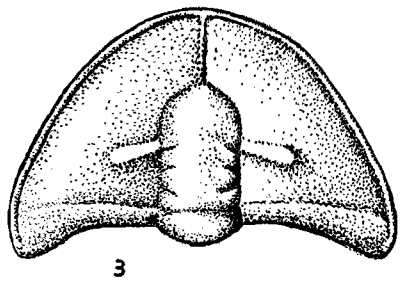


FIG. 405. Diceratocephalidae (p. *O*334), Sarkiidae (p. *O*512), Myindidae (p. *O*512).

medium in size and confluent with wide, oblique eye ridges. Librigenae with short spines. Thoracic pleurae with well-developed spines. Pygidium small; axis with 2 rings and end lobe. Surface of exoskeleton granulose. *Up.L.Cam.*, E.Sib.——FIG. 406,*3*. **J. quadriceps* (RJONSNITSKY); ceph., reconstr., ×1 (433) (HE).

Jangudaspis OGIENKO, 1956 [**P. princeps*]. *Up.L. Cam.*, USSR (HE).

Judaiella LERMONTOVA, 1951 [**J. vernicula*]. *L. Cam.*, Sib. (LB).

Kueichowia LU, 1942 [**K. liui*]. *L.Cam.*, China (HE).

Kuanyangia HUPÉ, 1953 [**Redlichia pustulosa* LU, 1941] [=*Kuanyiangia* HUPÉ, 1953 (obj.)]. *L. Cam.*, Yunnan (HE).

Meneghinella BORNEMANN, 1891 [**M. serrata*]. *L. Cam.*, Sard. (HE).

Metisaspina SIVOV, 1955 [**M. anomala*]. *Low.U. Cam.*, Salair, USSR (HE).

Namanoia LERMONTOVA, 1951 [**N. namandensis*]. [Family Namanoiidae LERMONTOVA, 1951]. *Up.L. Cam.*, E.Sib. (HE).

Paragraulos LU, 1941 [**P. kunmingensis*]. *L.Cam.*, China.——FIG. 406,*2*. **P. kunmingensis;* incomplete ceph., ×4 (136). (HE).

Protypus WALCOTT, 1886 [**Angelina hitchcocki* WHITFIELD, 1884] [=*Bicaspis* RESSER, 1938]. Glabella large, prominent, pear-shaped, unfurrowed, reaching anterior border; occipital ring simple; fixigenae downsloping; palpebral lobes of medium length, curved; palpebral furrows shallow; anterior facial sutures slightly divergent; posterior sections defining moderately long *(tr.)*, rounded posterior areas. Thorax of 12 segments, with prominent axis, pleurae bluntly terminated. Pygidium wide and short, much smaller than cephalon, with sharp anterior angles; marginal furrow and border indistinct. Possibly related to Ellipsocephalidae. *L.Cam.*, N.Am.——FIG. 406,*1*. *P. marginatus* RASETTI, Que.; *1a,b*, cran., lat., and dors., views, ×2.25; *1c*, pyg., ×1.5 (448n) (RA).

MIDDLE CAMBRIAN GENERA

Amgaspis CHERNYSHEVA, 1956 [**A. medius*]. *Low. M.Cam.*, USSR (HE).

Amginouyia CHERNYSHEVA, 1956 [**A. elegans*]. *Low.M.Cam.*, USSR (HE).

Chakasskia POLETAEVA, 1936 [**C. minussensis*]. Glabella elongate, sides tapering to broadly rounded front, with 3 pairs of lateral furrows, posterior 2 pairs complete, chevron-shaped, posterior pair touching occipital furrow; narrow eye ridges, palpebral rims and furrows prominent; no preglabellar field; anterior border furrow runs into axial furrow at sides; anterior border narrow; eyes of medium size, near mid-length of glabella; fixigenae convex, horizontal, with palpebral areas 0.7 of glabellar width, posterior areas broadly *(exsag.)* triangular, 0.7 of length *(tr.)* of occipital ring; librigenae, thorax and pygidium unknown. Outer surface granulose (102). *Low.M.Cam.*, Sib. (W. Sayan Mtns.) (LB).

Chittidilla KING, 1941 [**C. plana*]. Preglabellar area convex, sloping evenly to front margin; occipital ring with short blunt spine; palpebral lobes small, with ocular ridge reaching point near front of glabella, which bears 3 pairs of faint furrows. *M.Cam.*, S.Asia.——FIG. 408,*2*. **C. plana*, Magnesian Sandstone, Pak.; cran., ×3.6 (418) (RA).

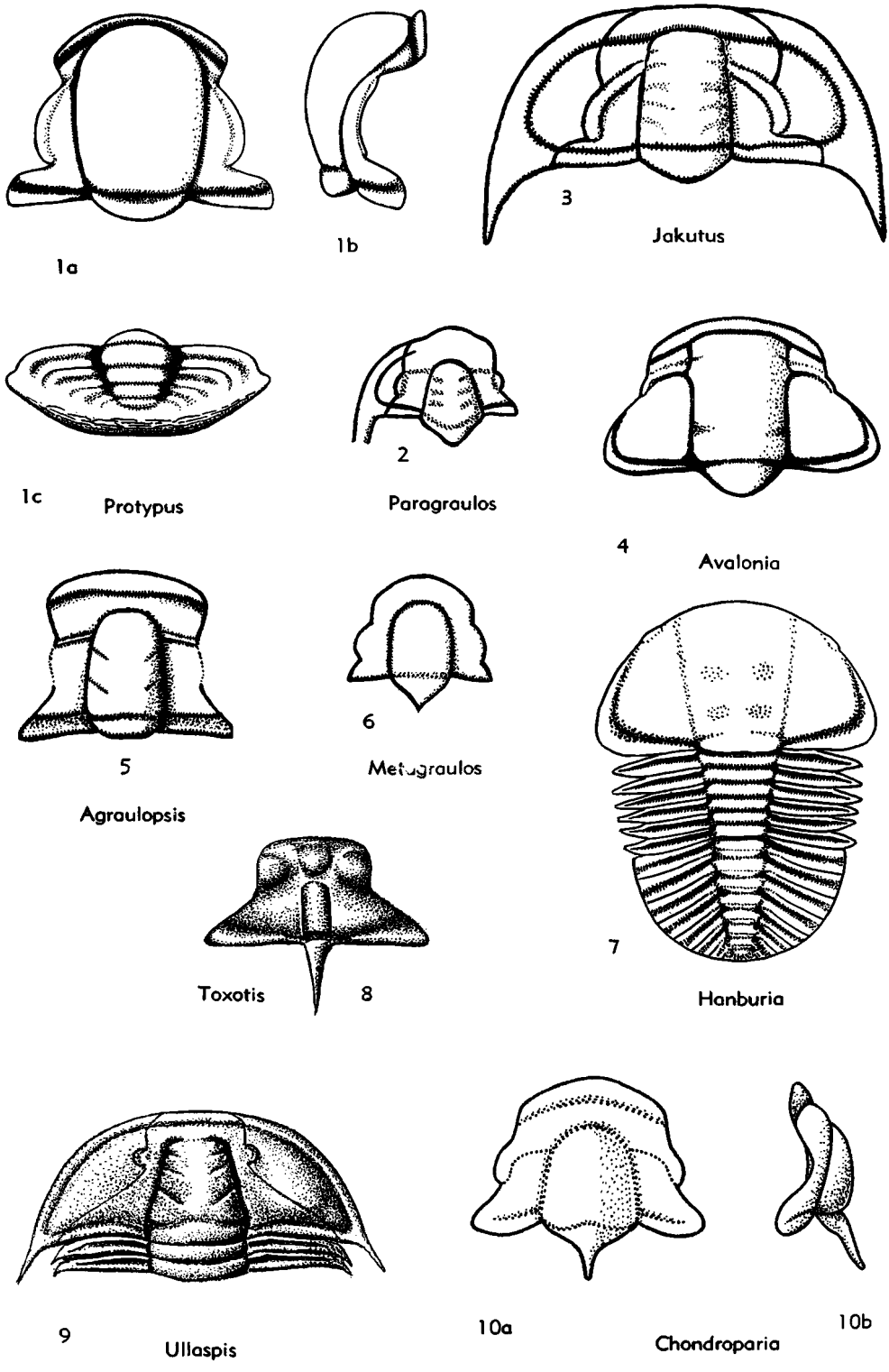


FIG. 406. Incertae sedis. Lower and Middle Cambrian genera (p. O512-O516; *Agraulopsis*, p. O234).

Chondragraulos LERMONTOVA, 1940 [**C. minussensis*]. *M.Cam.*, Sib. (HE).

Chondroparia LORENZ, 1906 [**Agraulos? pusillus* MATTHEW, 1897]. Cephalon small, elliptical, regularly convex; glabella tapering, with rounded front, 3 pairs of short, faint lateral furrows; eye ridges very faint; short occipital spine may be present; preglabellar area downsloping; anterior border furrow narrow, anterior border convex; palpebral lobes small, slightly anterior to center of glabella; fixigenae with palpebral areas slightly downsloping, 0.5 to 0.3 of glabellar width, posterior areas broadly *(sag.)* triangular, 0.7 of length *(tr.)* of occipital ring; librigenae, thorax and pygidium unknown. Outer surface may be finely granulose. *Up.M.Cam.*, E.Can.——FIG. 406,*10a,b*. **C. pusilla* (MATTHEW), N.B.; *10a,b*, cran., ×4 (429) (LB).

Conoides HOWELL, 1937 [**C. edsoni*]. *Up.M.Cam.*, E.USA. (Vt.) (LB).

Edelsteinaspis LERMONTOVA, 1940 [**E. ornata*]. Glabella elongate, rectangular, front converging very slightly, rounded, with 3 pairs of chevron-shaped complete lateral furrows; with distinct eye ridges, palpebral lobes and furrows; no preglabellar field, anterior border furrow curves into preglabellar furrow, narrow, rimlike anterior border; eyes large, slightly posterior to center of glabella; fixigenae of medium width, slightly upsloping, with arcuate palpebral areas, not quite 0.5 of glabellar width, posterior areas narrow *(exsag.)*, straplike, long; librigenae rectangular, with shallow marginal furrows, and short rounded genal spine. Thorax of 10 or 11 segments; axis convex; pleurae low, flat, wider *(tr.)* than axis, with deep pleural furrow. Pygidium semicircular, axis narrow, convex, tapered 0.8 of its length to narrow, rounded end, with 6 axial rings and terminal; pleural fields wider, convex, pleurae 5, separated by narrow interpleural grooves and crossed by deep pleural furrows that fade at inner edge of medium wide flat border, no border furrow. Outer surface finely granulose. *Low.M.Cam.*, Sib.——FIG. 407. **E. ornata*, Minusinsky Basin; exoskel., ×1.7 (423) (LB).

Eilura RESSER & ENDO, in ENDO & RESSER, 1937 [**E. typa*]. *M.Cam.*, Manch. (37) (LB).

Fabulaspis IVSHIN, 1953 [**F. famosus*]. *M.Cam.*, Kazakhstan (HE).

Hanburia WALCOTT, 1916 [**H. gloriosa*]. Cranidium semicircular in outline; glabella expanded forward, poorly defined, reaching margin of cephalon; librigenae presumably narrow and marginal; existence of palpebral lobes and eyes doubtful. Thorax of 6 segments; pleurae furrowed, slightly curved forward. Pygidium almost as large as cephalon, semicircular, with distinct furrows and grooves, no marginal furrow or border. Size small. *M.Cam.*, N.Am.——FIG. 406,*7*. **H. gloriosa*, B.C.; exoskel., restoration of cephalon uncertain, ×2 (448n) (RA).

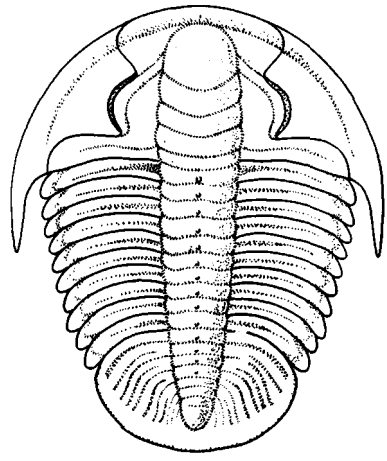


FIG. 407. **Edelsteinaspis ornatus* LERMONTOVA (Incertae sedis), M.Cam., exoskel. (reconstr.), ornamentation omitted, ×1.7 (423).

Inouyina POLETAEVA, 1936 [**I. quadratica*]. Glabella convex, rectangular, sides parallel to slightly rounded front, with 4 pairs of lateral furrows, anterior 3 pairs short, straight, posterior pair complete, curving back to touch occipital furrow on mid-length; eye ridges narrow, palpebral rims and furrows distinct; no preglabellar field; narrow anterior border furrow curves into preglabellar furrow; anterior border medium wide, convex, downsloping; eyes of medium size, near mid-length of glabella; fixigenae convex, horizontal, with palpebral areas 0.7 of glabellar width, posterior areas broadly *(exsag.)* triangular, more than 0.7 of length of occipital ring; librigenae, thorax and pygidium unknown, Outer surface granulose (102). *Low.M.Cam.*, Sib. (W. Sayan Mts.) (95) (LB).

Kolpura RESSER & ENDO, in ENDO & RESSER, 1937 [**Pterocephalus? liches* WALCOTT, 1911]. Cephalon and thorax unknown. Pygidium semicircular; axis convex, tapered 0.5 of its length to broad rounded end, with postaxial ridge continuing to notched posterior margin, 4 axial rings and terminal; pleural fields low, same in width as axis, pleurae 4 or 5, with interpleural grooves very faint anteriorly or obsolete, 4 broad shallow pleural furrows curved abruptly backward, crossing border nearly to margin, no border furrow, border of medium width, flat, anterior 2 segments ending in short flat spines, posterior pleurae fused to form a broad, flat notched pseudospine. Outer surface finely granulose. *M.Cam.*, E.Asia.——FIG. 408,*1*. **K. liches* (WALCOTT), China (Shantung); pyg., ×1.3 (488) (LB).

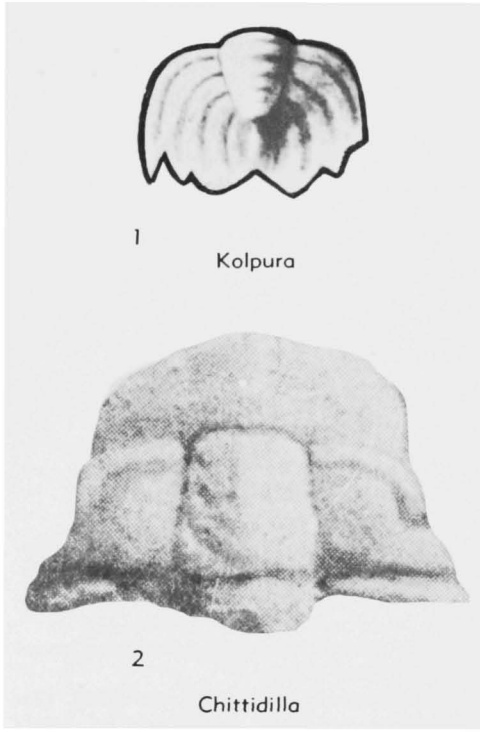


FIG. 408. Incertae sedis. Middle Cambrian genera (p. O513-O515).

Levisia WALCOTT, 1911 [**Agraulos agenor* WALCOTT, 1905], *M.Cam.*, China (Shantung) (LB).

Megagraulos KOBAYASHI, 1935 [**M. coreanicus*]. *M.Cam.*, NE.Asia (LB).

Metagraulos KOBAYASHI, 1935 [**Agraulos nitida* WALCOTT, 1906]. *M.Cam.*, China.——FIG. 406,6. **Metagraulos nitida* (WALCOTT); cran., ×3 (488) (HE).

Orloviella SIVOV, 1955 [**O. typica*]. *M.Cam.-U. Cam.*, Sib. (HE).

Pararania KOBAYASHI, 1942 [**Dolichometopus tatei* WOODWARD, 1884]. *M.Cam.*, S.Austral. (HE).

Plagiura RESSER, 1935 [**Ptychoparia? cercops* WALCOTT, 1917] [=*Plagiurella* RESSER, 1937]. Glabella subconical, unfurrowed in adult; palpebral lobes small, close to glabella, anterior in position; frontal area poorly differentiated into preglabellar field and border; anterior sections of facial sutures directed straight forward; posterior sections long, almost straight, defining large, triangular, furrowed posterior area; genal angles rounded. Thorax of 15 segments; pleurae furrowed at geniculation, sharply pointed distally. Pygidium wide and short; axis long, prominent; pleural fields furrowed; anterior angles sharp; border furrow indistinct, border downturned. *M. Cam.*, N.Am.——FIG. 409,*1*. **P. cercops* (WALCOTT), Mt. Whyte F., Alba; *a*, cran., ×2, *b*, pyg., ×3 (448n) (RA).

Prohedinella SIVOV, 1955 [**P. erbiensis*]. Cranidium resembles *Welleraspis*. *M.Cam.*, Sib. (HE).

Pseudoliostracina KOBAYASHI, 1938 [**Lioparia blautoeides* LORENZ, 1906]. *M.Cam.*, China (HE).

Schistometopus RESSER, 1938 [**S. typicalis*]. Glabella tapered, well defined, with 4 pairs of furrows occupying with occipital ring most of cranidial length; fixigenae half as wide as glabella at palpebral lobes; eye ridges strong; palpebral lobes about 0.25 of length of glabella, at level of glabellar mid-point; anterior border convex; preglabellar field reduced or lacking; anterior border furrow with a pair of backward inbends corresponding to axial furrows; anterior sections of facial sutures slightly divergent in front of palpebral lobes; posterior sections curving outward and backward; posterior area deeply furrowed. *M.Cam.*, N.Am.——FIG. 409,*2*. *S. convexus* RASETTI, Mt. Whyte F., B.C.; cran., ×3 (448n) (RA).

Toxotis WALLERIUS, 1895 [**T. pusilla*]. Minute, subtrapezoidal cranidium having short, very narrow, parallel-sided glabella delimited by shallow axial furrows, occipital ring with long, stout, backward-directed spine, effaced lateral furrows; long preglabellar field occupied by boss; narrow, indistinctly defined anterior border; wide anterior and palpebral regions of fixigenae occupied by boss, very wide posterior areas, usually effaced eye-ridges; converging course of anterior sections of facial sutures from eyes to anterior margin, wide, shallow, distinctly marked posterior border furrow, and finely punctate outer surface of preglabellar field and anterior genal area; other parts of exoskeleton unknown (336). *M.Cam.*, Swed.——FIG. 406,*8*. **T. pusilla;* cran., ×15 (336) (PO).

Trinia POLETAEVA, 1956 [**T. bella*]. [Family Triniidae POLETAEVA, 1956]. *Up.M.Cam.*, USSR (HE).

Ullaspis WESTERGÅRD, 1948 [**U. conifrons*]. Fairly small, opisthoparian, ovate, moderately convex exoskeleton having tapering, anteriorly truncated glabella, 3 pairs of well-defined lateral furrows; short preglabellar field; narrow, well-defined cephalic border; narrow anterior and palpebral and wide posterior areas of fixigenae, indistinctly defined eye-ridges, small eyes situated fairly close to anterior corners of glabella; slightly diverging, almost subparallel course of anterior sections of facial sutures from eyes to anterior border, almost straight posterior sections crossing posterior border close to genal angle; genal spines. Thorax of more than 10 segments with continuously tapering axis, furrowed pleurae, and short pleural spines. Surface smooth (336). *M.Cam.*, Swed.——FIG. 406,*9*. **U. conifrons;* ceph. with 2 attached thoracic segs., restored, ×1.6 (336) (PO).

Yorkella KOBAYASHI, 1942 [**Conocephalites australis* WOODWARD, 1884]. *M.Cam.*, S.Austral. (HE).

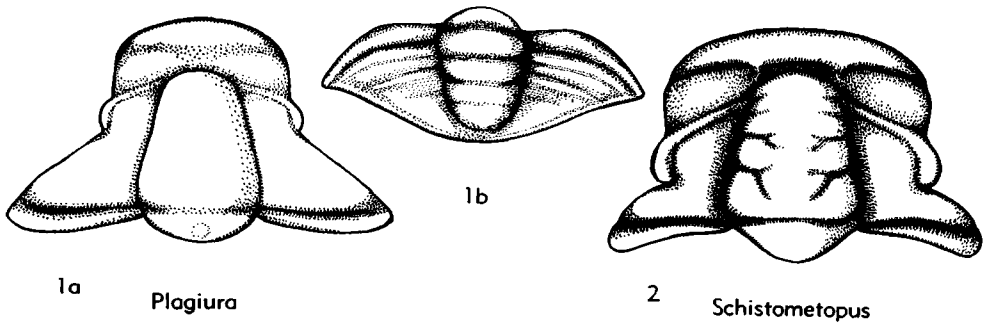


FIG. 409. Incertae sedis. Middle Cambrian genera (p. O516).

UPPER CAMBRIAN GENERA

Abakanopleura SIVOV, 1955 [**A. kenensis*]. *Low. U.Cam.*, Sib. (HE).

Acantholenus MATTHEW, 1898 [**Leptoplastus spiniger* MATTHEW, 1889]. *U.Cam.*, E.Can.(N.B.) (HE).

Acheilops ULRICH, in BRIDGE, 1930 [**A. dilatus*]. Glabella expanded forward, reaching front margin of cephalon; occipital ring short and simple; palpebral lobes long, narrow, curved, close to glabella, reaching axial furrow at anterior end; fixigenae lacking in front of eyes; posterior areas very slender, slanting backward. Size small. Cranidium suggests Corynexochidae, resemblance possibly due to homeomorphy. *U.Cam.(Trempeal.)*, N.Am.——FIG. 410,*3*. **A. dilatus*, Mo.; cran., ×2 (448n) (RA).

Acrohybus RAYMOND, 1937 [**A. argutus*]. *U.Cam. (Dresbach.)*, E.USA(Vt.). (LB).

Aidarella LERMONTOVA, 1951 [**A. vigilans*]. *U. Cam.*, NE.Kazakhstan (HE).

Bowmania WALCOTT, 1925 [**Arethusina americana* WALCOTT, 1886]. Glabella almost parallel-sided, prominent, rounded in front, with two pairs of short, lateral furrows; occipital furrow straight, occipital ring short *(sag.)* and simple; width of palpebral area about 0.7 of glabellar width; eye ridges straight, slanting backward; palpebral lobes small, slightly posterior to glabellar mid-point; anterior sections of facial suture directed straight outward-forward to margin; preglabellar field long *(sag.)*; border convex, narrow *(sag.)*; posterior sections of facial sutures not well known. *U.Cam.(Trempeal.)*, N.Am.——FIG. 410,*4*. **B. americana* (WALCOTT), Nev.; cran., ×4 (448n) (RA).

Bridgeia LOCHMAN, 1944 [**B. mirabila*]. Glabella narrowly tapering, strongly convex, with median ridge, no lateral furrows; no preglabellar area; wide, deep anterior border furrow runs into preglabellar furrow; anterior border wide *(sag.)*, strongly convex; eyes small, opposite anterior 0.3 of glabella; fixigenae slightly upsloping, with palpebral areas 0.75 of glabellar width, posterior areas long *(tr.)*; librigenae unknown. Thoracic segments, number unknown, axis and pleurae subequal in width. Pygidium ovate; axis wide, convex, nearly full length, 1 axial ring; pleurae steeply sloping, unfurrowed, narrow, flat border (132). *U.Cam.(Dresbach.)*, W.USA.——FIG. 410, *6*. **B. mirabilis*, Mont.; *6a,b*, cran.; *6c*, thoracic segments and pyg.; all ×7.5 (132) (LB).

Cryptoderaspis RASETTI, 1946 [**C. metisensis*]. Glabella extremely prominent, ovate, unfurrowed; occipital ring short, hidden by glabella in dorsal view; fixigenae downsloping; frontal area convex, undifferentiated; palpebral lobes small; posterior areas triangular, unfurrowed. Size small. *U.Cam.(Dresbach.)*, N.Am.——FIG. 410,*7*. **C. metisensis*, Que.; *7a-b*, cran., dors. and lat. views, ×3 (448n) (RA).

Ellipsocephaloides KOBAYASHI, 1935 [**Ellipsocephalus curtus* WHITFIELD, 1878]. Entire cranidium of low convexity; glabella parallel-sided, rounded in front; lateral furrows as pairs of pits that may be connected across glabella; occipital ring simple; frontal area narrow *(sag.)*, convex, undifferentiated; eye ridges and palpebral lobes forming long, continuous, thick band; fixigenae horizontal, of variable width; posterior areas not extending much farther than palpebral lobes. Pygidium with short, pointed axis and fanlike pleural regions extended into several pairs of flat spines. Size small. No relationship to *Ellipsocephalus*. *U.Cam.(Francon.)*, N.Am.——FIG. 410, *5c*. *E. silvestris* RESSER, Okla.; pyg., ×8 (239). ——FIG. 410,*5a,b*. *E. monsensis* RESSER, Alba.; cran., ×5; pyg., ×3 (239) (RA).

Eosaukia LU, 1954 [**E. latilimbata*]. *Low.U.Cam.*, SW.China (HE).

Esseigania KOBAYASHI, 1944 [**E. tolli*]. *Up.U.Cam.*, Sib.(Chatanga-Anabar Basin) (LB).

Goycoia RUSCONI, 1950 [**G. tellecheai*]. *U.Cam.*, Arg.(Mendoza) (LB).

Hamashania KOBAYASHI, 1942 [**H. pulchera*]. Cephalon and thorax unknown. Pygidium elongate ovoid; axis convex, tapered probably 0.83 of

length to narrow rounded end, may be postaxial ridge, 7 or more axial rings and terminal; pleural regions about same width as axis, low, with 8 or more pleurae, without pleural furrows but shallow posteriorly curved interpleural grooves reach nearly to margin; no border furrow or well-defined border, low slope continues to margin. Outer surface smooth. *U.Cam.(Fengshanian)*, E.Asia.—— Fig. 411,6. **H. pulchra*, Manch.; incompl. pyg., ×3 (419) (LB).

Hanivella Sivov, 1955 [**H. primaeva*]. *U.Cam.*, Salair, USSR (HE).

Jubileia Kobayashi, 1938 [**J. grandifrons*]. *U.Cam. (Francon.)*, Can.(B.C.) (LB).

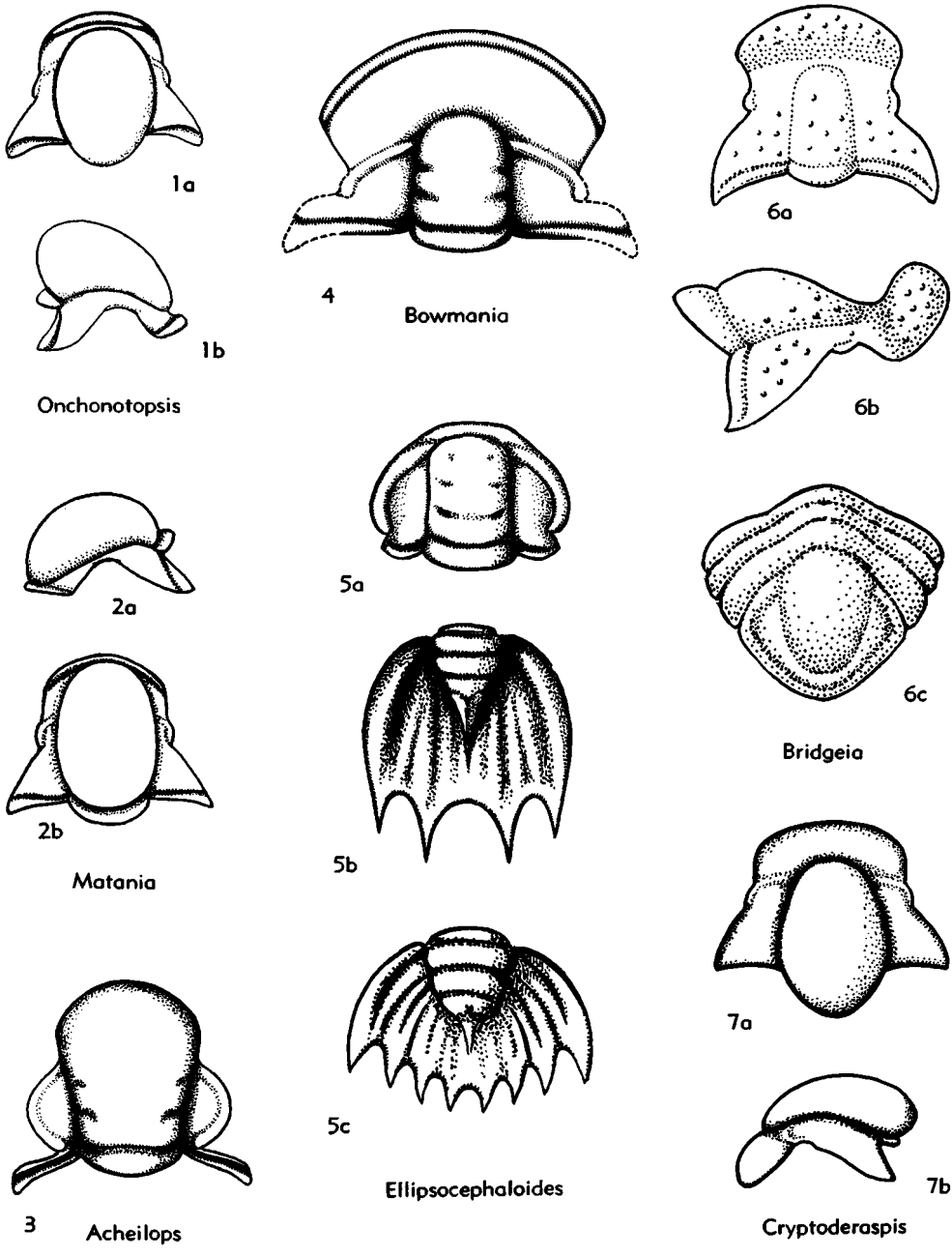


Fig. 410. Incertae sedis. Upper Cambrian genera (p. O517-O519).

[**Kaniniella** Sivov, 1955 [**K. alata*]. *Low.U.Cam.*, Sib. (HE). Invalid homonym; see *Kaniniella* Kobayashi, 1938 (p. O290)].

Kazellina Sivov, 1955 [**K. amsassiensis*]. *U.Cam.*, USSR (HE).

Knechtelia Lochman, 1950 [**K. ann*]. Glabella truncate-tapering, with 3 pairs of faint lateral furrows, preglabellar area narrow, flat; anterior border wide, rimlike, convex; eye ridges faint, eyes small, posterior to front of glabella; fixigenae convex, horizontal, with palpebral areas about 0.75 of glabellar width, posterior areas subrectangular, long *(tr.)*. Librigenae, thorax and pygidium unknown (129). *Up.M.Cam.-U.Cam. (Dresbach.)*, W.N.Am. (LB).

Koldinia Walcott & Resser, 1924 [**K. typa*] [=*Kolodinia* Kobayashi, 1943]. Glabella low, broadly tapering, without lateral furrows; all other furrows narrow, very faint on exterior, faint on interior; anterior border rimlike, eye ridges narrow, diagonal; eyes below medium size, posterior to center of glabella; fixigenae downsloping, with palpebral areas about 0.3 of glabellar width, posterior areas short *(tr.)*, triangular. Pygidium subtriangular; axis low, tapered 0.75 of its length to pointed end, with narrow postaxial ridge extending to margin, axis wider than pleural fields, with 5 axial rings and terminal; interpleural grooves and pleural furrows very faint, border of medium width (102). *U.Cam.(Francon.)*, Arct. Eurasia.——Fig. 411,*2*. *K. microphthalma* Kobayashi, Sib.; *3a,b*, cran.; *c*, pyg., ×2 (207) (LB).

Koldiniella Sivov, 1955 [**K. mitella*]. *U.Cam.*, Salair, USSR (HE).

Kujandina Ivshin, 1956 [**K. taskudukensis*]. *U. Cam.*, E.Sib. (LB).

Mareda Kobayashi, 1942 [**M. mukazegata*]. Glabella low, subquadrate, sides converging slightly, front straight, with 2 pairs of lateral furrows, posterior pair complete, 2nd pair diagonal, well defined; no preglabellar field; anterior border furrow obsolete; anterior border narrow; eyes just above medium size slightly behind mid-length of glabella; eye ridges absent, palpebral rims prominent, palpebral furrows arcuate; fixigenae horizontal, narrow, with arcuate palpebral areas, about 0.3 of glabellar width, posterior areas narrow, apparently short; librigenae unknown. Pygidium elongate, multisegmented; axis narrow, convex, tapering about 0.75 of its length, may have narrow postaxial ridge, 12 axial rings and very small terminal; pleural regions twice width of axis, no border; 10 to 12 pleurae, curved abruptly backward and remaining distinct at margin, interpleural grooves shallow, parallel pleural furrows deeper. Outer surface finely granulose. *U.Cam.*, NE.Asia-C.N.Am.——Fig. 411,*3*. **M. mukazegata*, Fengshanian, China(Chansi Basin); pyg., ×1.5 (419) (LB).

Matania Rasetti, 1946 [**M. ovata*]. Glabella large, prominent, ovate, unfurrowed, reaching anterior border; occipital ring short, simple; fixigenae narrow; palpebral lobes small, at level of glabellar mid-point; anterior facial sutures directed straight forward, posterior sections almost straight, directed outward and backward; posterior areas furrowed. Size small. *U.Cam.(Dresbach.)*, N.Am.——Fig. 410,*2*. **M. ovata*, Que.; *2a,b*, cran., dors., lat. views, ×5 (448n) (RA).

Mataninella Sivov, 1955 [**M. escharoida*]. *U.Cam.*, USSR (HE).

Meisterella Ivshin, 1953 [**M. meisteri*]. *U.Cam.*, Kazakhstan (LB).

Neoacrocephalites Sivov, 1955 [**N. togensis*]. *U. Cam.*, USSR (HE).

Ninaspis Ivshin, 1956 [**N. tschernyshevae*]. *U. Cam.*, E.Sib. (LB).

Oligometopus Resser, 1936 [**Ptychoparia (Solenopleura?) breviceps* Walcott, 1884]. *U.Cam. (Francon.)*, Nev. (LB).

Onchonotopis Rasetti, 1946 [**O. pergibba*]. Similar to *Matania*, with glabella greatly elevated posteriorly, overhanging occipital ring; preglabellar field present. Size small. *U.Cam.(Dresbach.)*, N. Am.——Fig. 410,*1*. **O. pergibba*, Que.; *1a,b*, cran., dors., and lat. views, ×4 (448n) (RA).

Parakoldinioidia Endo, in Endo & Resser, 1937 [**P. typicalis*]. Glabella convex, faintly keeled, rectangular, sides diverging very slightly at rounded front, with 3 pairs of short lateral furrows; eye ridges narrow diagonal; palpebral furrows and palpebral rims narrow, no preglabellar field or anterior border furrow; narrow, convex triangular border; eyes below medium size, somewhat behind center of glabella; fixigenae upsloping, with palpebral areas 0.75 of glabellar width, posterior areas short, triangular; librigenae narrow, rectangular, with short genal spine. ?Pygidium semicircular; axis convex, narrower than pleural fields, tapered 0.66 of its length to narrow rounded end, with 4 axial rings and terminal; pleurae 4, crossed by broad pleural furrows, interpleural grooves obsolete; with shallow border furrow and narrow flat border. Outer surface granulose (37). *U.Cam.(Fengshanian)*, N.E.Asia.——Fig. 411,*1*. **P. typicalis*, Manch.; *1a*, ceph., ×4; *1b*, pyg., ×1 (37) (LB).

Phoreotropis Raymond, 1924 [**P. puteatus*]. Small trilobite. Cranidium of low convexity; glabella parallel-sided, narrow and long, defined laterally, anteriorly merging with convex, undifferentiated anterior area of fixigenae; occipital furrow distinct; palpebral lobes small, lacking palpebral furrows, somewhat anterior to glabellar mid-point; anterior sections of facial sutures directed forward and slightly inward, posterior sections fairly straight to posterior margin. *U.Cam.(Trempeal.)*, N.Am.——Fig. 411,*5*. **P. puteatus*, E.USA(Vt.), cran., ×10 (448n) (RA).

Phylacterus Raymond, 1924 [**P. saylesi*]. *U.Cam. (Trempeal.)*, E.USA(Vt.) (LB).

Pseudosalteria RAYMOND, 1924 [**P. laevis*]. Small trilobite. Cranidium of low convexity, semicircular; glabella subovate, with faint furrows represented by pairs of pits; palpebral lobes, if present, small and anteriorly located; border lacking. *U.Cam. (Trempeal.)*, N.Am.——FIG. 411,*8*. **P. laevis*, E. USA(Vt.); cran., partly restored, ×6 (448n) (RA).

Pseudosaukia RASETTI, 1944 [**Dikelocephalus sesostris* BILLINGS, 1865]. *U.Cam.(Trempeal.)*, Que. (Levis) (LB).

Resseria HOWELL, 1945 [**Pseudosalteria welleri* RAYMOND, 1924]. *U.Cam.*, N.Am.(N.J.) (HE).

Tingocephalus SUN, 1935 [**T. granulosus*]. Glabella moderately convex, subrectangular, front slightly rounded, with 3 pairs of short, deep di-

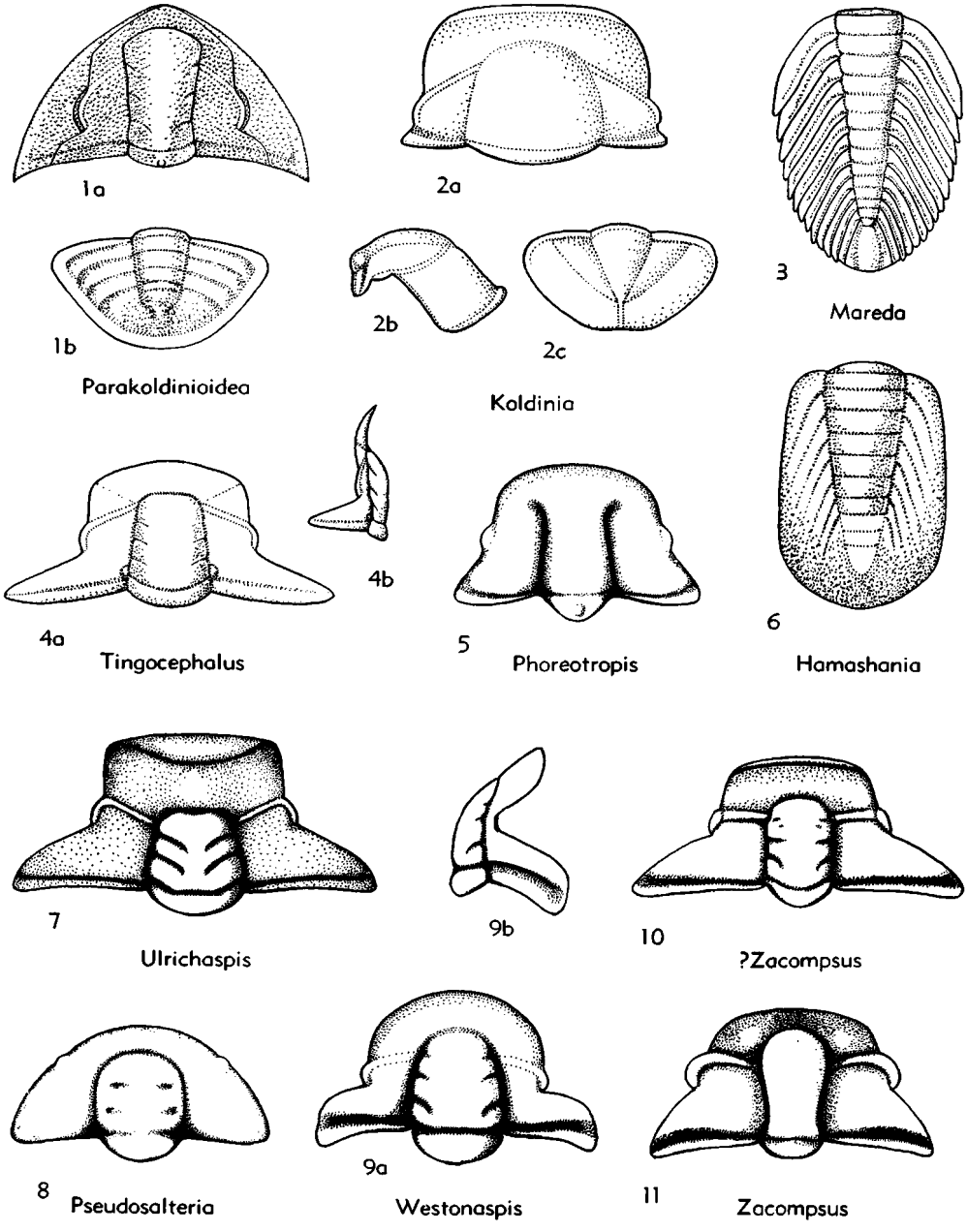


FIG. 411. Incertae sedis. Upper Cambrian genera (p. O517-O521).

agonal lateral furrows; preglabellar field a broad triangle in front of fixigenae only, anterior border furrow curving into corners of glabella, broad concave anterior border; wide diagonal eye ridges; eyes below medium size, opposite center of glabella; fixigenae horizontal, with palpebral areas about same in width as glabella, posterior areas narrow *(exsag.)*, very long *(tr.)*. Librigenae, thorax and pygidium unknown. Outer surface granulose (289). *Low.U.Cam.(Changshanian)*, NE.Asia.——Fig. 411,*4*. **T. granulosus*, China (Shantung); *4a,b*, cran., ×3 (289) (LB).

Triarthrella Hall, 1863 [**T. auroralis*]. *U.Cam. (Trempeal.)*, Wis. (LB).

Ulrichaspis Rasetti, 1945 [**U. paradoxa*]. Glabella subtrapezoidal, well defined, with two pairs of deep furrows; anterior area divided into longitudinally convex preglabellar field and transversely arched border; eye ridges strong, directed forward; palpebral lobes small, at level of anterior end of glabella; anterior sections of facial sutures directed forward, posterior sections almost straight backward and outward; posterior area large, subtriangular, with deep border furrow. *U.Cam. (Trempeal.)*, N.Am.——Fig. 411,*7*. **U. paradoxa*, Que.; cran., partly restored, ×1.2 (448n) (RA).

Volonellus Ivshin, 1953 [**V. granulatus*]. *U.Cam.*, Kazakhstan (LB).

Westonaspis Rasetti, 1945 [**W. laevifrons*]. Small trilobite. Glabella tapered, rounded in front; axial furrow deep laterally, shallow anteriorly; three pairs of lateral furrows; occipital furrow deep, occipital ring rounded; fixigenae downsloping; frontal area undifferentiated, convex, downsloping; palpebral lobes small; anterior sections of facial sutures describing a circular arc; posterior sections directed almost straight outward; posterior area wide *(tr.)*, deeply furrowed. *U.Cam.(Trempeal.)*, N.Am.——Fig. 411,*9*. **W. laevifrons*, Que.; *9a,b*, cran., dors. and lat. views, ×6 (448n) (RA).

Zacompsus Raymond, 1924 [**Z. clarki*]. Small trilobite. Cranidium of low convexity; glabella elevated, pyriform, narrow and long, unfurrowed in type species; occipital ring short *(sag.)*, rounded; fixigenae almost horizontal; anterior border apparently lacking in type species; eye ridges prominent, directed forward; palpebral lobes anterior in position; anterior sections of facial sutures directed forward and inward; posterior sections almost straight outward and backward, delimiting large, subtriangular, deeply furrowed posterior area. *U.Cam.(Trempeal.)*, N.Am.——Fig. 411,*11*. **Z. clarki*, E.USA(Vt.); cran., ×8.——Fig. 411, *10*. *Z.? levisensis* Rasetti, Que., cran., ×8 (448n) (RA).

ORDOVICIAN GENERA

Bodenbenderia Harrington & Leanza, 1957 [**B. longifrons*]. Cranidium small, slightly wider than long. Glabella long, convex, raised above level of fixigenae, parallel-sided, rounded anteriorly, with 2 pairs of lateral furrows oblique backward-inward, anterior *(2p)* furrows very faint, preoccipital stronger. Preglabellar field narrow, depressed; anterior border narrow, convex, raised; anterior margin rounded-subacuminate mesially. Eyes large, close to glabella, posterior. Anterior sections of facial sutures subparallel in front of eyes, intramarginal to mid-line. *L.Ord.*, Arg.——Fig. 412,*9*. **B. longifrons;* cran. (holotype), ×8.8 (59*) (HA).

Brackebuschia Harrington & Leanza, 1957 [**B. acheila*]. Cranidium small, slightly longer than wide. Glabella long, moderately convex, raised above level of fixigenae, defined by deep axial furrows, subparallel-sided, rounded-subtruncate anteriorly, with 4 pairs of faint lateral furrows oblique backward-inward. Occipital ring of moderate width. Frontal area narrow, depressed, without differentiated anterior border; anterior margin curved forward. Eyes large, moderately near glabella, slightly posterior; palpebral lobes elongated. Anterior sections of facial sutures slightly divergent in front of eyes. Associated pygidium small, semielliptical in outline; axis tapering backward, strongly raised above level of pleural regions, with 4 strongly marked rings and small triangular terminal segment; pleural regions with very faint indications of 2 to 3 ribs; border absent. *L.Ord.*, Arg.——Fig. 412,*2*. **B. acheila; a*, cran. (holotype), ×7.8; *b*, pyg. (paratype), ×9.0 (59*) (HA).

Carmon Barrande, 1872 [**Trilobites mutilus* Barrande, 1852]. *U.Ord.*, Boh. (HE).

Ceratopeltis Poulsen, 1937 [**C. latilimbatus*]. *L. Ord.*, E.Greenl. (HE).

Clelandia Cossmann, 1902 [**Harrisia parabola* Cleland, 1900] [=*Harrisia* Cleland, 1900, *non* Robineau-Desvoidy, 1830]. *L.Ord.*, N.Y. (HE).

Crossoura Moberg & Segerberg, 1906 [**C. parvula;* SD Vogdes, 1925]. *L.Ord.(Tremadoc.)*, Swed. (HE).

Curiaspis Sdzuy, 1955 [**C. notabilis*]. Cephalon proparian; glabella with slightly expanded frontal lobe in front of 2 transglabellar furrows *(1p, 2p)* and occipital furrow; eyes medium-sized, eye ridges distinct; fixigenae and occipital ring with well-developed spines. No preglabellar field. *L.Ord. (L.Tremadoc.)*, Ger.——Fig. 413,*5*. **C. notabilis; 5a,b*, cran., ×10 (272) (HE).

Cuyanaspis Rusconi, 1953 [**?Megalaspis emposadensis* Rusconi, 1953]. *L.Ord.*, Arg.(Mendoza) (LB).

Deltacare Harrington & Leanza, 1957 [**D. prosops*]. Cranidium triangular in outline, wider than long. Glabella long, tapering forward, rounded anteriorly, with 3 pairs of faint lateral furrows. Occipital ring moderately wide. Preglabellar field narrow, depressed; anterior border wider than field, convex, raised, subtriangular;

anterior margin acuminate. Fixigenae with wide triangular posterior areas; genal angles rounded. Eyes small, far forward, moderately far from glabella. Facial sutures proparian; anterior sections convergent in front of eyes, intramarginal to midline. *L.Ord.*, Arg.——FIG. 412,*1*. **D. prosops*; cran. (holotype), ×13 (59*) (HA).

Ellsaspis RASETTI, 1945 [**E. elliptica*]. Cranidium wide, subelliptical, of uniform convexity; glabella ovate; axial and lateral furrows barely indicated on interior surface; palpebral lobes poorly differentiated from fixigenae; facial sutures showing little change in direction at palpebral lobes; anterior border narrow *(sag.)*, flat; border furrow on posterior area well impressed. *L.Ord.*, N.Am. ——FIG. 412,*5*. **E. elliptica*, Que.; cran., partly exfoliated to show furrows on interior surface, ×6 (448n) (RA).

Endoaspis LOCHMAN, 1956 [*pro Wutingia* ENDO, 1935 (*non* MELICHAR, 1926)] [**Wutingia rectangulosa* ENDO, 1935]. *L.Ord.*, Manch. (LB).

Etheridgaspis KOBAYASHI, 1940 [**Ptychoparia? carolinensis* ETHERIDGE, ?1919]. *L.Ord.*, Tasm. (HE).

Eulomella KOBAYASHI, 1955 [**E. mckayensis*]. Resembles *Parabolinella*. *L.Ord.*, Can.(B.C.) (HE)

Eulomina RŮŽIČKA, 1931 [**Euloma mitratum* RŮŽIČKA]. Glabella broad, rising above fixigenae, strongly tapered, weakly furrowed; preglabellar field short *(sag.)*; border wide *(sag.)*, elevated; eyes small; anterior facial sutures divergent. *L. Ord.*, Eu.——FIG. 412,*6*. **E. mitratum* (RŮŽIČKA), Boh.; *6a,b*, cran., dors. and lat. views, ×2.5 (262) (RA).

Gignopeltis RAYMOND, 1924 [**Dolichmetopus? rarus* BILLINGS, 1865]. *L.Ord.*, Can. (HE).

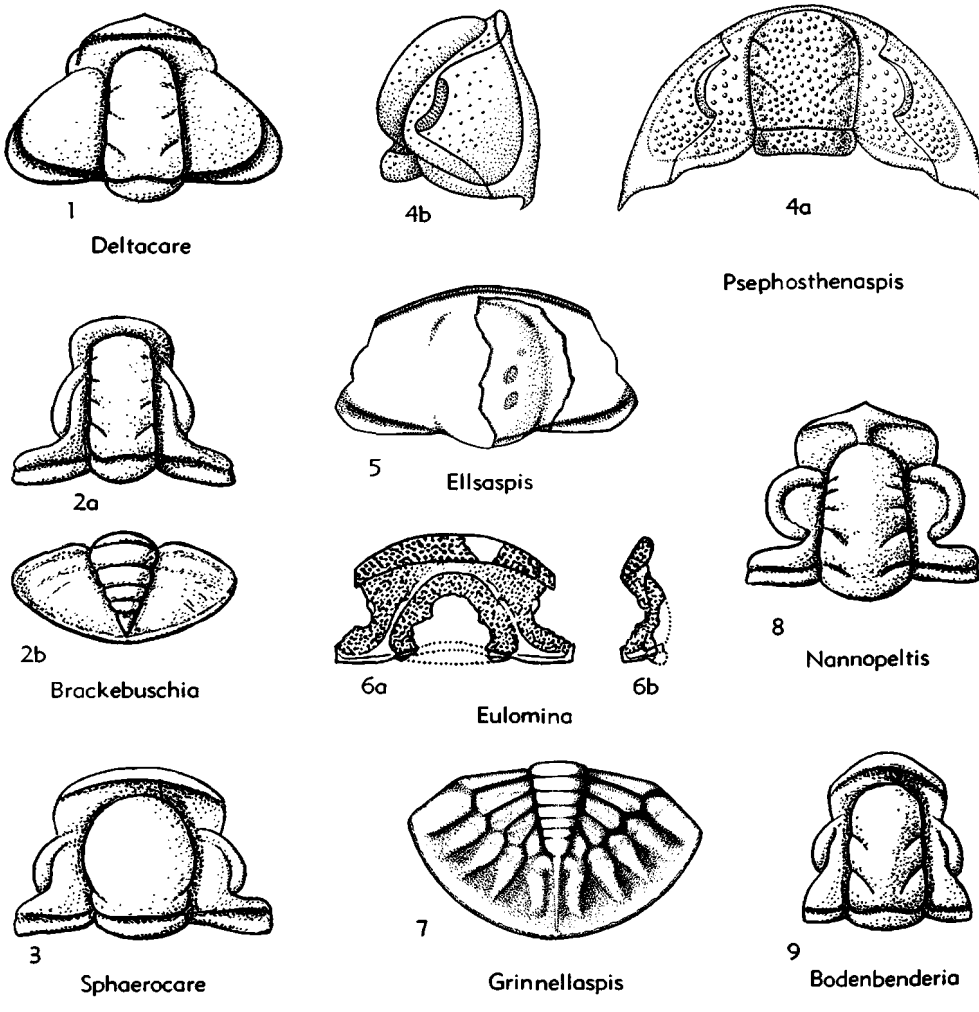


FIG. 412. Incertae sedis. Ordovician genera (p. *O521-O524*).

Grinnellaspis POULSEN, 1948 [*pro Actinopeltis* POULSEN, 1946, *non* HAWLE & CORDA, 1847] [**Actinopeltis feildeni* POULSEN]. Pygidium of low convexity, semicircular; axis short, tapering backward, annulated; pleural fields small, deeply furrowed; border wide, slightly concave, with low ribs opposite the pleural furrows. *L.Ord.*, Arctic.——FIG. 412,*7*. **G. feildeni* (POULSEN), Ellesmere Land; pyg., ×2.5 (175) (RA).

Hyperbolochilus ROSS, 1951 [**H. marginauctum*]. *L.Ord.*, N.Am. (HE).

Idiorhapha WHITTINGTON, 1953 [**Cheirurus solitarius* BILLINGS, 1865]. *L.Ord.* or *Low.M.Ord.*, Can. (HE).

Ischyrotoma RAYMOND, 1925 [**I. twenhofeli*]. *M. Ord.*, N.Am.——FIG. 413,*4*. **I. twenhofeli*, M. Ord., Que.; ceph., ×1.5 (78) (HE).

Koraipsis KOBAYASHI, 1934 [**K. spinus*] [=*Koreaspis* RICHTER, 1942, *nom. van.*]. *L.Ord.(Tremadoc.)*, S.Korea.——FIG. 413,*2*. **K. spinus*; cran., ×3 (96) (HE).

Leptopilus RAYMOND, 1924 [**L. declivis*]. Cephalon 5 mm. in length, convex, no concave border. Glabella about half length *(sag.)* of cephalon, parallel-sided, shallow occipital furrow. Genae confluent with long *(sag.)* preglabellar field, genal spine short. Eye lobes situated close to posterior part of glabella, anterior sections of suture diverge forward, then converge to meet at margin; posterior sections curve out to cross posterior margin at about half width. Placed by RAYMOND (210) in Styginidae, by HUPÉ (78, 79) in Bathyuridae. *L.Ord.(Tremadoc.)*, E.USA(Vt.) (WH).

Macroculites KOBAYASHI, 1955 [**M. enigmaticus*]. *L.Ord.*, W.Can.(B.C.) (HE).

Nannopeltis HARRINGTON & LEANZA, 1957 [**Hysterolenus modestus* HARRINGTON, 1938]. Cranidium very small, wider than long. Glabella large, raised above level of fixigenae, well defined by deep axial furrows, elongated, very slightly tapering forward, rounded anteriorly, with 4 pairs of lateral furrows, *4p* and *3p* furrows oblique forward-inward, *2p* furrows normal to axis, preoccipital furrows longer, oblique backward-inwards. Occipital furrow disconnected at middle; occipital ring narrow, bent backward mesially. Preglabellar field slightly wider than occipital ring, depressed, with raised mesial ridge; anterior border narrow, raised; anterior margin sharply acuminate. Eyes large, located close to glabella, posterior; palpebral lobes semicircular in outline, with narrow raised rim prolonged anteriorly into short eye ridge normal to axis. Anterior sections of facial sutures divergent in front of eyes, curved forward-inward at border furrow, intramarginal to midline, meeting in acute ogive. *L.Ord.*, Arg.——FIG. 412,*8*. **N. modesta*; cran., ×8.8 (59*) (HA).

Neseuretus HICKS, 1872 [**N. ramseyensis*; SD VOGDES, 1925]. *L.Ord.(Tremadoc.)* (HE).

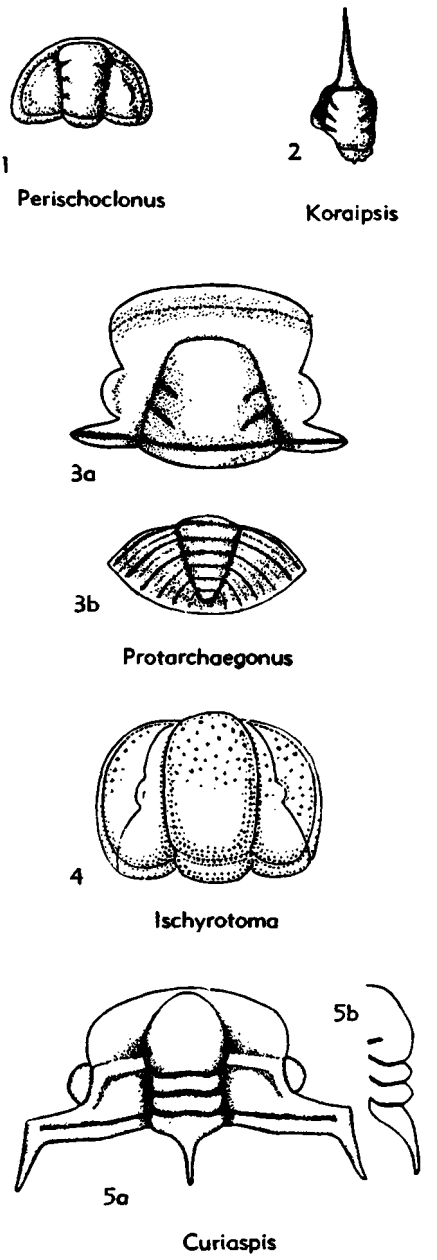


FIG. 413. Incertae sedis. Ordovician genera (p. O521-O524).

Onchonotus RAYMOND, 1924 [**Menocephalus globosus* BILLINGS, 1860]. *L.Ord.*, Can. (HE).

Perischoclonus RAYMOND, 1925 [**P. capitalis*]. Cephalic axis expanding slightly forward. Three pairs of short lateral glabellar furrows. Small eyes

rather distant from glabella and far back. No genal spines. Course of posterior sections of facial sutures uncertain. Only cephalon known. *M.Ord.*, Newf. ——FIG. 413,*1*. **P. capitalis*; ceph., ×2 (449) (HE).

Platycoryphe FOERSTE, 1919 [**Calymene platycephala* FOERSTE, 1910]. *M.Ord.(Trenton)*, N. Am. (HE).

Protarchaegonus SDZUY, 1955 [**P. moroffi*]. *L. Ord.(L.Tremadoc.)*, Ger.——FIG. 413,*3*. **P. moroffi; 3a,b*, cran., pyg., ×10 (HE).

Psephosthenaspis WHITTINGTON, 1953 [**Bathyurus strenuus* BILLINGS, 1865]. Glabella moderately convex, broadly rectangular, rounded in front, with 2 pairs of faint arcuate lateral furrows; preglabellar field very narrow *(sag.)*; anterior border narrow, rimlike, dying out laterally; eyes of medium size, slightly behind mid-length of glabella; fixigenae with palpebral areas about 0.25 of glabellar width, upsloping, posterior areas narrow *(exsag.)*, of medium length *(tr.)*; rostrum short *(sag.)*, broad *(tr.)* and convex; librigenae rectangular, with wide vertical ocular platform and short pointed genal spine. Pygidium unknown. Outer surface coarsely granulose (354). *?Up.L.Ord.(Chazyan)*, E.Can.——FIG. 412,*4*. **P. strenua* (BILLINGS), (erratic), Que.; *4a,b*, cran., ×2 (354) (LB).

Pseudocelandia Ross, 1951 [**P. cornupsittaca*]. *L. Ord.*, N.Am. (HE).

Pyraustocranium Ross, 1951 [**P. orbatum*]. *L.Ord.*, Utah (HE).

Rhamphopyge KOBAYASHI, 1955 [**R. altipolum*]. *L.Ord.(Tremadoc.)*, Can.(B.C.) (LB).

Sphaerocare HARRINGTON & LEANZA, 1957 [**S. globifrons*]. Cranidium small, length about 0.7 of width. Glabella slightly longer than wide, very globose, almost hemispherical, rounded anteriorly, with one pair of short lateral furrows. Occipital ring narrow. Preglabellar field narrow, depressed; anterior border slightly wider than field, convex, raised; anterior margin curved forward. Eyes of medium size, located close to glabella, posterior. Anterior sections of facial sutures divergent in front of eyes, intramarginal for short stretch, marginal to mid-line. *L.Ord.*, Arg.——FIG. 412,*3*. **S. globifrons;* cran. (holotype), ×8.8 (59*) (HA).

Tasmanaspis KOBAYASHI, 1940 [**T. lewisi*]. *L.Ord.*, Tasm. (HE).

Tasmanocephalus KOBAYASHI, 1936 [**Conocephalites? stephensi* R. ETHERIDGE, 1882]. *L.Ord.*, Tasm. (LB).

Thomondia HARPER, 1942 [**T. globosa*]. *U.Ord. (Ashgill)*, Ire. (HE).

Triarthroides RAYMOND, 1938 [**T. cyclas*]. *L.Ord. (Tremadoc.)*, E.USA(Vt.) (LB).

DEVONIAN GENERA

Jonotus MEYER, 1848 [**J. reflexus*]. *Dev.*, Ger. (Eifel) (HE).

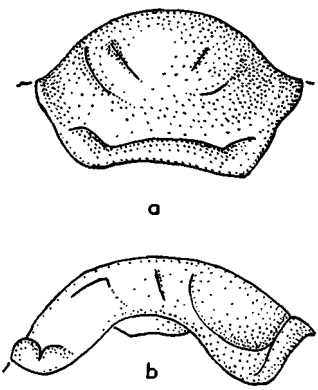


FIG. 414. **Piliolites orioensis* COZZENS (Incertae sedis), M.Dev., Ohio Valley; *a,b*, ceph., ?front, side, ×2.3 (391a, 1848).

Piliolites COZZENS, 1848 [**Piliolites ohioensis*]. Buckler gibbous, ovate, arched, margined, anterior margin smaller and sloping downward; posterior, thicker and turning up; lateral margins very small. [Author's original description of type species.] *M.Dev.*, Ohio Valley. [Description and figures based on 3 specimens, seemingly from "falls of the Ohio river." VOGDES (1893, 1925) lists genus as synonym of *Proetus*, but it resembles no genus of Proetidae.]——FIG. 414. **P. ohioensis*, M.Dev., Ohio Valley; *a,b*, "ceph.," ?front, side, ×2, ×3 (391a) (ST).

Unrecognizable genera

Acheilus CLARK in RAYMOND, 1924 [**A. levisensis*]. *U.Cam.*, N.Am. (RA).

Aligerites HOWELL, 1942 [*pro Aliger* HOWELL, 1937 (*non* THIELE, 1929)] [**Aliger venustus* HOWELL, 1937]. *U.Cam.*, E.USA(Vt.) (LB).

Alloctops RAFINESQUE, 1832 [**A. flexuosa*] (HE).

Annamitella MANSUY, 1920 [**A. asiatica*] (LB).

Anthracopeltis BOULAY, 1880 [**A. crepini*] (HE).

Arthricocephalus BERGERON, 1899 [**A. chauveaui*]. Fr. (RA).

Billingaspis RESSER, 1935 [**Conocephalites vulcanus* BILLINGS, 1863]. *L.Cam.*, E.USA(Vt.) (LB).

Cancapolia RUSCONI, 1954 [**C. proa*]. *Low.U.Cam.*, Arg.(Mendoza) (HE).

Canotiana RUSCONI, 1950 [**C. villavicensis*]. *U. Cam.*, Arg.(Mendoza) (LB).

Cayastaia RUSCONI, 1954 [**C. flexuosa*]. *U.Cam.*, Arg.(Mendoza) (LB).

Changshanocephalus SUN, 1935 [**C. reedi*] (LB).

Chosenia KOBAYASHI, 1934 [**C. laticephala*] (LB).

Chuangites HOWELL, 1945 [**C. jerseyensis*]. *U.Cam. (Trempeal.)*, E.USA(N.J.) (LB).

Cobboldites KOBAYASHI, 1943 [**Microdiscus comleyensis* COBBOLD]. *L.Cam.*, Eng. (RA).

Conagraulos HOWELL, 1937 [**C. rarus*]. *Up.M. Cam.*, E.USA(Vt.) (LB).

Costapyge HOWELL, 1937 [**C. vermontensis*]. *Up. M.Cam.*, E.USA(Vt.) (LB).

Cylindrocephalus TRENKNER, 1868 [*non* MOTSCHOULSKY, 1860] [**C. angustus*] (SC).

Dictyella KOBAYASHI, 1933 [**D. wuhuensis*] (LB).

Dipharus CLARK, 1923 [**D. insperatus*]. *L.Cam.*, N.Am. (RA).

Diplopsites RAFINESQUE, 1832 [**D. levis*] (HE).

Diplozyga RAYMOND, 1938 [**D. striata*]. *L.Ord. (Tremadoc.)*. E.USA(Vt.) (LB).

Exigua HOWELL, 1937 [**E. quadrata*]. *Up.M.Cam.*, E.USA(Vt.) (LB).

Fengtienia ENDO, in ENDO & RESSER, 1937 [**F. peculiaris*] (LB).

Glabrella LERMONTOVA, 1940 [**G. ventrosa*] [non SCUDDER, 1882]. *M.Cam.*, USSR (RA).

Glossicephalus HOWELL, 1937 [**G. longifrons*]. *Up.M.Cam.*, E.USA(Vt.) (LB).

Hagiorites KOBAYASHI, 1951 [**H. omeishanensis*] (LB).

Hamptonella RESSER, 1937 [**Ptychoparia? fitchi* WALCOTT, 1887]. *L.Cam.*, E.USA(N.Y.) (RA).

Hesa RICHTER & RICHTER, 1941 [**H. problematica*]. *L.Cam.*, Dead Sea (HA).

Hoekaspiella RUSCONI, 1950 [**H. spinosa*]. *M.Cam.*, Arg.(Mendoza) (LB).

Hsiaella RESSER & ENDO, in ENDO & RESSER, 1937 [**H. striata*]. *M.Cam.*, Manch. (LB).

Huaquinchaia RUSCONI, 1955 [**H. spinosa*]. *?U. Cam.*, Arg.(Mendoza) (LB).

Huilichia RUSCONI, 1955 [**R. trispinata*]. *M.Cam.*, Arg.(Mendoza) (LB).

Isidreana RUSCONI, 1955 [**I. tellecheai*]. *L.Ord.*, Arg.(Mendoza) (LB).

Isidrella RUSCONI, 1955 [**I. bispinata*]. *M.Cam.*, Arg.(Mendoza) (LB).

Isoctomesa RAFINESQUE, 1822 [**Trilobites emarginata*] (HE).

Leiostegioides KOBAYASHI, 1934 [**L. raymondi*] (LB).

Levinia RUSCONI, 1950 [**L. brachypyge*]. *U.Cam.*, Arg.(Mendoza) (LB).

Liaotungia RESSER & ENDO, in ENDO & RESSER, 1937 [**L. puteata*]. *M.Cam.*, Manch. (LB).

Litocodia RESSER, 1938 [**L. typicalis*]. *L.Cam.*, USA(Ala.) (RA).

Mendodiscus RUSCONI, 1950 [**M. tuberculatus*]. *M. Cam.*, Arg.(Mendoza) (RA).

Mendogaspis RUSCONI, 1951 [**M. trispinatus*]. *?M. Cam.*, Arg.(Mendoza) (LB).

Mendoparabolina RUSCONI, 1951 [**M. pirquinensis*]. *U.Cam.*, Arg.(Mendoza) (LB).

Micragraulos HOWELL, 1937 [**M. franklini*]. *Up. M.Cam.*, E.USA(Vt.) (LB).

Mimana KOBAYASHI, 1935 [=*Mimana* KOBAYASHI, 1934; *nom. nud.*] [**M. eurycephala*] (LB).

Notocoryphe RUSCONI, 1950 [**N. andinus*]. *U.Cam.*, Arg.(Mendoza) (LB).

Orkekeia RUSCONI, 1955 [**O. ornata*]. *?M.Cam.*, Arg.(Mendoza) (LB).

Orimops RAFINESQUE, 1832 [**Calymene calicephala* GREEN, 1832] (HE).

Oryctocephalina LERMONTOVA, 1940 [**O. reticulata*]. *M.Cam.*, USSR (RA).

Perimetopus RESSER, 1937 [**Conocephalites arenosus* BILLINGS, 1861]. *L.Cam.*, E.USA(Vt.) (RA).

Pseudolevinia RUSCONI, 1951 [**P. macropyge*]. *M. Cam.*, Arg.(Mendoza) (LB).

Ptychopleurites KOBAYASHI, 1936 [*pro Ptychopleura* KOBAYASHI, 1936 (*non* FRITZINGER, 1843)] [**Ptychopleura brevifrons* KOBAYASHI, 1936] (LB).

Querandinia RUSCONI, 1954 [**Q. conicephala*]. *Low. U.Cam.*, Arg.(Mendoza) (LB).

Retusites RAFINESQUE, 1832 [**R. levis*] (HE).

Taianocephalus SUN, 1924 [**T. grabaui*] (LB).

Telesiops RAFINESQUE, 1832 [**T. leiocephas*] (HE).

Tomoligus RAFINESQUE, 1832 [**Trilobites mimulus*] (HE).

Vinakainella RUSCONI, 1953 [**V. asperoensis*]. *L. Cam.* or *Low.M.Cam.*, Arg.(Mendoza) (RA).

Wedekindia SUN, 1935 [*non* SCHINDEWOLF, 1935, *non* DUNBAR & HENBEST, 1931] [**W. cylindrica*] (LB).

Yanquetruzia RUSCONI, 1955 [**Y. chupina*]. *M. Cam.*, Arg.(Mendoza) (LB).

Yoyarria RUSCONI, 1955 [**Y. puelchana*]. *L.Ord.*, Arg.(Mendoza) (LB).

Nomina nuda

Carlopsia LAMONT, 1949. [Introduced as *Cyphoproetus (Carlopsia) glaudii*. The subgenus *Carlopsia* as well as the species *glaudii* are nomina nuda.] (RR).

"Mesembria" CLARKE, 1913. Does not exist in nomenclature. Mesembria was introduced by CLARKE, 1913 (pp. 141, 151) as a term for a group of genera. Contrary to the originally "synthetic term" *Synphoria* (see there) it has never attained nomenclatorial status, despite the generally accepted opinion. Though thus being available for nomenclature the name should be strictly avoided in order to prevent taxonomic and nomenclatorial confusion (RR).

Particeps REED, 1943 (WE).

SUPPOSED TRILOBITA HERE REJECTED FROM CLASS

Dalmaniopsis GEINITZ, 1862 [**Dalmanites? Kablikae*]. *Perm. (Rotliegenden)*, Boh. [An arthropod, but no trilobite, according to RICHTER & RICHTER, 1955 (Senckenbergiana lethae, vol. 36, no. 3/4, p. 294).] (HE).

Family BOHEMILLIDAE Barrande, 1872

Cephalon composed of median segmented region and lateral cheeks with prominent spines and large

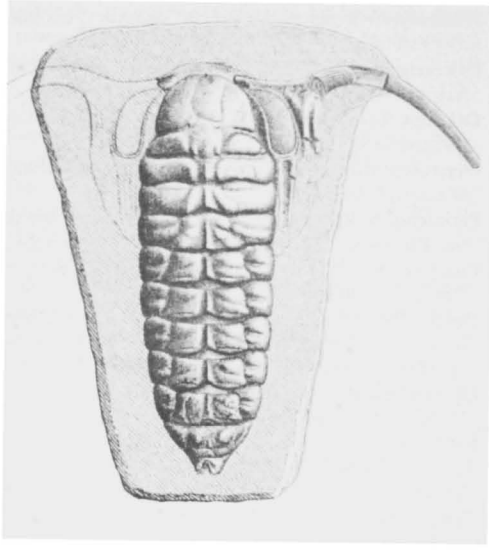


FIG. 415. **Bohemilla stupenda* BARRANDE (Bohemillidae), Ord. (D gamma 2), St.Benigna, Boh.; exoskel. (restored), ×3 (4).

eyes with facets. Facial sutures (if present) undetected. Median segmented region composed of subsemicircular frontal lobe and 4 segments, separated by furrows and progressively more like the free posterior segments; thus the posterior 3 have a median keel and the hindermost head-segment is divided longitudinally into 3 portions. Six free segments occur posterior to cephalon; if the last is interpreted as pygidium, thorax comprises 5 segments, longitudinally divided into 3 parts; the middle about 0.5 of total width and carrying median keel, separated from lateral parts by oblique and posteriorly directed furrows. The sixth segments is incompletely preserved (in only specimen showing posterior part of exoskeleton), and possesses similar structure; it may represent last thoracic segment, in which case a minute bifid structure at posterior tip may represent fragment of pygidium. [Interpreted by WHITTARD, 1952, as an anthropod other than trilobite.] *Ord.*

Bohemilla BARRANDE, 1872 [**B. stupenda*]. Characters of family. *Ord.*, Eu.——FIG. 415. **B. stupenda*, D gamma 2, Boh. (St. Benigna); exoskel., ×2 (4) (HE).

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