

- exsagittal marginal spines. [Probably the juvenile form of a Redlichiida; too imperfectly known.] *Lower Cambrian*: USA (Massachusetts), Mongolia.
- Discagnostus** ÖPIK, 1963, p. 55 [**D. spectator*; OD; holotype (ÖPIK, 1963, pl. 2, fig. 14–15), CPC 4262, AGSO, Canberra]. Glabella short, with continuous glabellar furrow dividing short anterior glabellar lobe, with rear of glabella roundly expanded posterodorsally; border with closely spaced, radial scrobicules; two pairs of prominent genal tubercles situated anteriorly and posteriorly. [SHERGOLD and others (1990) assigned this genus to the Eodiscoidea. If this genus is a derivative of the *Pagetia-Opsidiscus* lineage, one of the pairs of genal tubercles would be a new feature; if it is an Agnostina, both pairs of tubercles are new features. Its assignment, which is doubtful, must await further knowledge, particularly of the cephalothoracic area and pygidium.] *Upper Cambrian*: Australia (Queensland), *Glyptagnostus stolidotus* Zone.
- Glabella** LERMONTOVA, 1940, p. 120 [**G. ventrosa*; OD; syntypes (LERMONTOVA, 1940, pl. 35, fig. 9, 9a–d), 64, 74, 77, TsGM, St. Petersburg]. Probably belongs to Kingstoniidae or Corynexochida. *Middle Cambrian (Amgaian)*: Russia (Tian-Shan, southern Fergama).
- Mendodiscus** RUSCONI, 1950a, p. 74 [**M. tuberculatus*; OD; holotype (RUSCONI, 1956, fig. 4), 2644, MHN, Mendoza]. The holotype and only figured specimen is a trilobite pygidium, probably belonging to the Corynexochidae; it is not an eodiscoid, much less a cranidium. *lower Middle Cambrian*: Argentina.
- Miraculaspis** ROMANENKO in ROMANENKO & ROMANENKO, 1967, p. 72 [**M. picta*; OD; holotype (REPINA & ROMANENKO, 1978, pl. 7, fig. 14–15), 1329/18, ZSGU, Novokuznetsk]. Cephalon unknown. Pygidium subquadrate; axis wide, parallel sided to slightly narrowed at rear of first ring, bluntly rounded posteriorly at border furrow, with 3 pairs of pits laterally but isolated from axial furrow; pleural areas narrow, shorter than axis, with widely spaced tubercles; border furrow and border forming wide flange tapering forward and crossed by numerous dividing radial ridges. [Style of furrows laterally on axis and caecal network suggest a cephalon, but structure of the transverse margin, particularly the oblique lateral sections, suggest a pygidium. Similar furrows on the pygidial axis are known on pygidia of the Condylropygidae (Agnostina). Moreover, an expanded border region is common in the Condylropygidae. Assignment of this genus must await a cephalon.] *Lower Cambrian (Botomian)*: Russia (Gorno-Altayskaya).
- Shivelicus** POKROVSKAYA, 1959, p. 180 [**S. parvus*; OD; holotype (POKROVSKAYA, 1959, pl. 10, fig. 15), 3536/99, VNIGNI, Moscow]. Probably belongs to Corynexochida. *Lower Cambrian (Botomian)*: Russia (Tuva, Transbaikal, Gorno-Altayskaya, western Sayan, Kuznetsk Altay).
- Triangulaspis** LERMONTOVA, 1940, p. 120 [**Ptychoparia meglitzkii* TOLL, 1899, p. 22; OD; holotype (LERMONTOVA, 1940, pl. 35, fig. 5), 21/5156, TsGM, St. Petersburg] [= *Angusteva* HUPE, 1953a, p. 114 (type, *Ptychoparia? annio* COBBOLD, 1910, p. 24; OD; syntypes Cobbold Nos. 401–403); *Acutaspis* REPINA in REPINA, BELYAEVA, & SOBOLEV, 1976, p. 151 (type, *A. facilis*; OD; IGGN 509/51)]. Pygidium not known with certainty as markedly different forms have been assigned to different species apart from the type. [Probably belongs to Ellipsocephaloidea, especially after SDZUY (1962b) showed the Spanish species *T. fusca* (pl. 22, fig. 13) with at least five thoracic segments.] *Lower Cambrian (Atdabanian, Botomian)*: Russia (Siberian Platform), England, Spain, Morocco, Canada (Newfoundland).
- Triangullina** REPINA in KHOMENTOVSKII & REPINA, 1965, p. 107 [**T. parvula*; OD; holotype (KHOMENTOVSKII & REPINA, 1965, pl. 1, fig. 11), 265/1608, CSGM, Novosibirsk] [= *Plenudiscus* KOROBOV, 1980, p. 74 (type, *P. crassus*; OD; PIN 71, coll. 4251)]. Probably belongs to Ellipsocephaloidea; closely related to *Triangulaspis*. *Lower Cambrian (Atdabanian)*: Russia (Siberian Platform), Mongolia.

Order REDLICHIIA

Richter, 1932

[*nom. transl.* FORTEY & WHITTINGTON, herein, ex suborder Redlichiida RICHTER, 1932, p. 852]

Ocular lobe attached to glabella in front of S3, prominent throughout development; eye ridge may be subdivided. Many-segmented thorax, with pleural spines; may be subdivided into prothorax and opisthothorax. *Lower Cambrian–Middle Cambrian*.

The systematic arrangement of this section follows recent practice, but these views were questioned by GEYER (1996), who gave arguments for placing the Fallotaspidioidea in Suborder Redlichiina.

Suborder OLENELLINA

Walcott, 1890b

[*nom. correct. et transl.* PALMER & REPINA, 1993, p. 20, *pro* Olenellidae WALCOTT, 1890b, p. 635] [= Mesonacidae WALCOTT, 1890b, p. 635; WALCOTT, 1910, p. 236; Mesonacida SWINNERTON, 1915, p. 538; C. POULSEN, 1927, p. 315; Olenellidea RICHTER & RICHTER, 1941a, p. 33; Protoparia STORMER, 1942, p. 59, *non* SWINNERTON, 1915; Olenellacea HENNINGSMOEN, 1951, p. 184; BERGSTRÖM, 1973a, p. 39; BERGSTRÖM, 1973b, p. 284; Olenelloidea HUPE, 1953a, p. 116; Olenellida BERGSTRÖM, 1973a, p. 39; BERGSTRÖM, 1973b, p. 284; AHLBERG, BERGSTRÖM, & JOHANSSON, 1986, p. 40; Olenelloidea REPINA, 1979, p. 27; Olenellina PALMER & REPINA, 1993, p. 20]

No facial suture; wide (tr.) rostral plate extending between genal angles, perrostral suture. Hypostome probably conterminant in holaspides in which preglabellar area was

short (sag.) or absent (Fig. 30.1). Thorax nonfulcrate. Pygidium narrow (tr.), with few segments. Calcified protaspis unknown; earliest meraspis with segmented interocular area. *Lower Cambrian*.

INTRODUCTION TO SUBORDER OLENELLINA

A. R. PALMER and L. N. REPINA

Olenellina are a morphologically varied and highly diverse group of generally micropygous trilobites that share a primary absence of facial sutures, the presence of a well-developed ocular lobe at all developmental stages, and an ontogeny in which the first mineralized stages are already early meraspids (PALMER, 1957). They are restricted to and characteristic of rocks of later Early Cambrian age and constitute a major suborder within the order Redlichiida (MOORE, 1959). More than 50 genera or subgenera and their associated higher taxa are recognizable (PALMER & REPINA, 1993). These taxa form the principal basis for biostratigraphic subdivisions (Fig. 254) of the later Lower Cambrian rocks of Laurentia (North America exclusive of the eastern seaboard from Newfoundland to Florida and including Spitsbergen and northwestern Scotland) and are major indices for the later Lower Cambrian biostratigraphy of Baltica (northern Europe exclusive of the British Isles), Avalonia (England, Wales, eastern Newfoundland, Nova Scotia, eastern New England, USA), Siberia, and the Moroccan sector of Gondwana (including Spain).

Ancestry of the Olenellina can only be speculative. They first appear as fully developed and morphologically diverse trilobites in the early, but not earliest, part of the shelly fossil record and are the oldest trilobites known. The principal phylogenetic trend within the Olenellina involves the relationship between the ocular lobe and the frontal (anterior) lobe (LA) of the glabella (REPINA, 1990a). In all of the earliest Olenellina, which include forms from Siberia, Laurentia, and the Moroccan sector of Gondwana, the

glabella has parallel sides or tapers forward, LA is short, and the ocular lobe is attached along the entire margin of LA (Fallotaspidae, Daguinaspidae). In later genera, LA first becomes elongate, so that the ocular lobes connect only to its posterior part (Judomiidae, Nevadiidae), and then generally expands laterally, and the glabella as a whole expands anteriorly from the level of S1 (Olenellidae, Holmiidae). LA in these genera is also commonly inflated. Accompanying this modification, the distal parts of L3 extend laterally and posterolaterally and encroach on L2, often isolating the S2 furrows (Fig. 255), and L3 takes on a broad M-shape.

This phylogenetic trend underlies the proposed classification of the superfamilies. Within the Fallotaspidoidea, all Fallotaspidae, the earliest family of the Olenellina, have the ocular lobe attached along the entire margin of LA and an unmodified L3, and the anterior end of LA does not project forward of a line tangent to the anterolateral margin of the ocular lobe. In the remaining, generally younger families of the Fallotaspidoidea (Archaeaspidae, Judomiidae, Neltneriidae, Nevadiidae), the anterior end of LA projects forward of the junction with the anterior margin of the ocular lobe, but L3 remains unmodified. All Olenelloidea, which includes the youngest Olenellina, have the ocular lobe attached to the posterior part of LA and have a modified L3.

Within the superfamilies of the Olenellina, morphological changes of taxonomic value at the family level follow different patterns. The principal character distinguishing the two families in the Olenelloidea is the relationship between the extraocular area and the interocular area. The Holmiidae all have a narrow extraocular area that is less than twice the width of the interocular area. With minor exceptions (*Olenelloides* and some undescribed Laurentian forms), the Olenellidae have a wide extraocular area that is more than twice the width of the interocular area. In the Fallotaspidoidea, the relationship between the ocular lobe and LA, the shape of the glabella (parallel sided versus tapered),

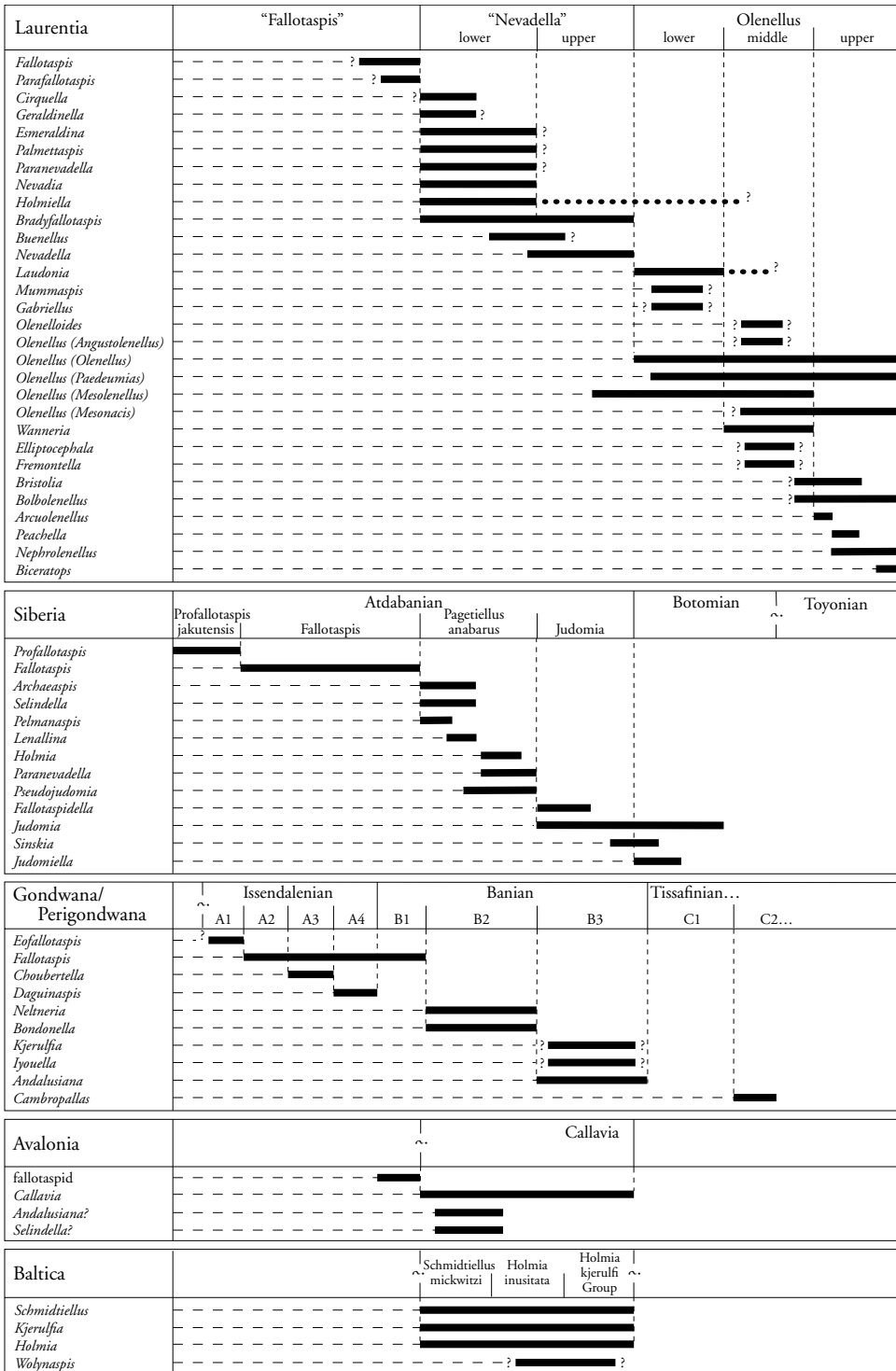


FIG. 254. Ranges of Olenellina within the principal paleogeographic regions of the Early Cambrian world (adapted from Palmer & Repina, 1993).

and the outline of the cephalon distinguish families.

Subfamilies of the Olenellidae are discriminated by the shape of the glabella and form of the thorax. Subfamilies of the Holmiidae are discriminated by general form of the thorax, by presence or absence of a preglabellar field, and by relative positions of the genal and intergenal spines. Subfamilies of the Fallotaspidae are discriminated by presence or absence of genal spines.

At the generic and subgeneric level, all taxonomically useful characters represent parts of continuous trends, including exsagittal shortening of the ocular lobes, changes in width of the interocular area, modification in sagittal length of the preglabellar field, position of the genal spines relative to the posterior cephalic margin, elaboration of the third thoracic segment, loss of genal spines, and position and degree of development of the intergenal spines. These characters are thus difficult to characterize precisely. Nevertheless, within-population variability in these characters is low (RICCIO, 1952; COWIE & MCNAMARA, 1978; MCNAMARA, 1978), and their various combinations generally distinguish groups of species.

One of the many mysteries regarding the Olenellina is their complete absence from Lower Cambrian rocks of the Asiatic sector of Gondwana/peri-Gondwana (Australia, Antarctica, India, and southeastern Asia), where the characteristic Early Cambrian trilobites are Redlichiina. This has been traditionally expressed in an Early Cambrian biogeography that has recognized an olenellid realm or province and a redlichiid realm or province (e.g., RICHTER & RICHTER, 1941b; COWIE, 1971; W. ZHANG, 1989). Olenellina and Redlichiina coexisted in the Moroccan sector of Gondwana, in the epicontinental seas of southern Siberia, and in areas now included in some central Asian orogens. In these areas of coexistence, the earliest Olenellina may be direct ancestors of the earliest Redlichiina (REPINA, 1990a). Perhaps their subsequent geographic segregation resulted from some kind of environmental or

competitive control of dispersal to the more peripheral parts of the Cambrian world.

Superfamily OLENELLOIDEA Walcott, 1890

[Olenellidae WALCOTT, 1890b, p. 635] [=Olenellidea RICHTER & RICHTER, 1941a, p. 33, *partim*; Olenellacea HENNINGSMOEN, 1951, p. 184, *partim*; BERGSTRÖM, 1973b, p. 284, *partim*; Olenelloidea HUPE, 1953a, p. 116, *partim*; Olenelloidea SUVOROVA in TCHERNYSHEVA, 1960, p. 62, *partim*; REPINA, 1979, p. 27, *partim*; WHITTINGTON, 1989, p. 113, *partim*; PALMER & REPINA, 1993, p. 21]

LA usually enlarged; glabella narrowest at L2 or S1. L3 usually modified distally with posterolateral part bending backward and encroaching on L2. Ocular lobe connected only to posterolateral part of LA. *Lower Cambrian*.

Family OLENELLIDAE Walcott, 1890

[Olenellidae WALCOTT, 1890b, p. 635, *sensu* REPINA, 1979, p. 20] [=Mesonacidae WALCOTT, 1890b, p. 635; WALCOTT, 1910, p. 236, *partim*; Olenellidae HUPE, 1953a, p. 124, *partim*; POULSEN in MOORE, 1959, p. 191, *partim*; SUVOROVA in TCHERNYSHEVA, 1960, p. 62, *partim*; BERGSTRÖM, 1973b, p. 312, *partim*; AHLBERG, BERGSTRÖM, & JOHANSSON, 1986, p. 40; PALMER & REPINA, 1993, p. 21]

Width (tr.) of interocular area generally half or less that of extraocular area. Third thoracic segment slightly to strongly macropleural. *Lower Cambrian*.

Subfamily OLENELLINAE Walcott, 1890

[Olenellinae WALCOTT, 1890b, p. 635] [=Olenellinae POULSEN in MOORE, 1959, p. 192, *partim*; SUVOROVA in TCHERNYSHEVA, 1960, p. 62, *partim*; REPINA, 1979, p. 22, *partim*; Fremontiinae REPINA, 1979, p. 22, *partim*; PALMER & REPINA, 1993, p. 21]

Glabellar furrows weakly to moderately defined. Width (tr.) of anterior part of L1 equal to or only slightly less than width (tr.) of occipital ring. LA slightly to moderately expanded anteriorly. Posterior tip of ocular lobe ranging from opposite L2 to opposite posterior part of occipital ring. Posterior margin of cephalon nearly straight or slightly deflected forward distal to intergenal spine or swelling. Intergenal spine or distinct intergenal angle usually present. Prothorax, where known, with axis narrower than inner part of pleurae. Third thoracic segment weakly to moderately macropleural, with pleural spine not greatly elongated. Fifteenth thoracic segment with long axial spine. Opisthothorax with variable number of uniformly small segments, each bearing narrow

pleurae. Pygidium small, subquadrate, may have 1 or 2 pairs of short marginal spines. *Lower Cambrian*.

Olenellus HALL, 1861, p. 114 (for explanation of date of this name, see WHITTINGTON, 1989, p. 114) [**Olenus thompsoni* HALL, 1859, p. 59; SD WALCOTT, 1886, p. 163; holotype (HALL, 1859, p. 59, fig. 1), 244, AMNH, New York (lost)]. External surface generally smooth or with faint Bertillon pattern of lirae, rarely granular or reticulate. Occipital ring smooth or with small node near posterior margin; occipital spine rare; genal spine angle opposite or posterior to L1; genal spine slender. *Lower Cambrian*: North America (including Greenland), northwestern Scotland, Spitsbergen, Argentina (San Juan area), *Olenellus* Zone; ?Novaya Zemlya, zone uncertain.

O. (Olenellus). Genal spines at posterolateral cephalic corners or slightly advanced to position opposite L1; intergenal spines, if present, small, close to genal spines, and directed slightly posterolaterally. Preglabellar field absent or very short, length (sag.) usually less than twice length (sag.) of anterior border; ocular lobe curved, its posterior tip convergent toward glabella and situated opposite or posterior to posterior part of L1; S2 isolated from axial furrow, usually present as distinct transverse slit. *Lower Cambrian*: North America (including Greenland), *Olenellus* Zone; Spitsbergen, ?*Olenellus* Zone; ?Novaya Zemlya, zone uncertain.—FIG. 255,1. **O. (O.) thompsoni*, Vermont; topotype, complete individual, USNM 15418a, $\times 2$ (Palmer & Repina, 1993, fig. 3.1).

O. (Angustolenellus) PALMER & REPINA, 1993, p. 22 [**Olenellus hamoculus* COWIE & MCNAMARA, 1978, p. 627; OD; holotype (COWIE & MCNAMARA, 1978, pl. 70, fig. 3), 13302, GSE, Edinburgh]. Posterior margin of cephalon directed slightly anterolaterally distal to intergenal spine; intergenal spine about midway between genal spine and axial furrow or closer to axial furrow. Length (sag.) of preglabellar field equal to or slightly greater than that of anterior border; posterior tip of ocular lobe directed nearly straight backward, situated opposite or anterior to midlength of L1. *Lower Cambrian*: northwestern Scotland, middle *Olenellus* Zone.—FIG. 255,5. **O. (A.) hamoculus*; cephalon, holotype, $\times 3$ (Cowie & McNamara, 1978, pl. 70, fig. 3).

O. (Mesolenellus) PALMER & REPINA, 1993, p. 22 [**Holmia hyperborea* V. POULSEN, 1974, p. 84; OD; holotype (V. POULSEN, 1974, pl. 1, fig. 4), 13008, MMK, Copenhagen]. Posterior margin of cephalon directed slightly forward distal to intergenal spine or intergenal angle. Length (sag.) of preglabellar field equal to or slightly greater than length (sag.) of anterior border; intergenal spine or angle about midway between genal spine and axial furrow or closer to axial furrow; posterior tip of ocular lobe convergent

toward glabella, situated opposite or posterior to occipital furrow. *Lower Cambrian*: USA (Nevada), Canada (southern Rocky Mountains, Devon Island), northern Greenland, Argentina (San Juan region), lower? and middle *Olenellus* Zone.—FIG. 255,4. **O. (M.) hyperborea* (POULSEN), northern Greenland; topotype, complete individual, MGUH 13.945 from GGU 184219, $\times 4$ (Palmer & Repina, 1993, fig. 3.7).

O. (Mesonacis) WALCOTT, 1885, p. 328 [**Olenus vermontanus* HALL, 1859, p. 60; OD; holotype (HALL, 1859, p. 60, fig. 2), 230, AMNH, New York (lost)] [= *Fremontia* RAW, 1936, p. 243 (type, *Olenellus fremonti* WALCOTT, 1910, p. 320; SD HARRINGTON, 1956, p. 57), USNM 56819a]. Posterior margin of cephalon angled forward distal to intergenal angle. Preglabellar field absent or very short, with length (sag.) generally equal to or less than that of anterior border; posterior tip of ocular lobe directed nearly straight posteriorly; situated opposite of or anterior to medial part of L1; interocular area may be extended posteriorly as low, broad ridge. Most species with width (tr.) of inner part of macropleural third segment, exclusive of spine, less than 1.5 times width of axis. Pygidium, known only for type species, with 2 pairs of short marginal spines. *Lower Cambrian*: North America (all parts), northwestern Scotland, middle and upper *Olenellus* Zone.—FIG. 255,2. **O. (M.) vermontanus* (HALL), Vermont; complete individual, topotype, USNM 15399a, $\times 1.3$ (Palmer & Repina, 1993, fig. 3.2).

O. (Paedeumias) WALCOTT, 1910, p. 304 [**Paedeumias transitans*; OD; lectotype (WALCOTT, 1910, pl. 34, fig. 1; SD RESSER, 1928, p. 4), 56808b, USNM, Washington, D.C.]. Posterior margin of cephalon nearly straight or only slightly angled forward distal to position of intergenal spines; intergenal spine or swelling generally closer to genal spine than to axial furrow. Length (sag.) of preglabellar field greater than twice length (sag.) of anterior border; posterior tip of palpebral lobe convergent toward glabella, opposite or posterior to posterior part of L1. *Lower Cambrian*: North America (all parts), northwestern Scotland, *Olenellus* Zone.—FIG. 255,3. **O. (P.) transitans* (WALCOTT), Vermont; complete individual, lectotype, USNM 56808b, $\times 3$ (Palmer & Repina, 1993, fig. 3.3).

Fremontella HARRINGTON, 1956, p. 58 [**Wanneria halli* WALCOTT, 1910, p. 301; OD; lectotype (WALCOTT, 1910, pl. 31, fig. 3; SD HARRINGTON, 1956, p. 58), 56806c, USNM, Washington, D.C.]. External surface smooth. Genal spine strongly advanced; genal spine angle anterior to S2; intergenal angle nearly a right angle. Preglabellar field absent; posterior tip of ocular lobe opposite anterior part of L1. *Lower Cambrian*: USA (Alabama), Argentina (San Juan area), *Olenellus* Zone.—FIG. 256,2. **F. halli* (WALCOTT), Alabama; cephalon, lectotype, $\times 1.25$ (Palmer & Repina, 1993, fig. 3.4).

Mummaspis FRITZ, 1992, p. 17 [**Wanneria occidens* WALCOTT, 1913b, p. 314; OD; holotype (WALCOTT, 1913b, pl. 53, fig. 2), 60080, USNM, Washington, D.C.]. Parts of external surface reticulate. Posterior margin of cephalon nearly straight; intergenal swelling slightly distal to midlength of posterior margin. Preglabellar field absent or length (sag.) less than that of border; S3 deep, continuous across glabella; occipital spine may be present. Ocular furrow deep; outer band of ocular lobe narrower than inner band. Third thoracic segment generally only weakly macropleural. *Lower Cambrian*: Canada (southern Rocky Mountains), lower *Olenellus* Zone.—FIG. 256, 1a, b. **M. occidens* (WALCOTT); a, complete individual, topotype, USNM 443745, $\times 4$ (Fritz, 1992, pl. 9, fig. 2); b, cephalon and partial thorax, topotype, USNM 443750, $\times 1.7$ (Fritz, 1992, pl. 10, fig. 2).

Subfamily BICERATOPSINAE

Pack & Gayle, 1971

[Biceratopsinae PACK & GAYLE, 1971, p. 895] [=Olenellidae BERGSTRÖM, 1973b, p. 312, *partim*; AHLBERG, BERGSTRÖM, & JOHANSSON, 1986, p. 40, *partim*; Biceratopsinae REPINA, 1979, p. 22; PALMER & REPINA, 1993, p. 23]

Glabella narrowest at midlength; glabellar furrows very poorly developed; width (tr.) of L1 less than width (tr.) of occipital ring; ocular lobe close to glabella, its posterior tip opposite or anterior to L1. Genal spine absent or opposite midlength of ocular lobe; intergenal spine absent; intergenal angle may be developed. Thorax divided into prothorax and opisthothorax; third segment strongly expanded distally; pleural spine extremely long, with tips posterior to body; fifteenth segment with long axial spine. *Lower Cambrian*.

Biceratops PACK & GAYLE, 1971, p. 895 [**B. nevadensis*; OD; holotype (PACK & GAYLE, 1971, pl. 102, fig. 2–3), 168225, USNM, Washington, D.C.]. Posterior margin of cephalon nearly straight; genal angle broadly rounded; genal and intergenal spines absent. Length (sag.) of prelabellar field equal to or less than that of anterior border; ocular lobe prominent, close to glabella, with posterior tip opposite S1 and elevated above top of glabella. Opisthothorax of at least 11 segments. *Lower Cambrian*: USA (Arizona, Nevada), upper *Olenellus* Zone.—FIG. 257, 1. **B. nevadensis*, Nevada; complete individual, holotype, USNM 168225, $\times 3$ (Pack & Gayle, 1971, pl. 102, fig. 2).

Peachella WALCOTT, 1910, p. 342 [**Olenellus iddingsi* WALCOTT, 1884b, p. 28; OD; holotype (WALCOTT, 1884b, pl. 9, fig. 12), 15407a, USNM, Washington, D.C.]. Posterior margin of cephalon nearly straight. Glabella extended to or nearly to border furrow; posterior tip of ocular lobe approximately

opposite S1; genal spine at posterolateral corner or slightly advanced, strongly inflated. Opisthothorax of at least 10 segments. *Lower Cambrian*: USA (California, Nevada), upper *Olenellus* Zone.—FIG. 257, 2. **P. iddingsi* (WALCOTT), California; nearly complete individual, LACMIP 11621, $\times 2$ (Palmer & Repina, 1993, fig. 4.2).

Subfamily BRISTOLIINAE

Palmer & Repina, 1993

[Bristoliinae PALMER & REPINA, 1993, p. 23] [=Olenellinae POULSEN in MOORE, 1959, p. 162, *partim*; Olenellidae BERGSTRÖM, 1973b, p. 312, *partim*; AHLBERG, BERGSTRÖM, & JOHANSSON, 1986, p. 40, *partim*; Fremontiinae REPINA, 1979, p. 22, *partim*]

Glabella usually strongly constricted at S1 or L2; width (tr.) of anterior part of L1 usually distinctly narrower than occipital ring; glabellar furrows generally well developed. Preglabellar field shorter (sag.) than anterior border or absent. Posterior tip of ocular lobe opposite or anterior to L1. Third thoracic segment with inner part of pleural region strongly expanded distally; pleural spine may be extended posterior to end of thorax. Opisthothorax well developed. Pygidium not known. *Lower Cambrian*.

Bristolia HARRINGTON, 1956, p. 59 [**Mesonacis bristolensis* RESSER, 1928, p. 7; OD; lectotype (RESSER, 1928, pl. 2, fig. 5–6; SD HARRINGTON, 1956, p. 59), 78390, USNM, Washington, D.C.]. Cephalon subpentagonal to subquadrate in outline; genal spine originating opposite or anterior to L2; intergenal spine absent. Preglabellar field absent; posterior tip of ocular lobe opposite or anterior to L1. Fifteenth thoracic segment with long axial spine; opisthothorax of at least 17 segments. *Lower Cambrian*: USA (California, Nevada), Greenland (Inglefield Land), *Olenellus* Zone.—FIG. 258, 1. **B. bristolensis*, California; nearly complete individual, UCR 10/7, $\times 1$ (Palmer & Repina, 1993, fig. 4.5).

Arcuolenellus PALMER & REPINA, 1993, p. 24 [**Olenellus arcuatus* PALMER in PALMER & HALLEY, 1979, p. 67; OD; holotype (PALMER & HALLEY, 1979, pl. 2, fig. 12), 177200, USNM, Washington, D.C.]. Posterior margin of cephalon strongly and evenly curved back distally; genal spine short, situated at posterolateral corner well behind level of occipital ring; intergenal spine absent. Preglabellar field short (sag.); width of interocular area about half width of glabella at L2; posterior tip of ocular lobe opposite L1. *Lower Cambrian*: USA (California), upper *Olenellus* Zone; Argentina (San Juan area), *Olenellus* Zone.—FIG. 258, 2. **A. arcuatus* (PALMER), California; cephalon, holotype, USNM 177200, $\times 6$ (Palmer & Halley, 1979, pl. 2, fig. 12).

Bolbolenellus PALMER & REPINA, 1993, p. 24 [**Olenellus euryparia* PALMER in PALMER & HALLEY,



1

Olenellus



2

Mesonacis



3

Paedeumias



4

Mesolenellus



5

Angustolenellus

FIG. 255. Olenellidae (p. 408)

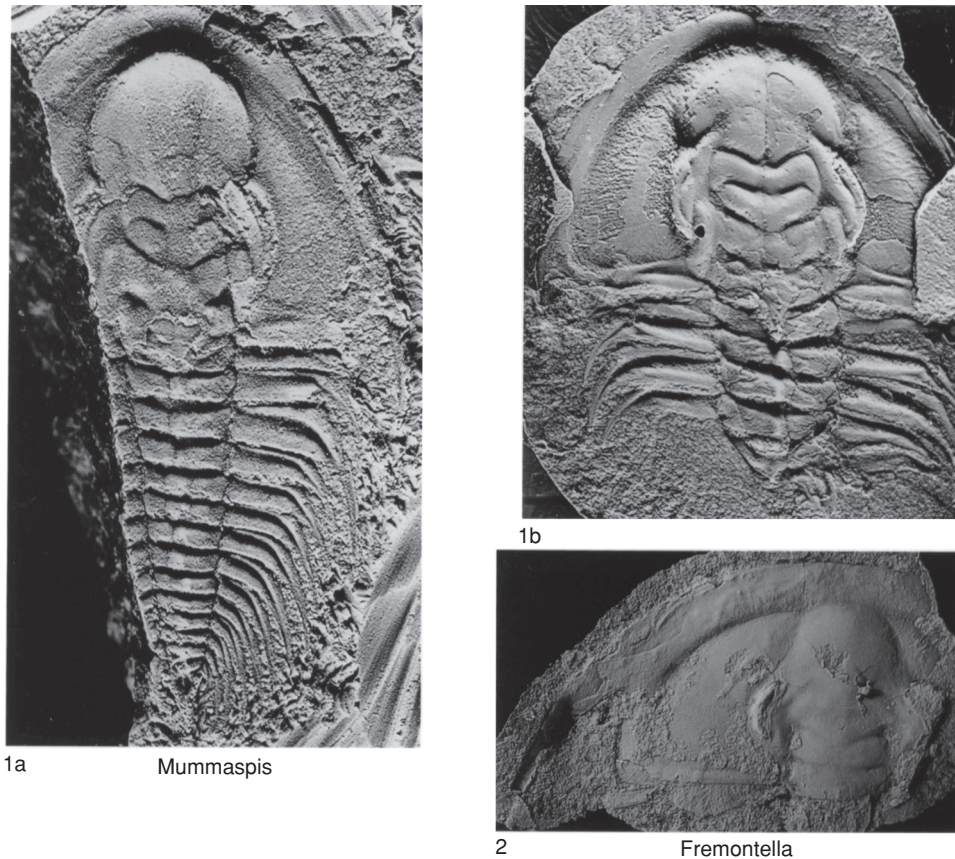


FIG. 256. Olenellidae (p. 408–409)

1979, p. 69; OD; holotype (PALMER & HALLEY, 1979, pl. 2, fig. 18), 177204, USNM, Washington, D.C.]. Posterior margin of cephalon nearly straight or deflected anterolaterally distal to intergenal spine or intergenal angle; genal spine originating opposite or posterior to L1; intergenal spine present on some species. LA prominent, subglobular, may overlap border in dorsal view; preglabellar field absent; posterior tip of ocular lobe approximately opposite occipital furrow. *Lower Cambrian*: USA (California, Nevada), Canada (Cordilleran region, Devon Island), ?northern Greenland, Mexico (Caborca), middle? and upper *Olenellus* Zone.—FIG. 258,3. **B. euryparia* (PALMER), California; cephalon, holotype, USNM 177204, ×2 (Palmer & Halley, 1979, pl. 2, fig. 18).

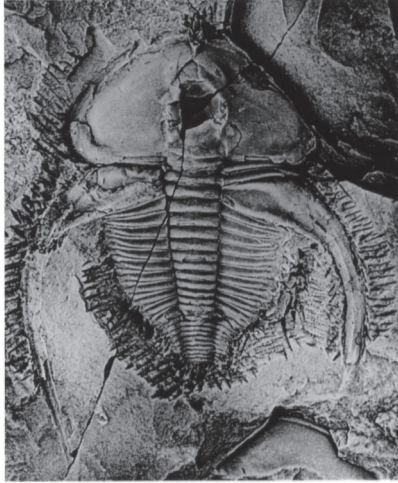
Nephrolenellus PALMER & REPINA, 1993, p. 24 [**Olenellus multinodus* PALMER in PALMER & HALLEY, 1979, p. 72; OD; holotype (PALMER & HALLEY, 1979, pl. 4, fig. 4), 177225, USNM, Washington, D.C.]. Posterior margin of cephalon directed slightly posterolaterally to intergenal spine or intergenal swelling that is situated near slightly advanced genal spine. Preglabellar field short (sag.);

width of interocular area approximately half or more width of glabella at L2; posterior tip of ocular lobe opposite L1. Third thoracic segment macropleural, having extremely long pleural spine with tip posterior to end of thorax; prothorax of 13 segments; opisthothorax of at least 17 segments; 15th segment lacking strong axial spine. *Lower Cambrian*: USA (California, Nevada); Canada (southern Rocky Mountains), upper *Olenellus* Zone.—FIG. 258,4a. **N. multinodus* (PALMER), California; cephalon, holotype, USNM 177225, ×5 (Palmer & Halley, 1979, pl. 4, fig. 4).—FIG. 258,4b. *Nephrolenellus* sp., Nevada; nearly complete individual, USNM 466536, ×3 (Palmer & Repina, 1993, fig. 4.3).

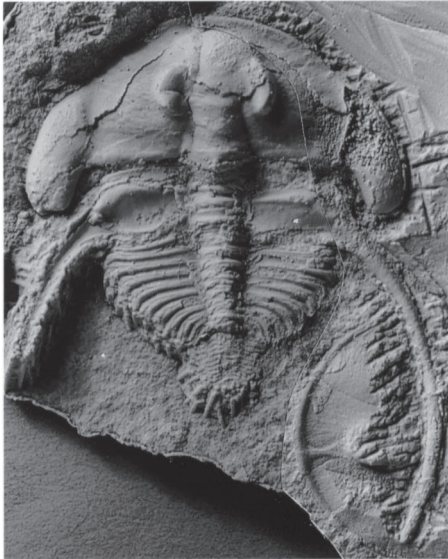
Subfamily GABRIELLINAE
Palmer & Repina, 1993

[Gabriellinae PALMER & REPINA, 1993, p. 24]

Posterior margin of cephalon curved forward. Intergenal angle variably developed, situated slightly distal to midlength of



1 Biceratops



2 Peachella

FIG. 257. Olenellidae (p. 409)

posterior margin. Genal spine originating opposite or anterior to S1. Glabella bullet shaped. Ocular lobe close to glabella, its tip opposite or posterior to occipital furrow. Thorax with at least 17 segments; each segment with width (tr.) of thoracic axis greater than width of inner parts of pleural region; third thoracic segment not modified; fifteenth segment with long axial spine.

Opisthothorax not clearly differentiated. Pygidium elongate; sides convergent posteriorly; end bluntly pointed. *Lower Cambrian*.

Gabriellus FRITZ, 1992, p. 20 [**G. lanceatus*; OD; holotype (FRITZ, 1992, pl. 17, fig. 6), 443792, USNM, Washington, D.C.] Characters as for subfamily. *Lower Cambrian*: USA (Nevada), Canada (Cordilleran region), lower *Olenellus* Zone.—FIG. 259,3. *Gabriellus* sp.; complete individual, Canada, GSC 104195, ×1.7 (Palmer & Repina, 1993, fig. 4.9).

Subfamily LAUDONIINAE Palmer & Repina, 1993

[Laudoniinae PALMER & REPINA, 1993, p. 24]

Cephalon subquadrate to subhexagonal in outline. Genal spine strongly advanced, originating anterior to S1. Intergenal spine strongly developed in adult at posterolateral corner of cephalon. Width (tr.) of anterior ring of L1 nearly equal to that of occipital ring. Thorax with third segment weakly macropleural; 15th segment lacking axial spine. Opisthothorax not clearly differentiated. Pygidium small, bilobate. *Lower Cambrian*.

Laudonia HARRINGTON, 1956, p. 60 [**L. bispinata*; OD; holotype (HARRINGTON, 1956, pl. 15, fig. 4), 9465T1, KUMIP, Lawrence]. Cephalon subquadrate to subpentagonal in outline; genal spine originating opposite or anterior to L3; procranial spine not developed in adult; intergenal ridge distinct. Preglabellar field absent or shorter (sag.) than border; posterior tip of ocular lobe opposite or anterior to L1. Thorax of about 20 segments. External surface reticulate. *Lower Cambrian*: Canada (southern Rocky Mountains), USA (Nevada), Mexico (Caborca), lower *Olenellus* Zone.—FIG. 259,2. *L. amputata* FRITZ; cephalon and partial thorax, Canada, USNM 443754, ×2 (Fritz, 1992, pl. 11, fig. 4).

?**Olenelloides** PEACH, 1894, p. 668 [**Olenellus (Olenelloides) armatus* PEACH, 1894, p. 669; OD; lectotype (PEACH, 1894, pl. 32, fig. 4; SD McNAMARA, 1978, p. 637), 472, GSE, Edinburgh]. Cephalon subhexagonal in outline; prominent procranial, genal, or intergenal spine at each angle of the hexagon; intergenal spine close to glabella; LA subglobular. Preglabellar field absent; width (tr.) of narrow interocular area about equal to width of equally narrow extraocular area opposite midlength of ocular lobe; posterior tip of ocular lobe opposite L2. Thorax with 9 segments; axis wider than inner part of pleural region exclusive of spines; third and sixth thoracic segments macropleural. *Lower Cambrian*: northwestern Scotland, middle *Olenellus* Zone.—FIG. 259,1a,b. **O. armatus* (PEACH); a,

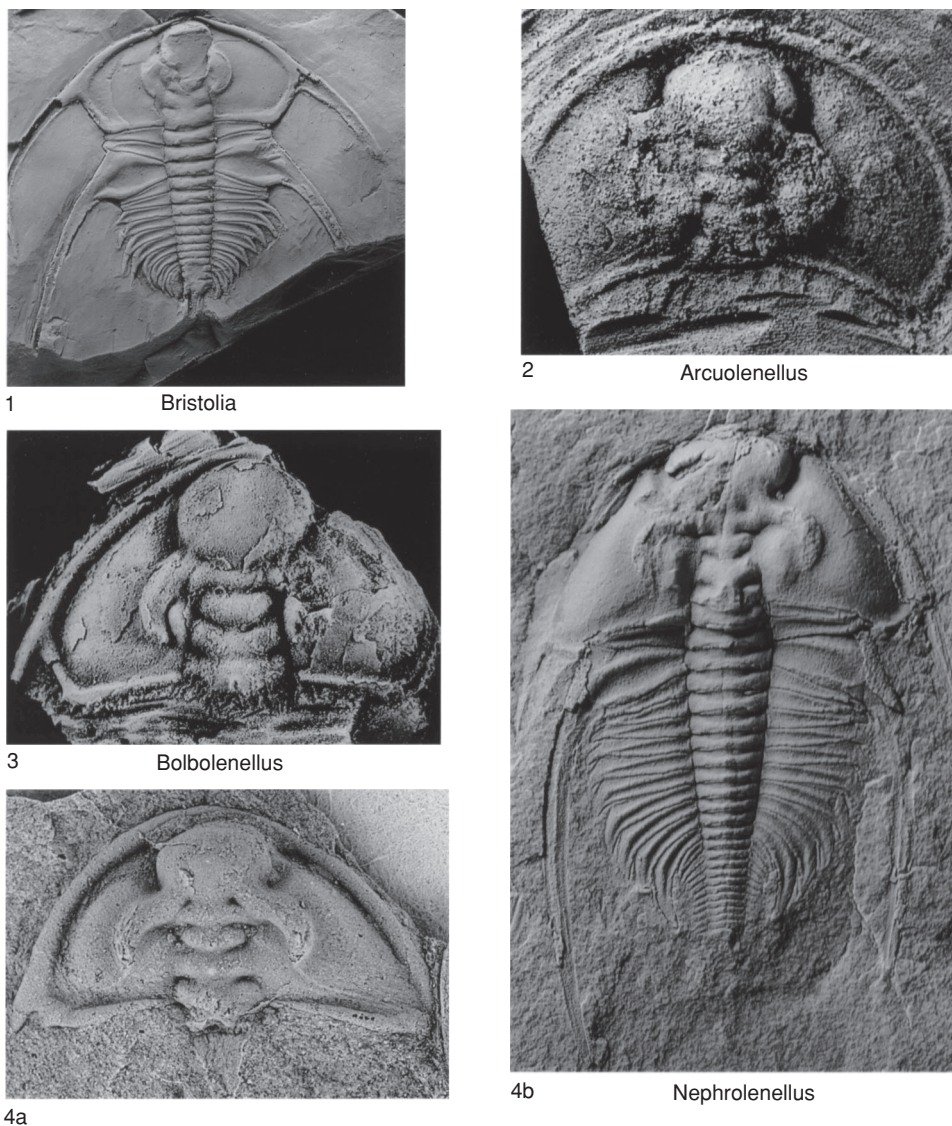


FIG. 258. Olenellidae (p. 409–411)

reconstruction of entire individual, $\times 5$ (McNamara, 1978, fig. 1); *b*, cephalon, lectotype, GSE 472, $\times 8$ (McNamara, 1978, pl. 71, fig. 1).

Subfamily WANNERIINAE HUPÉ, 1953

[Wanneriinae HUPÉ, 1953a, p. 124] [=Olenellinae SUVOROVA in TCHERNYSHEVA, 1960, p. 62, *partim*; Holmiidae BERGSTRÖM, 1973b, p. 285, *partim*; Wanneriidae AHLBERG, BERGSTRÖM, & JOHANSSON, 1986, p. 40, *partim*; Wanneriinae PALMER & REPINA, 1993, p. 25]

LA enlarged. Posterior margin of cephalon straight or curved backward towards base of

genal spine. Intergenal spine absent. Preglabellar field absent. Posterior tip of ocular lobe opposite or anterior to occipital furrow. Thorax with 17 segments, not divided into prothorax and opisththorax; third segment unmodified; fifteenth segment bearing long axial spine. Pygidium small, subquadrate, with prominent median notch. External surface reticulate; polygons may have central granule; on well-preserved specimens

boundaries of polygons marked by rows of perforations on underside of exoskeleton.

Lower Cambrian.

Wanneria WALCOTT, 1910, p. 296 [**Olenellus* (*Holmia*) *walcottanus* WANNER, 1901, p. 267; OD; lectotype (WANNER, 1901, pl. 31, fig. 1; SD RESSER & HOWELL, 1938, p. 227, pl. 10, fig. 9), 56807a, USNM, Washington, D.C.]. Characters as for subfamily. *Lower Cambrian*: North America (wide-spread, including Greenland), middle *Olenellus* Zone.—FIG. 260. **W. walcottana* (WANNER), Pennsylvania; complete individual, topotype, USNM 85357, $\times 1$ (Palmer & Repina, 1993, fig. 5).

Family HOLMIIDAE Hupé, 1953

[*nom. transl.* BERGSTRÖM, 1973b, p. 285, ex Holmiinae HUPÉ, 1953a, p. 125] [=Holmiinae HUPÉ, 1953a, p. 125, *partim*; POULSEN in MOORE, 1959, p. 194, *partim*; SUVOROVA in TCHERNYSHEVA, 1960, p. 62, *partim*; Holmiidae BERGSTRÖM, 1973b, p. 285, *partim*; REPINA, 1979, p. 20, *partim*; AHLBERG, BERGSTRÖM, & JOHANSSON, 1986, p. 43, *partim*; PALMER & REPINA, 1993, p. 25; Callaviinae POULSEN in MOORE, 1959, p. 192, *partim*; BERGSTRÖM, 1973b, p. 309, *partim*; Callaviidae AHLBERG, BERGSTRÖM, & JOHANSSON, 1986, p. 40, *partim*]

Width (tr.) of interocular area more than half that of extraocular area. Third thoracic segment generally unmodified; prothorax and opisthothorax not differentiated. *Lower Cambrian.*

Subfamily HOLMIINAE Hupé, 1953

[Holmiinae HUPÉ, 1953a, p. 125] [=Holmiinae POULSEN in MOORE, 1959, p. 194, *partim*; SUVOROVA in TCHERNYSHEVA, 1960, p. 62, *partim*; REPINA, 1979, p. 20, *partim*; PALMER & REPINA, 1993, p. 25; Holmiidae AHLBERG, BERGSTRÖM, & JOHANSSON, 1986, p. 43, *partim*; Elliptocephalinae HUPÉ, 1953a, p. 124, *partim*; POULSEN in MOORE, 1959, p. 194, *partim*; Wanneriidae AHLBERG, BERGSTRÖM, & JOHANSSON, 1986, p. 40, *partim*; Callaviinae BERGSTRÖM, 1973b, p. 309, *partim*]

Glabella expanded forward. Cephalic border generally convex in cross section. Inner pleural region of thorax narrower than axis. *Lower Cambrian*—?lowest Middle Cambrian.

Holmia MATTHEW, 1890, p. 160 [**Paradoxides kjerulfi* LINNARSSON, 1873, p. 790; OD; lectotype (LINNARSSON, 1873, pl. 16, fig. 1; SD PALMER & REPINA, 1993, p. 25), 5329a,b, SGU, Uppsala]. Intergenal spine generally well developed at or slightly proximal to midlength of posterior cephalic margin. Glabella expanded anteriorly, L3 modified; posterior tip of ocular lobe opposite or posterior to L1. Thorax narrow, with 16 or 17 segments; pleural spines thornlike; each segment with axial spine. Pygidium small, subquadrate, nonspinose; posterior margin nearly straight (tr.). *Lower Cambrian*: Sweden, Norway, Poland, *Schmidtellus mickewitzii* to *Holmia kjerulfi* group Zones; Russia (Siberian Platform), upper *Pagetiellus anabarus* Zone.—FIG. 261, 1. **H. kjerulfi* (LINNARSSON);

cephalon, partial thorax, pygidium, Norway, paratype, PMO 61378, $\times 3$ (Whittington, 1990, fig. 13).

Andalusiana SDZUY, 1961, p. 246 [**A. cornuta*; OD; holotype (SDZUY, 1961, pl. 3, fig. 4), L3072, UMU, Münster]. Posterior cephalic margin nearly straight; intergenal spine not apparent. Glabella expanded anteriorly; LA with distinct lateral projections situated in front of ocular lobe and segregated by shallow longitudinal furrow; preglabellar field narrow; posterior tip of ocular lobe opposite posterior part of L1. Thorax narrow; each segment with axial node and short (exsag.) pleural spine not constricted at base; number of segments not known. *Lower Cambrian*: Spain (Guadalcanal), Marianian stage; United Kingdom (Comley, Shropshire), *Callavia* Zone; Morocco (Anti-Atlas), *Sectigena* Zone; ?Norway (Oslo Region), *Holmia kjerulfi* group Zone.—FIG. 261, 3. *Andalusiana* sp.; cephalon, Morocco, IGR 19613, $\times 2$ (Palmer & Repina, 1993, fig. 6.3).

Cambropallas GEYER, 1993, p. 76 [**C. telesto*; OD; holotype (GEYER, 1993, fig. 4; pl. 1, fig. 1–2; pl. 4, fig. 2–3), 93VII1, PIW, Würzburg]. Posterior cephalic margin arcuate, intergenal spine not apparent. Glabella slightly expanded anteriorly, extended onto inner part of broad anterior border; posterior tip of ocular lobe opposite anterior part of L1; genal spine broad based. Thorax with 15 or 16 segments, each with axial node; pleural spine short (exsag.), not constricted at base. Pygidium small, with short, blunt posterolateral spine. ?lowest Middle Cambrian: Morocco (Anti-Atlas), *Cephalopyge notabilis* Zone.—FIG. 261, 4. **C. telesto*; complete individual, Morocco, holotype, $\times 0.5$ (Geyer, 1993, pl. 1, fig. 1).

Elliptocephala EMMONS, 1844, p. 21 [**E. asaphoides*; OD; neotype (WALCOTT, 1910, pl. 24, fig. 1; SD PALMER & REPINA, 1993, p. 26), 18350a, USNM, Washington, D.C.]. Posterior margin of cephalon straight or slightly angled forward distal to intergenal swelling; intergenal spine absent. Posterior tip of ocular lobe opposite or slightly anterior to occipital furrow. Length (sag.) of preglabellar field equal to or slightly greater than that of anterior border. Thorax moderately wide, consisting of 18 segments; pleural regions of adults lacking macropleurae; 15th through 18th segments with strong axial spine. Pygidium small, subquadrate, with single pair of short anterolateral spines. External surface with some reticulate areas. *Lower Cambrian*: USA (New York), Canada (Quebec), *Olenellus* Zone.—FIG. 262, 4. **E. asaphoides*; cephalon and partial thorax, New York, NYSM 4598, $\times 5$ (Palmer & Repina, 1993, fig. 6.7).

Esmeraldina RESSER & HOWELL, 1938, p. 228 [**Holmia rowei* WALCOTT, 1910, p. 292; OD; lectotype (WALCOTT, 1910, pl. 29, fig. 3; FRITZ, 1995, p. 714), 568011c, USNM, Washington, D.C.]. Intergenal spine generally well developed at or slightly proximal to midlength of posterior cephalic margin. Glabella slightly expanded anteriorly; L3 not modified; posterior tip of ocular lobe opposite

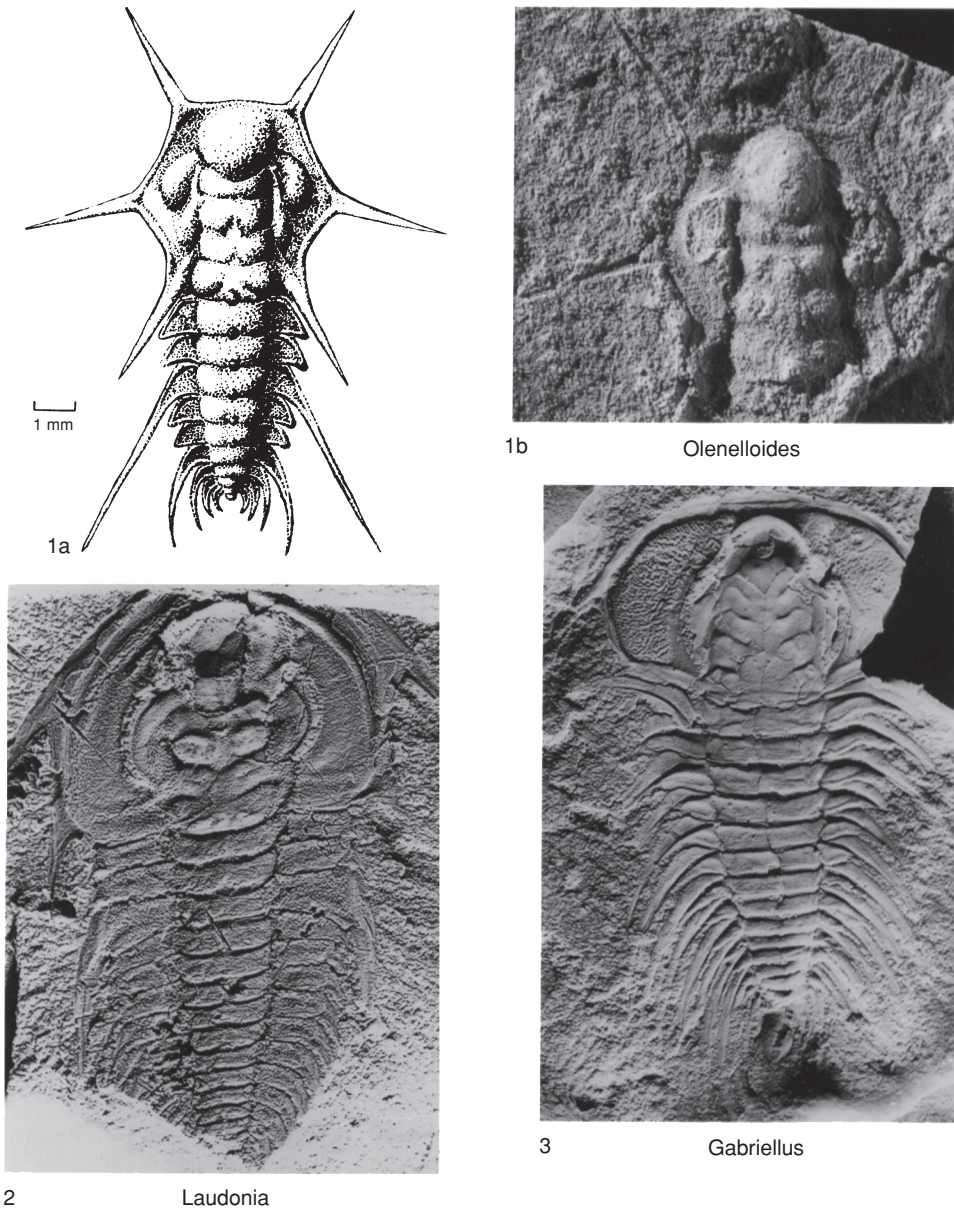


FIG. 259. Olenellidae (p. 412–413)

L1. Thorax narrow, with 17 segments; pleural spines chelate; each segment with axial spine. Pygidium small, expanded posteriorly; posterior margin spinose. External surface granular. *Lower Cambrian*: USA (Nevada), lower "Nevadella" Zone.—FIG. 262, 1a, b. **E. rowei* (WALCOTT); a, cephalon, ICS 3642, $\times 1.6$ (new); b, cephalon and partial thorax, ICS 3643, $\times 0.8$ (new).

Holmiella FRITZ, 1972, p. 25 [*H. preancora*; OD; holotype (FRITZ, 1972, pl. 4, fig. 4–6), 27241, GSC, Ottawa]. Outline of cephalon subpentagonal; genal spine prominent, originating opposite or anterior to S3; short intergenal spine or node located at or on axial side of intergenal angle. Glabella expanded anteriorly; posterior tip of ocular lobe opposite or posterior to L1. Pygidium large, wider



Wanneria

FIG. 260. Olenellidae (p. 414)

than long, of at least three segments; anterior two segments extended into short border spines. *Lower Cambrian*: USA (Nevada), Canada (Mackenzie Mountains), "Nevadella" Zone.—FIG. 262,2a,b. **H. preancora*, Canada; a, cephalon, paratype, GSC 27240, $\times 4$ (Fritz, 1972, pl. 4, fig. 1); b, pygidium, holotype, GSC 27241, $\times 5$ (Fritz, 1972, pl. 4, fig. 6).

Iyouella GEYER & PALMER, 1995, p. 470 [**I. contracta*; OD; holotype (GEYER & PALMER, 1995, fig. 6.9–6.10), 52260b, SMF, Frankfurt am Main]. Glabella slightly tapered forward, reaching onto anterior border. Ocular lobe long, posterior tip opposite occipital furrow. Genal spine slightly advanced; intergenal spine small, midway between axial furrow and genal spine. *Lower Cambrian*: Morocco (Anti-Atlas), *Sectigena* Zone.—FIG. 262,3. **I. contracta*; incomplete cephalon, holotype, $\times 4.5$ (Geyer & Palmer, 1995, fig. 6.9).

Palmetaspis FRITZ, 1995, p. 718 [**P. consorta* FRITZ, 1995, p. 720; OD; holotype (FRITZ, 1995, fig. 8.4), 476024, USNM, Washington, D.C.]. Intergenal spine generally well developed at or slightly proximal to midlength of posterior cephalic margin. Glabella parallel sided or slightly expanded anteriorly; L3 not modified. Posterior tip of ocular lobe opposite L1 or occipital furrow. Thorax narrow; pleural spines chelate or setate; each segment with axial spine or node. Pygidium unknown. *Lower Cambrian*: USA (Nevada), lower "Nevadella" Zone.

—FIG. 262,5. **P. consorta*; cephalon, paratype, USNM 476021, $\times 5$ (Fritz, 1995, fig. 8.2).

Schmidtellus MOBERG in MOBERG & SEGERBERG, 1906, p. 35 (footnote) [**Olenellus mickwitzii* SCHMIDT, 1888, p. 13; types not designated, original specimens missing (diagnosis based on *S. mickwitzii torelli* MOBERG, 1899, redescribed by BERGSTRÖM, 1973b, p. 296–301)]. Posterior margin of cephalon nearly straight; intergenal spine not developed. Glabella with prominent axial spine on anterior margin of occipital ring and encroaching on occipital furrow; posterior tip of ocular lobe opposite or posterior to L1. Thorax narrow; each segment with short (exsag.) pleural spine not constricted at base; at least 1 posterior segment bearing strong, posteriorly directed axial spine. Pygidium small, subquadrate. *Lower Cambrian*: Sweden (Scania), Estonia, *Schmidtellus mickwitzii* Zone.

—FIG. 261,2. *S. reetae*; cephalon and partial thorax, holotype, GIT 2590a, $\times 1.4$ (Bergström, 1973b, fig. 15a).

Subfamily CALLAVIINAE Poulsen in Moore, 1959

[Callaviinae POULSEN in MOORE, 1959, p. 192, *partim*] [=Callaviinae BERGSTRÖM, 1973b, p. 309, *partim*; REPINA, 1979, p. 20, *partim*; PALMER & REPINA, 1993, p. 26; Callaviidae AHLBERG, BERGSTRÖM, & JOHANSSON, 1986, p. 40, *partim*; Holmiinae HUPE, 1953a, p. 125, *partim*; SUVOROVA in TCHERNYSHEVA, 1960, p. 62, *partim*; Holmiidae REPINA, 1979, p. 20, *partim*; AHLBERG, BERGSTRÖM, & JOHANSSON, 1986, p. 43, *partim*; Neltneriinae BERGSTRÖM, 1973b, p. 309, *partim*]

Glabella subcylindrical in outline or slightly expanded anteriorly; LA extended onto inner part of border. Preglabellar field absent. Border broad. Posterior tip of ocular lobe opposite or posterior to midlength of L1. Thorax broad, with 16 to 18 segments; not clearly differentiated into prothorax and opisthothorax. Pleural regions lack macropleurae. Pleural spines elongate. Pygidium small, subquadrate. *Lower Cambrian*.

Callavia MATTHEW, 1897, p. 397 [**Olenellus (Mesonacis) broeggeri* WALCOTT, 1890a, p. 41; SD WALCOTT, 1910, p. 275; lectotype (WALCOTT, 1890b, pl. 92, fig. 1, part; SD HUTCHINSON, 1962, p. 119), 18331, USNM, Washington, D.C.]. Intergenal spine well developed, adjacent to genal spine; intergenal ridge usually present. *Lower Cambrian*: United Kingdom (Comley, Shropshire), Canada (Avalon Peninsula), USA (eastern Massachusetts), *Callavia* Zone.—FIG. 263,1a. **C. broeggeri* (WALCOTT), Canada; cephalon, topotype, USNM 462671, $\times 1$ (Palmer & Repina, 1993, fig. 6.8).

—FIG. 263,1b. *C. crosbyi*, eastern Massachusetts; complete individual, paratype, USNM 56798g, $\times 4$ (Palmer & Repina, 1993, fig. 6.5).

Kjerulfia KIAER, 1917, p. 71 [**K. lata*; OD; lectotype (KIAER, 1917, pl. 10, fig. 1; SD NIKOLAISEN &



1 Holmia



2 Schmidtiellus



3 Andalusiana



4 Cambropallas

FIG. 261. Holmiidae (p. 414–416)

HENNINGSMOEN, 1990, p. 63), 61376, PMO, Oslo]. Posterior margin of cephalon nearly straight or deflected slightly forward distal to intergenal swelling; intergenal swelling closer to genal angle than axial furrow. *Lower Cambrian*: Norway (Oslo region), Denmark (borehole in Sealand), Poland (Holy Cross Mountains), Germany (Gorlitz), *Holmia*

kjerulfii group Zone; United Kingdom (Comley, Shropshire), *Callavia* Zone; Morocco (Anti-Atlas), *Sectigena* Zone.—FIG. 263,2a,b. **K. lata*, Norway; a, cephalon, lectotype, PMO 61376, ×0.8 (Palmer & Repina, 1993, fig. 6.9); b, partial cephalon and thorax, paratype, PMO 73170, ×0.8 (Palmer & Repina, 1993, fig. 6.10).

Superfamily
FALLOTASPIDOIDEA
Hupé, 1953

[*nom. transl.* PALMER & REPINA, 1993, p. 27, *ex* Fallotaspidae HUPE, 1953a, p. 124] [=Daguinaspidae HUPE, 1953a, p. 137; Olenellidae POULSEN in MOORE, 1959, p. 191, *partim*; Daguinaspidae POULSEN in MOORE, 1959, p. 197; BERGSTRÖM, 1973b, p. 309, *partim*; Olenelloidea SUVOROVA in TCHERNYSHEVA, 1960, p. 62, *partim*; REPINA, 1979, p. 11, *partim*; Olenellida AHLBERG, BERGSTRÖM, & JOHANSSON, 1986, p. 40, *partim*]

Glabellar outline typically cylindrical or slightly conical in dorsal view. L3 simple, its form similar to L2. *Lower Cambrian*.

Family FALLOTASPIDIDAE Hupé, 1953

[*nom. transl.* REPINA, 1979, p. 19, *ex* subfamily Fallotaspidae HUPE, 1953a, p. 124] [=Daguinaspidae HUPE, 1953a, p. 137; Fallotaspidae POULSEN in MOORE, 1959, p. 194; Holmiinae SUVOROVA in TCHERNYSHEVA, 1960, p. 62, *partim*; Daguinaspidae BERGSTRÖM, 1973b, p. 309, *partim*; AHLBERG, BERGSTRÖM, & JOHANSSON, 1986, p. 40, *partim*; Fallotaspidae PALMER & REPINA, 1993, p. 27]

Projection of anterior margin of ocular lobe more or less tangent to anterior end of LA or continuous as parafrontal band in front of LA. Glabella slightly to moderately tapered forward. Length of LA less than one-third length of glabella, exclusive of occipital ring. Interocular area ranging from significantly wider (tr.) to slightly narrower than extraocular area. *Lower Cambrian*.

Subfamily FALLOTASPIDINAE
Hupé, 1953

[=Fallotaspidae HUPE, 1953a, p. 124] [=Fallotaspidae POULSEN in MOORE, 1959, p. 194; BERGSTRÖM, 1973b, p. 309, *partim*; AHLBERG, BERGSTRÖM, & JOHANSSON, 1986, p. 40, *partim*; PALMER & REPINA, 1993, p. 27; Holmiinae SUVOROVA in TCHERNYSHEVA, 1960, p. 62, *partim*; Fallotaspidae REPINA, 1979, p. 19, *partim*]

Genal spines present. Interocular area slightly wider (tr.) to slightly narrower than extraocular area. *Lower Cambrian*.

Fallotaspis HUPE, 1953a, p. 125 [**F. typica* HUPE, 1953a, p. 131; OD; holotype (HUPE, 1953a, pl. 2, fig. 2), G.26, MNHN, Paris]. Posterior margin of cephalon straight or gently curved forward distally; intergenal spine not developed, but intergenal ridge intersecting posterior border closer to glabella than to genal spine. Glabella slightly tapered forward; ocular lobe directed posterolaterally from junction with LA; width (tr.) of interocular area half or less width of extraocular area. Thorax of 21 segments (17 in prothorax, 4 in opisththorax); opisththorax not strongly differentiated; width (tr.) of inner pleural region of each prothoracic segment about same width as axis. Third thoracic segment macropleural. Pygidium small, subquadrate. *Lower Cambrian*: Morocco (Anti-Atlas), *Fallotaspis tazem-mourtentis*, *Choubertella*, *Daguinaspis*, and *Antat-*

lasia hollardi Zones; USA (White-Inyo Mountains), "*Fallotaspis*" Zone; Russia (Siberian Platform), *Fallotaspis* Zone; ?United Kingdom (Comley, Shropshire), sub-*Callavia* Zone.—FIG. 264.3. **F. typica*, Morocco; cephalon and partial thorax, holotype, MNHN G.26, $\times 2$ (Palmer & Repina, 1993, fig. 7.2).

Eofallotaspis SDZUY, 1978, p. 89 [**E. tioutensis*; OD; holotype (SDZUY, 1978, pl. 1, fig. 1–2), 28567, SMF, Frankfurt am Main]. Posterior margin of cephalon nearly straight; small intergenal spine on posterior border approximately midway between axial furrow and genal spine. Glabella slightly tapered forward. Ocular lobe directed posterolaterally from junction with LA. Width (tr.) of interocular area equal to or greater than width of extraocular area opposite midlength of ocular lobe. Occipital ring simple. Thorax narrow; width (tr.) of inner pleural region of each segment less than that of axis; third segment macropleural. External surface strongly pitted. *Lower Cambrian*: Morocco (Anti-Atlas), *Eofallotaspis* Zone.—FIG. 264.6a, b. **E. tioutensis*; a, cephalon, holotype, $\times 5$ (Sdzuy, 1978, pl. 1, fig. 1); b, cephalon and partial thorax, SMF 41984, $\times 10$ (Sdzuy, 1981, fig. 12).

Lenallina REPINA, 1990a, p. 40 [**L. lata*; OD; holotype (REPINA, 1990a, pl. 3, fig. 1–2), 902/1, CSGM, Novosibirsk]. Posterior margin of cephalon directed anterolaterally distal to intergenal angle; intergenal angle closer to axial furrow than to genal spine. Glabella slightly tapered forward. Interocular area narrow; width (tr.) less than half width of extraocular area. Posterior tip of ocular lobe about opposite occipital furrow. External surface reticulate. *Lower Cambrian*: Russia (southeastern Siberian Platform), *Pageiellus anabarus* Zone.—FIG. 264.5. **L. lata*; cephalon, holotype, TsGM 902/1, $\times 6$ (Repina, 1990a, pl. 3, fig. 2).

Parafallotaspis FRITZ, 1972, p. 27 [**P. grata*; OD; holotype (FRITZ, 1972, pl. 1, fig. 1–2), 27202, GSC, Ottawa]. Posterior margin of cephalon nearly straight or slightly backswep. Glabella moderately tapered forward; plectrum strongly developed; ocular lobe directed posterolaterally from junction with LA; width (tr.) of interocular area slightly more than one-half width of extraocular area opposite midlength of ocular lobe; posterior tip of ocular lobe opposite occipital ring. *Lower Cambrian*: Canada (Mackenzie Mountains); USA (Nevada), "*Fallotaspis*" Zone.—FIG. 264.1. **P. grata*, Mackenzie Mountains; cephalon, holotype, GSC 27202, $\times 3$ (Fritz, 1972, pl. 1, fig. 1).

Pelmanaspis REPINA, 1990a, p. 41 [**P. jurii*; OD; holotype (REPINA, 1990a, pl. 4, fig. 1–2), 902/15, CSGM, Novosibirsk]. Posterior margin of cephalon nearly straight. Glabella gently tapered forward; occipital ring with prominent axial spine; length (sag.) of preglabellar field greater than length of border; width (tr.) of interocular area slightly more than half width of extraocular area; ocular lobe directed posterolaterally from junction with LA; posterior tip of ocular lobe about opposite occipital furrow. External surface coarsely pitted, grading to reticulate. *Lower Cambrian*: Russia (southeastern

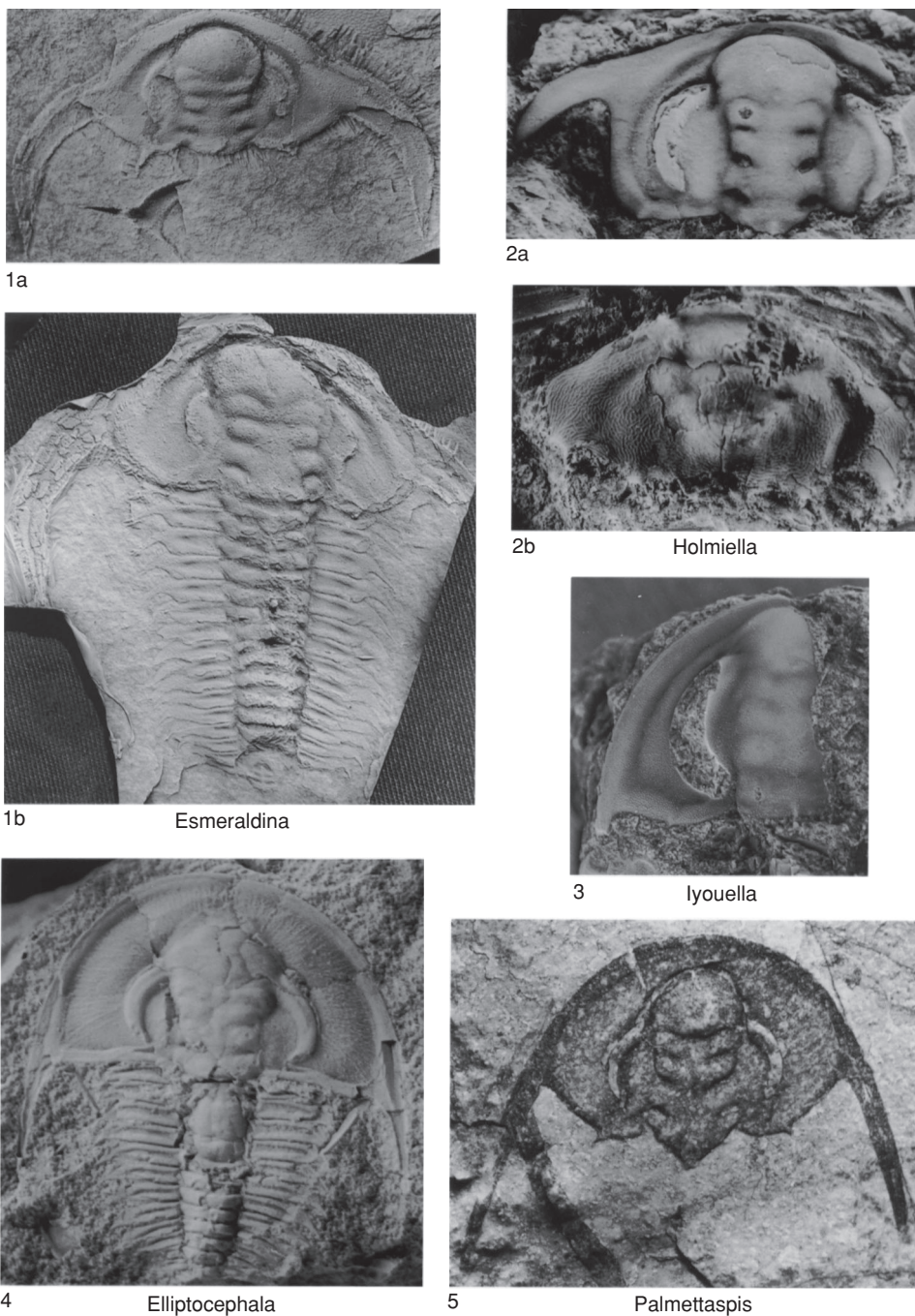


FIG. 262. Holmiidae (p. 414–416)

Siberian Platform), *Pagetiellus anabarus* Zone.—
 FIG. 264, 4. **P. jurei*; cephalon, holotype, CSGM
 902/15, ×6 (Repina, 1990a, pl. 4, fig. 2).

Profallotaspis REPINA in KHOMENTOVSKII & REPINA,
 1965, p. 110 [**P. jakutensis*; OD; holotype (KHO-
 MENTOVSKII & REPINA, 1965, pl. 2, fig. 4), 265/1,

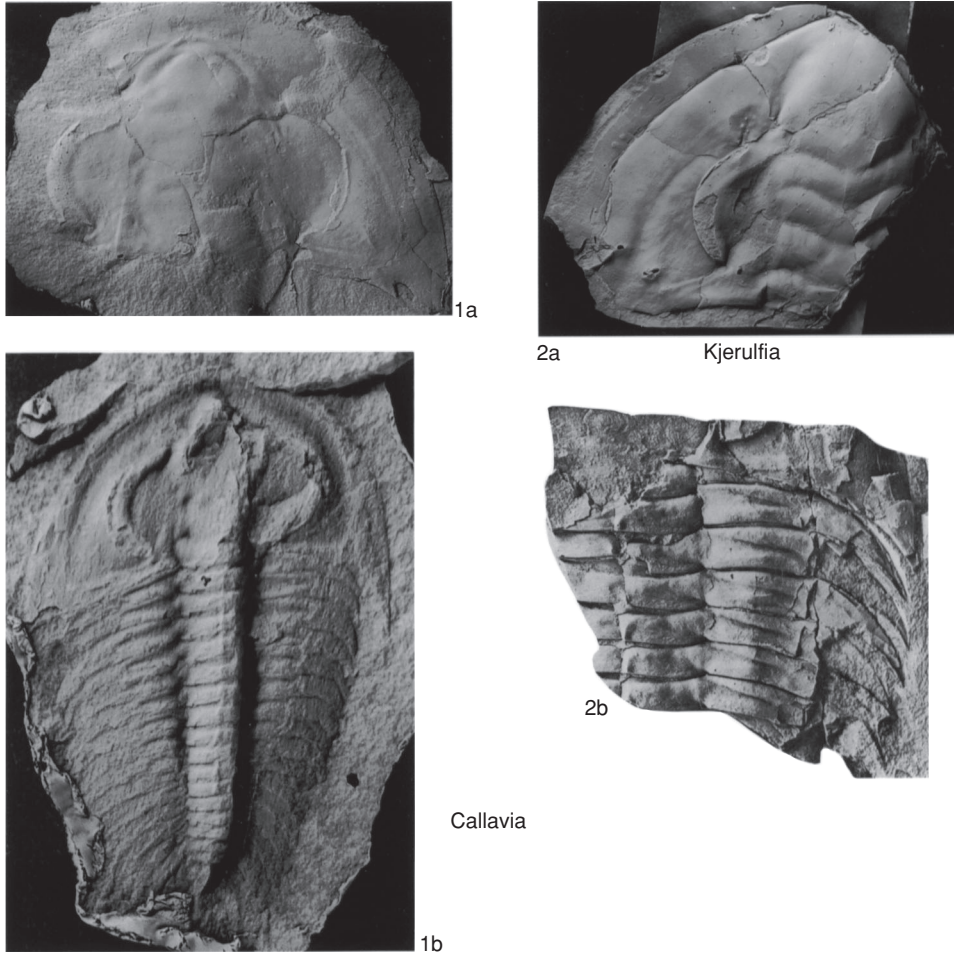


FIG. 263. Holmiidae (p. 416–417)

CSGM, Novosibirsk]. Posterior margin of cephalon straight or slightly backswept. Glabella tapered forward, but area opposite L3 and LA merging laterally with ocular lobe; ocular lobe directed only slightly posterolaterally at junction with LA; interocular area wider (tr.) than extraocular area opposite midlength of ocular lobe; posterior tip of ocular lobe opposite L1. Cephalic border concave in sagittal profile; lateral and posterior border furrows not connected across base of genal spine. External surface coarsely pitted, grading to reticulate. *Lower Cambrian*: Russia (southeastern Siberian Platform), *Profallotaspis jakutensis* Zone.—FIG. 264.2. **P. jakutensis*; cephalon, paratype, CSGM 265/13, $\times 7$ (Khomentovskii & Repina, 1965, pl. 2, fig. 5).

Subfamily DAGUINASPIDINAE Hupé, 1953

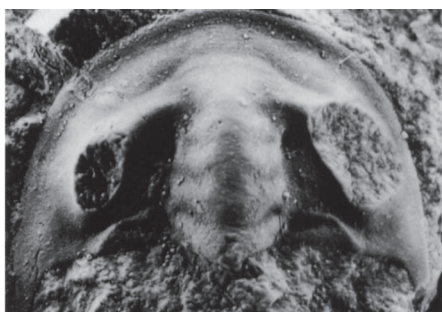
[*nom. correct.* POULSEN in MOORE, 1959, p. 197, ex *Daguinaspidae* HUPÉ, 1953a, p. 137] [=Daguinaspidae POULSEN in MOORE, 1959, p. 197, *partim*; BERGSTRÖM, 1973b, p. 309, *partim*; REPINA, 1979, p. 19; AHLBERG, BERGSTRÖM, & JOHANSSON, 1986, p. 40, *partim*; Daguinaspidae PALMER & REPINA, 1993, p. 28; Holmiinae SUVOROVA in TCHERNYSHEVA, 1960, p. 62, *partim*]

Interocular area significantly wider (tr.) than extraocular area. Genal spine absent. *Lower Cambrian*.

Daguinaspis HUPÉ & ABADIE, 1950, p. 2112 [**D. ambroggii*; OD; holotype (HUPÉ, 1953a, pl. 5, fig. 1), G.200, MNHN, Paris]. Anterior margin of



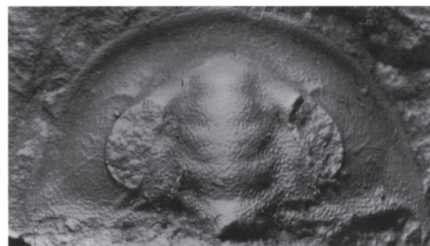
1 Parafallotaspis



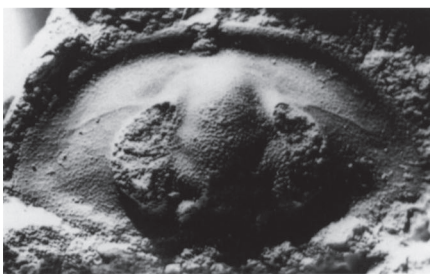
2 Profallotaspis



3 Fallotaspis



4 Pelmanaspis



5 Lenallina



6a Eofallotaspis



6b

FIG. 264. Fallotaspidae (p. 418–420)



1 Choubertella



2 Daguinaspis



3 Wolynaspis

FIG. 265. Fallotaspididae (p. 420–422)

cephalon bluntly pointed. Width (tr.) of interocular area less than one-half basal glabellar width; width

of extraocular area about equal to width of ocular lobe; length (sag.) of frontal area greater than that of occipital ring. Interglacial ridge well developed. Thorax of 16 (17?) segments; pleura about equal in width to axial lobe, unmodified. Pygidium small, subquadrate. [HUPÉ (1953a) created three subgenera for minor morphological variations that seem to have limited merit. These are *Eodaguinaspis* (type species, *D. (E.) abadieii*), *Daguinaspis* (type species, *D. (D.) ambroggii*), and *Epidaguinaspis* (type species, *D. (E.) angusta*).] *Lower Cambrian*: Morocco (Anti-Atlas), *Daguinaspis* Zone.—FIG. 265,2. **D. ambroggii*; cephalon, holotype (at bottom), MNHN G.200, $\times 3$ (Palmer & Repina, 1993, fig. 8.2).

Choubertella HUPÉ, 1953a, p. 143 [**C. spinosa*; OD; holotype (HUPÉ, 1953a, pl. 4, fig. 8), G.230, MNHN, Paris]. Anterior margin of cephalon gently curved. Glabella moderately to strongly tapered forward; width (tr.) of interocular area opposite tip of ocular lobe nearly equal to basal glabellar width; width of extraocular area about equal to width of ocular lobe; length (sag.) of frontal area greater than that of occipital ring. Interglacial ridge well developed. *Lower Cambrian*: Morocco (Anti-Atlas), *Choubertella* Zone.—FIG. 265,1. **C. spinosa*; cephalon, holotype, MNHN G.230, $\times 3$ (Palmer & Repina, 1993, fig. 8.1).

?*Wolynaspis* TCHERNYSHEVA in KIR'IANOV & TCHERNYSHEVA, 1967, p. 123 [**W. unica*; OD; holotype (KIR'IANOV & TCHERNYSHEVA, 1967, fig. 2), 1731/8, GMU, Kiev]. Anterior margin of cephalon gently curved. Glabella gently tapered forward; extraocular area steeply downsloping; width (tr.) of interocular area more than half basal glabellar width; frontal area short (sag.), length about equal to that of occipital ring. *Lower Cambrian*: Ukraine, zone uncertain.—FIG. 265,3. **W. unica*; cephalon, holotype, GMU 1731/8, $\times 2$ (Kir'ianov & Tchernysheva, 1967, fig. 2).

Family ARCHAESPIDIDAE Repina, 1979

[Archaeaspididae REPINA, 1979, p. 20] [=Archaeaspidinae AHLBERG, BERGSTROM, & JOHANSSON, 1986, p. 40; Archaeaspididae PALMER & REPINA, 1993, p. 29]

Anterior part of LA anterior to line tangent to anterolateral margin of ocular lobe. Parafrenal band usually present, continuing to or nearly to anterior end of LA. Width (tr.) of interocular area approximately same as width of extraocular area. Genal spine usually present. *Lower Cambrian*.

Archaeaspis REPINA in KHOMENTOVSKII & REPINA, 1965, p. 116 [**A. hupei*; OD; holotype (KHOMENTOVSKII & REPINA, 1965, pl. 4, fig. 1), 265/146, CSGM, Novosibirsk]. Glabella slightly tapered forward; LA slightly conical; width (tr.) of interocular area greater than width of extraocular area opposite midlength of ocular lobe; posterior tip of ocular lobe approximately opposite occipital furrow. Genal

spine short, broadly based; border broad, convex, well defined, its length (sag.) greater than length of preglabellar field. External surface strongly reticulate. *Lower Cambrian*: Russia (southeastern Siberian Platform), lower *Pagetiellus anabarus* Zone.—FIG. 266,2. **A. hupei*; cephalon, holotype, CSGM 265/146, $\times 15$ (Khomentovskii & Repina, 1965, pl. 4, fig. 1).

Bradyfallotaspis FRITZ, 1972, p. 19 [**B. fusa*; OD; holotype (FRITZ, 1972, pl. 3, fig. 1–3), 27226, GSC, Ottawa]. Glabellar outline subcylindrical; anterior end of glabella strongly rounded; length (sag.) of preglabellar field about equal to that of border; width (tr.) of interocular area less than width of extraocular area opposite midlength of ocular lobe; ocular lobe raised above level of glabella. *Lower Cambrian*: Canada (northern Rocky Mountains), “*Nevadella*” Zone.—FIG. 266,1. **B. fusa*; cephalon, holotype, GSC 27226, $\times 6$ (Fritz, 1972, pl. 3, fig. 1).

Fallotaspidella REPINA, 1961, p. 40 [**F. musatovi*; OD; holotype (REPINA, 1961, pl. 1, fig. 1a), 3556/1001, CSGM, Novosibirsk]. Glabella slightly tapered forward, with anterior end bluntly rounded; preglabellar field short (sag.), crossed by plectrum; posterior tip of ocular lobe opposite L1; width (tr.) of interocular area about half or less width of extraocular area opposite midlength of ocular lobe; S1 and S2 usually continuous across glabella. *Lower Cambrian*: Russia (southern Siberian fold belt, Altay-Sayan region), *Sajanaspis* Zone; northern Mongolia, *Fallotaspis-Buliaspis* Zone.—FIG. 266,4. **F. musatovi*; cephalon, Altay-Sayan region, topotype, TsGM 3556/1020, $\times 4$ (photograph courtesy of L. N. Repina).

Geraldinella FRITZ, 1993, p. 866 [**G. corneiliana*; OD; holotype (FRITZ, 1993, fig. 13.10), 102363, GSC, Ottawa]. Cephalon strongly arched (tr.); anterior and lateral borders about equal in breadth to sagittal length of occipital ring; intergenal swelling barely apparent, situated nearer to glabella than to genal spine, and marked by slight anterior deflection of distal part of posterior margin. Intergenal ridge weak. Glabella slightly constricted at L2; L3 slightly expanded distally; preglabellar field absent; width (tr.) of interocular area less than that of extraocular area; posterior tip of ocular lobe opposite L2. External surface has fine, reticulate sculpture. *Lower Cambrian*: Canada (southern Cordillera), “*Nevadella*” Zone.—FIG. 266,3a,b. **G. corneiliana*; a, cephalon, holotype, GSC 102363, $\times 4$ (Fritz, 1993, fig. 13.10); b, cephalon, paratype, GSC 102355, $\times 7$ (Fritz, 1993, fig. 11.10).

Selindella REPINA, 1979, p. 27 [**S. gigantea*; OD; holotype (REPINA, 1979, pl. 1, fig. 1), 560/1, CSGM, Novosibirsk]. Glabella slightly tapered forward, sides slightly concave, and anterior end strongly rounded; posterior tip of ocular lobe about opposite midlength of L1; width (tr.) of interocular area about equal to width of extraocular area; length (sag.) of border about equal to that of preglabellar field. *Lower Cambrian*: Russia (southeastern Siberian Platform), lower *Pagetiellus anabarus* Zone;

northern Siberian Platform, *Pseudojudomia* Zone.—FIG. 266,5. **S. gigantea*; cephalon, southeastern Siberian Platform, holotype, TsGM 560/1, $\times 1.2$ (Repina, 1979, pl. 1, fig. 1).

Family JUDOMIIDAE Repina, 1979

[*nom. transl.* PALMER & REPINA, 1993, p. 29, ex Judomiinae REPINA, 1979, p. 20] [=Callaviinae POULSEN in MOORE, 1959, p. 192, *partim*; Holmiinae SUVOROVA in TCHERNYSHEVA, 1960, p. 62, *partim*; Nevadiinae BERGSTRÖM, 1973b, p. 309, *partim*; Holmiidae BERGSTRÖM, 1973b, p. 285, *partim*; Judomiinae AHLBERG, BERGSTRÖM, & JOHANSSON, 1986, p. 40]

Posterior margin of cephalon straight or curved backward distally. Glabella typically parallel sided; glabellar furrows weakly to moderately developed. LA elongate. Ocular lobe connected only to posterior part of LA. Interocular area very narrow or absent; width (tr.) equal to or less than width of ocular lobe. Inner margin of ocular lobe typically undifferentiated or only weakly differentiated from interocular area. Posterior tip of ocular lobe opposite or posterior to occipital furrow. Intergenal spine not apparent. *Lower Cambrian*.

Judomia LERMONTOVA, 1951a, p. 48 [**J. dzevanovskii*; OD; lectotype (LERMONTOVA, 1951a, pl. 5, fig. 2); SD PALMER & REPINA, 1993, p. 30), 53/5156, CNIGR, St. Petersburg]. Glabella barely touching border, or preglabellar field present. Border well defined, with length (sag.) greater than preglabellar field, when present, and about equal to or slightly greater than length (sag.) of occipital ring. Posterior tip of ocular lobe opposite occipital ring. Thorax with 15 to 17 segments; pleural furrows weak or absent; opisthothorax not developed; pleural spines long; width (tr.) of thoracic pleurae more than twice width of axis. Pygidium elongate, with posterior median notch; last 2 thoracic segments may be fused with pygidium in axial region only. *Lower Cambrian*: Russia (southern Siberian Platform), *Judomia* and *Bergeroniellus micmaccaformis-Erbiella* Zones; Russia (Kharaulakh region), *Judomia* Zone.—FIG. 267,1. *J. tera*; complete individual, Kharaulakh region, CSGM 659/50, $\times 2$ (Palmer & Repina, 1993, fig. 10.7).

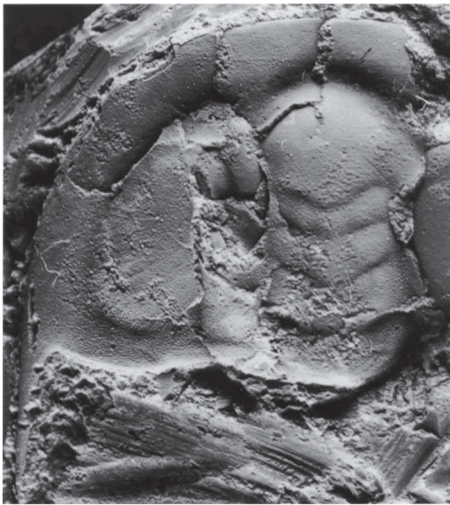
Judomiella LAZARENKO, 1962, p. 48 [**J. heba*; OD; holotype (LAZARENKO, 1962, pl. 3, fig. 6), 8270-138, 8270-139, CNIGR, St. Petersburg]. Cephalon strongly arched (tr.). Glabella reaching nearly to anterior margin. Border poorly differentiated. Ocular lobe adjacent to glabella; interocular area poorly differentiated from ocular lobe; posterior tip of ocular lobe reaching to posterior margin of cephalon. *Lower Cambrian*: Russia (northern Siberian Platform), *Protolenus borealis* Zone; Russia (southeastern Siberian Platform), *Bergeroniellus micmaccaformis-Erbiella* Zone.—FIG. 267,2. **J. heba*; cephalon, northern Siberian Platform, CSGM 659/55, $\times 1.5$ (Palmer & Repina, 1993, fig. 10.8).



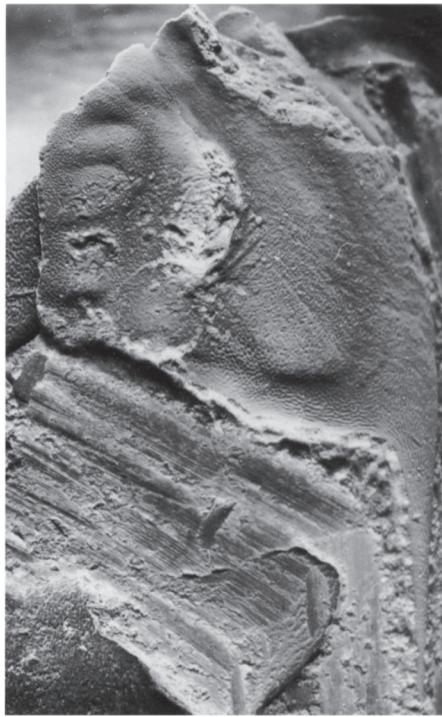
1 Bradyfallotaspis



2 Archaeaspis



3a Geraldinella



3b



4 Fallotaspidella



5 Selindella

FIG. 266. Archaeaspididae (p. 422–423)

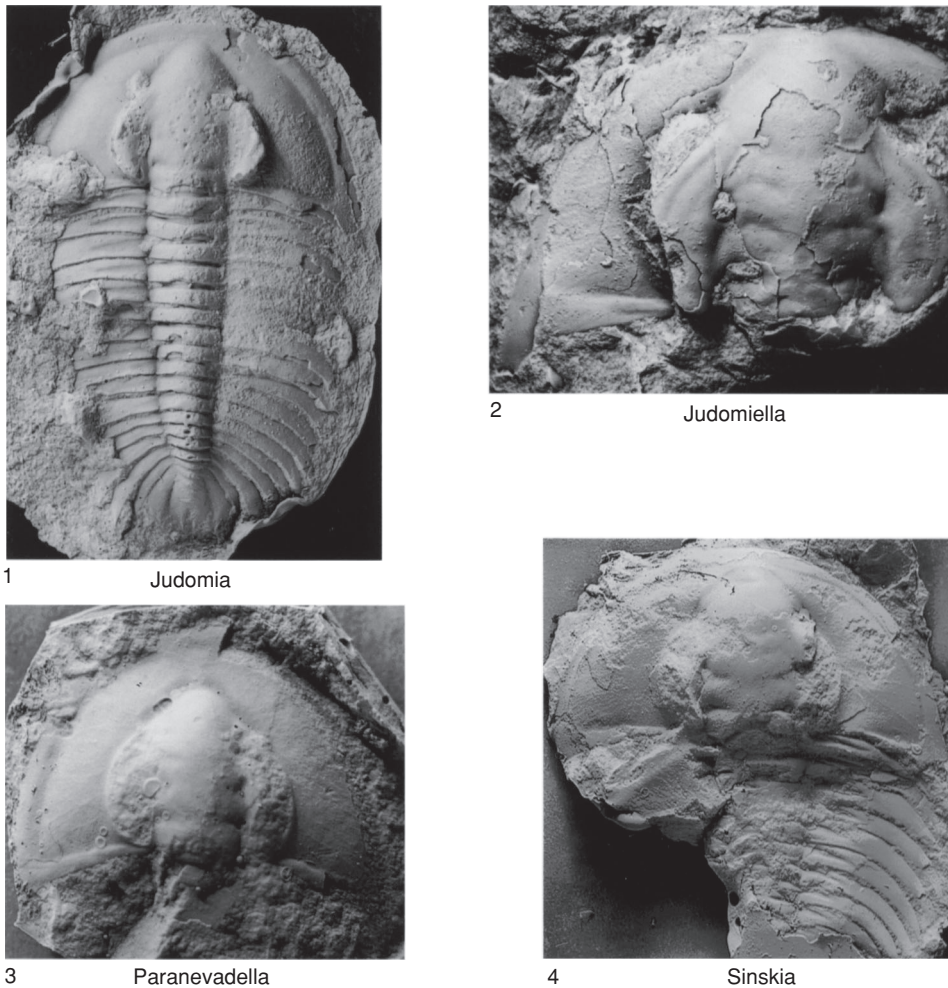


FIG. 267. Judomiidae (p. 423–425)

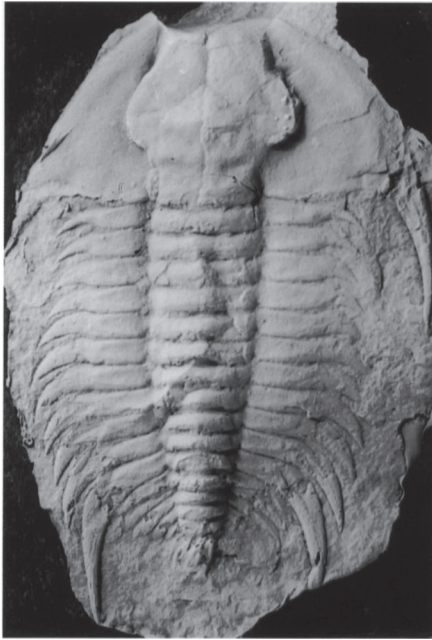
Paranevadella PALMER & REPINA, 1993, p. 30 [**Paedeumias? subgroenlandicus* REPINA in KHOMENTOVSKII & REPINA, 1965, p. 121; OD; holotype (KHOMENTOVSKII & REPINA, 1965, pl. 3, fig. 8), 265/174, CSGM, Novosibirsk]. Glabella weakly tapered forward to nearly parallel sided; preglabellar field present; posterior tip of ocular lobe opposite occipital ring. Interocular area distinctly developed. *Lower Cambrian*: USA (California), Canada (Mackenzie Mountains), “*Nevadella*” Zone; Russia (Siberian Platform), upper *Pagetiellus anabarus* Zone. —FIG. 267,3. **P. subgroenlandicus* (REPINA); cephalon, southern Siberian Platform, holotype, CSGM 265/174, $\times 3$ (Palmer & Repina, 1993, fig. 10.4).

Sinskia SUVOROVA, 1960, p. 18 [**S. optabilis*; OD; holotype (SUVOROVA, 1960, pl. 1, fig. 1), 496/121, PIN, Moscow]. LA slightly expanded in front of

ocular lobe. Border narrow, its length (sag.) less than length (sag.) of occipital ring. Length (sag.) of preglabellar field approximately equal to that of border; posterior tip of ocular lobe opposite posterior part of occipital ring. *Lower Cambrian*: Russia (southern Siberian Platform), *Bergeroniellus micmaccaformis-Erbiella* Zone. —FIG. 267,4. **S. optabilis?*; cephalon and partial thorax, CSGM 452/500, $\times 1.5$ (Palmer & Repina, 1993, fig. 10.5).

Family NELTNERIIDAE Hupé, 1953

[*nom. transl.* PALMER & REPINA, 1993, p. 30, ex Neltneriinae HUPÉ, 1953a, p. 125] [=Holmiinae POULSEN in MOORE, 1959, p. 194, *partim*; SUVOROVA in TCHERNYSHEVA, 1960, p. 62, *partim*; REPINA, 1979, p. 20, *partim*; AHLBERG, BERGSTRÖM, & JOHANSSON, 1986, p. 40, *partim*; Neltneriinae POULSEN in MOORE, 1959, p. 196; BERGSTRÖM, 1973b, p. 309, *partim*; REPINA, 1979, p. 20; AHLBERG, BERGSTRÖM, & JOHANSSON, 1986, p. 40]



1

Neltneria



2

Bondonella

Posterior margin of cephalon deflected slightly forward distally. Glabella parallel sided, bluntly rounded anteriorly. LA elongate. Ocular lobe connected only to posterior part of LA. Ocular lobe close to glabella; interocular area poorly differentiated. Thorax with 17 segments. *Lower Cambrian*.

Neltneria HUPE, 1953a, p. 133 [**Wanneria Jacqueti* Neltner & Poctey, 1949, p. 74; OD; lectotype (Neltner & Poctey, 1949, pl. 6, fig. 5; SD Palmer & Repina, 1993, p. 30), R50864, MNHN, Paris]. Preglabellar field absent; interocular area poorly defined, its width (tr.) less than half that of extraocular area; posterior tip of ocular lobe opposite L1. Thorax has 17 segments; each segment with short (exsag.) pleural spine; width (tr.) of inner pleural region about same as that of axis; 11th segment macropleural; 12th to 17th segments decreasing in width (tr.) rapidly and progressively backward. Pygidium small, subquadrate, possibly of 2 or 3 segments. *Lower Cambrian*: Morocco (Anti-Atlas), *Antatlasia gutta-pluviae* Zone.—FIG. 268, 1. **N. jacqueti*; complete individual, ICS replica 122, ×2 (Palmer & Repina, 1993, fig. 11.1).

Bondonella HUPE, 1953a, p. 135 [**B. typica* Hupe, 1953a, p. 136; OD; holotype (Neltner & Poctey, 1949, pl. 6, fig. 1), R50865, MNHN, Paris]. Length (sag.) of prelabellar field about equal to that of anterior border; interocular area poorly defined, its width (tr.) more than half width of extraocular area; posterior tip of ocular lobe opposite occipital furrow. Thorax with 17 segments; width (tr.) of inner pleural region of each segment narrower than axis; no macropleural segments. *Lower Cambrian*: Morocco (Anti-Atlas), *Antatlasia gutta-pluviae* Zone.—FIG. 268, 2. **B. typica*; complete individual, holotype, MNHN R50865, ×3 (Palmer & Repina, 1993, fig. 11.2).

Family NEVADIIDAE Hupé, 1953

[*nom. transl.* REPINA, 1979, p. 19, ex Nevadiinae Hupé, 1953a, p. 124] [=Nevadiinae Poulsen in Moore, 1959, p. 196; Suvorova in Tchernysheva, 1960, p. 62; Bergström, 1973b, p. 309, *partim*; Nevadiidae Repina, 1979, p. 19, *partim*; Ahlberg, Bergström, & Johansson, 1986, p. 40, *partim*; Palmer & Repina, 1993, p. 31]

Glabella weakly to strongly tapered forward in dorsal view. LA elongate. Ocular lobe connected only to posterior part of LA. Interocular area narrow. Posterior tips of ocular lobes opposite or anterior to occipital furrow. Width of interocular area variable. Thorax with 15 to 27 segments, without development of macropleurae. *Lower Cambrian*.

Nevadia WALCOTT, 1910, p. 256 [**N. weeksi*; OD; lectotype (Walcott, 1910, pl. 23, fig. 2; SD Palmer

FIG. 268. Neltneriidae (p. 426)



1

Nevadella



2

Nevadia



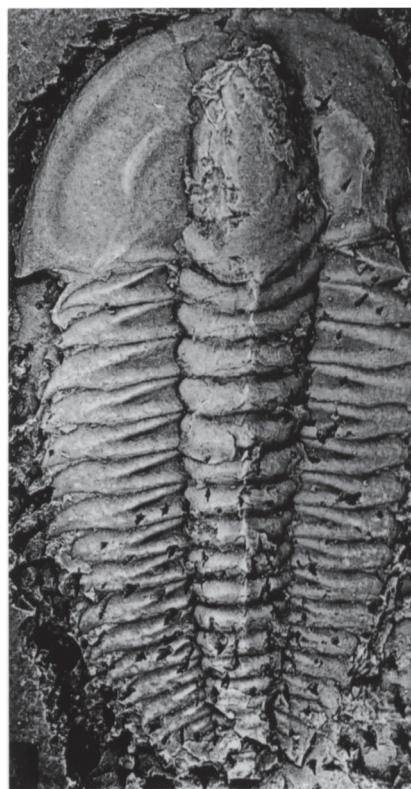
3

Pseudojudomia



5

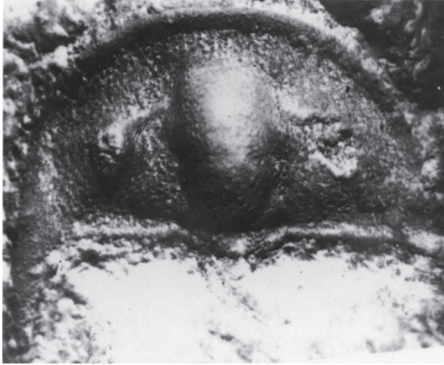
Cirquella



4

Buenellus

FIG. 269. Nevadiidae (p. 426–428)



Poletaevella

FIG. 270. Superfamily Uncertain (p. 428)

& REPINA, 1993, p. 31), 56792b, USNM, Washington, D.C.]. Width (tr.) of interocular area less than one-fourth width of extraocular area; preglabellar field present. Thorax with 27 segments; pleural spines long; width (tr.) of pleurae at least twice width of axis; transition to opisthothorax between segments 15 and 18. Pygidium small, subquadrate. *Lower Cambrian*: USA (California, White-Inyo region; Nevada; northeastern Washington), Canada (northern Rocky Mountains), “*Nevadella*” Zone; Russia (northern Siberian Platform), “*Nevadella*” Zone.—FIG. 269,2. **N. weeksi*, California; complete individual, topotype, LACMIP 7376, $\times 3$ (photograph courtesy of C. A. Nelson).

Buenellus BLAKER, 1988, p. 34 [**B. higginsi* BLAKER, 1988, p. 36; OD; holotype (BLAKER, 1988, fig. 3b), 18.287, MGUH, Copenhagen]. Glabella slightly tapered forward; ocular lobe small, posterior tip about opposite S1 or anterior part of L1; width (tr.) of interocular area equal to or greater than that of extraocular area. Thorax with 17 or 18 segments, maintaining width or widening slightly backward to 8th segment, then tapering posteriorly; posterior segment may be fused with anterior part of simple pygidium; pleural spines short (exsag.); inner pleural regions only slightly wider (tr.) than axis. *Lower Cambrian*: Greenland (Peary Land), “*Nevadella*” Zone; Russia, Novaya Zemlya, ?“*Nevadella*” Zone.—FIG. 269,4. **B. higginsi*, Greenland; complete individual, paratype, MGUH 17.589, $\times 3$ (Blaker, 1988, fig. 5a).

Cirquella FRITZ, 1993, p. 858 [**C. nummularia*; OD; holotype (FRITZ, 1993, fig. 7.2–7.4), 102330, GSC, Ottawa]. Glabella moderately tapered forward; glabellar furrows weakly developed; posterior tip of ocular lobe opposite L1. Genal spine absent or indicated only by slight angularity of margin opposite L1. *Lower Cambrian*: USA (White-Inyo and western Death Valley regions), Canada (southern Rocky Mountains), lower “*Nevadella*” Zone.—FIG. 269,5. **C. nummularia*; cephalon, Canada, paratype, USNM 458891, $\times 7$ (Fritz, 1993, fig. 7.5).

Nevadella RAW, 1936, p. 250 [**Callavia eucharis* WALCOTT, 1913b, p. 315; SD WHITEHOUSE, 1939, p. 191; holotype (WALCOTT, 1913b, pl. 53, fig. 1), 60079, USNM, Washington, D.C.]. Glabella distinctly tapered forward, sides slightly concave, narrowest opposite L2 or S2; preglabellar field short or absent; basal glabellar width (tr.) about equal to width of extraocular area opposite midlength of ocular lobe; posterior tip of ocular lobe opposite L1; width (tr.) of interocular area more than one-fourth width of extraocular area opposite midlength of ocular lobe. Thorax with 17 to 23 segments. Pleural spines long, falcate; opisthothorax not clearly differentiated. Pygidium small, subquadrate. *Lower Cambrian*: USA (California, Nevada), Canada (Cordilleran region), “*Nevadella*” Zone.—FIG. 269,1. **N. eucharis*; complete individual, Canada, holotype, USNM 60079, $\times 2$ (Palmer & Repina, 1993, fig. 13.2).

Pseudojudomia EGOROVA in GORYANSKII, EGOROVA, & SAVITSKII, 1964, p. 22 [**P. egregia*; OD; holotype (GORYANSKII, EGOROVA, & SAVITSKII, 1964, pl. 5, fig. 1a,b), 8363/15, CNIGR, St. Petersburg]. Border furrows weakly developed; cephalon strongly convex (tr.); posterior margin strongly curved backward. Glabella slightly tapered forward; basal glabellar width (tr.) about equal to width of extraocular area. Lateral parts of poorly differentiated border nearly vertical. Ocular lobe poorly differentiated from interocular area; posterior tip about opposite occipital furrow. *Lower Cambrian*: Russia (northern Siberian Platform), *Pseudojudomia* Zone.—FIG. 269,3. **P. egregia*; cephalon, holotype, CNIGR 8363/15, $\times 1.5$ (Egorova & Savitskii, 1969, pl. 10, fig. 1).

Superfamily UNCERTAIN

Poletaevella DALMATOV & REPINA, 1971, p. 125 [**P. baljutica*; OD; holotype (DALMATOV & REPINA, 1971, fig. 2b–d, 3), 0213/11, BGU, Ulan-Ude]. Olenellinid? with posterior margin of cephalon nearly straight. Glabella parallel sided, bluntly rounded anteriorly; occipital ring unusually short (sag.); palpebral lobe short (exsag.), prominent, located about midway between axial and lateral border furrows, and connected to posterior part of LA by narrow eye ridge, with its posterior tip opposite L2; preglabellar field longer (sag.) than anterior border. Genal spine well developed; intergenal spine not indicated. [The structure of the palpebral lobe is unlike the ocular lobe of all olenellinid trilobites. Assignment of this form even to the Olenellina is questionable.] *Lower Cambrian*, Russia (eastern Sayan region), zone unknown.—FIG. 270. **P. baljutica*; cephalon, holotype, $\times 13$ (Dalmatov & Repina, 1971, fig. 2b).

Postfallotaspis ORLOWSKI, 1985, p. 234 [**P. spinatus*; OD; holotype (ORLOWSKI, 1985, pl. 3, fig. 5a–d), 1.496, IGUW, Warsaw]. The type and only specimen of this genus is too incomplete and poorly illustrated for generic or higher level taxonomic

evaluation. *Lower Cambrian*: Poland (Holy Cross Mountains), *Holmia* Zone.

Suborder REDLICHIIINA Richter, 1932

W. T. CHANG, with L. N. REPINA and GERD
GEYER

[*nom. corr.* FORTEY & WHITTINGTON, herein, *pro* Redlichiiida RICHTER,
1932, p. 852]

Opisthoparian facial suture; rostral plate narrower (tr.) than in *Olenellina* (except in xystridurids, Fig. 30.3) and bounded by rostral and connective sutures. Hypostome conterminant in *Redlichia* (Fig. 30), but not in *Dolerolenus* (Fig. 27.3). Thorax fulcrate or nonfulcrate; pygidium small, or large and many-segmented. *Lower Cambrian–Middle Cambrian*.

The diagnosis of this suborder (and of the order) presents problems because it may be paraphyletic and because the systematic section on Redlichiina in this volume is incomplete. Xystriduridae (ÖPIK, 1975b) are not included in the section on Paradoxidoidea. Ellipsocephaloidea will be treated in a subsequent volume; currently authors (GEYER, 1990b; PILLOLA, 1991) include this group in Redlichiina, but FORTEY (1990a, p. 549, 563) considered that at least some ellipsocephaloids should be placed in Ptychoptariina.

Superfamily EMUELLOIDEA Pocock, 1970

[*nom. transl.* CHANG, herein, *ex* Emuellidae POCOCK, 1970, p. 527]

Cranidium subquadrate; glabella cylindrical, slightly contracted at S3, with 3 pairs of glabellar furrows; preglabellar field short (sag.) or absent; eye ridge wide (tr.), long, directed slightly posterolaterally; palpebral lobe crescentic; posterior area of fixigena with fulcrum; posterior border with section abaxial to fulcrum directed anterolaterally. Anterior section of facial suture diverging anteriorly to border furrow, curving sharply inwards, and crossing anterior border diagonally before becoming marginal-ventral; connective suture concave abaxially; rostral

plate narrow (tr.), notched laterally; posterior section of facial suture divergent; hypostomal suture functional. Hypostome with depressed anterior wings; median body with large, subtriangular lobe, subdivided anteriorly by median depression; posterior lobe small. Librigena with long genal spine. Thorax with prothorax of 6 segments and extremely long opisthothorax of 42 to 55 segments; 6th prothoracic segment macropleural and fused to 5th; macropleural spine long, extending to level of pygidium. Pygidium a minute, segmented disc with border entire. *Lower Cambrian*.

Family EMUPELLIDAE Pocock, 1970

[Emuellidae POCOCK, 1970, p. 527]

Characters of the superfamily. *Lower Cambrian*.

Emuella POCOCK, 1970, p. 528 [**E. polymera*; OD; holotype (POCOCK, 1970, pl. 106, fig. 1), F16653, AUGD, Adelaide]. Preglabellar field absent; anterior border furrow becoming shallow abruptly anterior to frontal glabellar lobe; palpebral lobe relatively short, curved; posterior border with section abaxial to fulcrum directed anterolaterally at 45° and slightly depressed; librigena with advanced genal spine. Thorax with 48 to 58 segments; axis more than half thoracic width; pleurae very narrow (tr.); pleural furrow terminating before pleural spine. Strong, closely spaced granules on dorsal surface. *Lower Cambrian*: Australia (Kangaroo Island), *Pararaia janeae* Zone.—FIG. 271,1. **E. polymera*; holotype, complete dorsal exoskeleton, ×9.5 (new).

Balcoracania POCOCK, 1970, p. 533 [**B. daiyi*; OD; holotype (POCOCK, 1970, pl. 108, fig. 1), F16663, AUGD, Adelaide]. Preglabellar field short (sag.), down-sloping, or may be absent; palpebral lobe long, crescentic; posterior border with section abaxial to fulcrum directed anterolaterally at 60° and strongly depressed; librigena with genal spine only slightly advanced. Thorax with 53 to 61 segments; axis less than half thoracic width; pleural furrows terminating at base of pleural spines. Fine, closely spaced granules on dorsal surfaces. The cephalon of *Balcoracania* differs from that of *Emuella* in having a longer palpebral lobe and consequently shorter posterior section of the facial suture; the abaxial section of the posterior border is much more strongly depressed and not directed forward as strongly. The thoracic axis of *Balcoracania* is narrower than in *Emuella*, and the pleural furrows extend to the base of the spines. *Lower Cambrian*: Australia (Flinders Ranges), *Pararaia janeae* Zone.—FIG. 271,2. **B. daiyi*; holotype, external mold of nearly complete exoskeleton, ×6.5 (new).

Superfamily REDLICHIOIDEA Poulsen, 1927

[*nom. transl.* RICHTER, 1932, p. 852 *ex* Redlichidae C. POULSEN, 1927, p. 318]

Characters of the suborder; preglabellar field short to long (sag., exs.), or lacking. *Lower Cambrian–lower Middle Cambrian.*

Family REDLICHIIDAE Poulsen, 1927

[*nom. correct.* RICHTER, 1932, p. 852, *pro* Redlichidae C. POULSEN, 1927, p. 318] [=Latiredlichidae HUPE, 1953a, p. 192, *partim*]

Glabella long, tapering forward, and rounded in front, S1–3 evenly spaced, S3 faint, short, slightly oblique forward or backward, S1 and S2 oblique backward-inward, subparallel to occipital furrow; S4 and S5 present in some genera; preglabellar field short (sag.); anterior border longer, raised; eye lobe arcuate, long, arising from frontal glabellar lobe and extending to level of occipital furrow or farther back; anterior sections of facial sutures slightly to strongly divergent; posterior area of fixigena long or short (exs.); librigena wide, with or without advanced genal spine. Thorax with 14 to 19 segments, pleurae ending in spines, fulcrum distal. Pygidium small, with few segments. Surface of exoskeleton smooth or very finely granulate; facial line may be present on anterior area of fixigena. *Lower Cambrian–lower Middle Cambrian.*

Subfamily REDLICHIIINAE Poulsen, 1927

[*nom. transl.* HARRINGTON in MOORE, 1959, p. 199, *ex* Redlichidae C. POULSEN, 1927, p. 318]

Proximal portion of anterior section of facial suture close to axial furrow, meeting eye lobe at level of midlength of frontal glabellar lobe; posterior extremity of eye lobe close to axial furrow; thorax with 14 to 17 segments; thoracic axial spine on 10th, 11th, 12th, 13th, or 14th axial ring. Pygidium with semiankylosed segment and slightly bilobed terminal piece. *Lower Cambrian–lower Middle Cambrian.*

Redlichia COSSMANN, 1902, p. 52, *nom. nov. pro* *Hoeferia* REDLICH, 1899, p. 3, *non* BITTNER, 1895 [**Hoeferia noetlingi* REDLICH, 1899, p. 3; OD; lectotype (REDLICH, 1899, pl. 1, fig. 1; SD WHITE-

HOUSE, 1939, p. 188), 7/232, GSI, Calcutta] [=*Mesodema* WHITEHOUSE, 1939, p. 187 (type, *M. venulosa*; OD); *Dongsbania* LIN in QIU & others, 1983, p. 48 (type, *D. triangularis*; OD)]. Glabella conical, S1 may be transglabellar; facial line may be present on anterior areas of fixigenae. *Lower Cambrian (upper Canglangpuan to Longwangmiaoan):* China, Korea, Pakistan, Himalayan region, Iran, Spain, southern Siberia, Antarctica. *Middle Cambrian (Ordian):* Australia.

R. (Redlichia). Facial and rostral sutures present; hypostome fused to rostral plate; rostral plate shorter (exs.) than anterior border of the cranidium. Glabella long and tapering forward; glabellar furrows shallow; occipital furrow also shallow, with deeper lateral portions. Eye lobe long, with extremity almost reaching the axial furrow in adults. Librigena wide. Posterolateral limb repeating the structure of the posterior half of the thoracic pleurae and in some also with advanced intergenal spines. Short occipital spine in some species. Hypostome with or without 2 pairs of lateral spines. Thorax gradually decreasing in width (tr.) posteriorly; pleurae with spines advanced on anterior and falcate on posterior segments. Pygidium with 3 segments, dimorphic in each species. One morph with narrow, depressed flanks and arched posterior margin, the other with continuous doubleure and more or less rounded posterior margin. *Occurrence and distribution as for genus.*—FIG. 272.3. **R. (R.) noetlingi* (REDLICH), Lower Cambrian (upper Canglangpuan), Pakistan (Salt Range); lectotype, cranidium, $\times 2$ (King, 1941).

R. (Conoredlichia) W. CHANG, 1966, p. 152 [**Redlichia conica* DU & SHAO, 1963, p. 304; OD; holotype (DU & SHAO, 1963, fig. on p. 304; W. CHANG, 1966, pl. 1, fig. 9), specimen number not traced, YIGS, Kunming]. Similar to *R. (Redlichia)*, but having relatively small, conical glabella; broad (sag.), depressed preglabellar field with prominent mesial ridge; large and triangular anterior area of fixigena; and narrower (tr.) eye lobe. Librigena, thorax, and pygidium unknown. *Lower Cambrian (upper Canglangpuan):* China (eastern Yunnan), *Palaeolenus* Zone.—FIG. 272.2. **R. (C.) conica*, eastern Yunnan (Wuting); holotype, cranidium, $\times 1$ (Du & Shao, 1963).

R. (Latiredlichia) HUPE, 1953a, p. 194 [**Redlichia* sp. cf. *R. walcotti* (MANSUY), SAITO, 1934, p. 225, *non* MANSUY, 1912; =*Redlichia saitoi* LU, 1950, p. 166; lectotype herein designated (SAITO, 1934, pl. 26, fig. 19), 344, UMUT, Tokyo]. Differs from *R. (Pteroredlichia)* in having broad and short conical glabella, short (tr.) anterior sections of facial sutures, and shorter (exs.) librigena. *Lower Cambrian (Longwangmiaoan):* China (Liaoning, Shandong, Hubei), northwestern Korea, *Redlichia chinensis* Zone.—FIG. 272.1a,b. **R. (L.) saitoi* (LU), northwestern Korea (Antakkol, Hwanghai-do); *a*, lectotype, cranidium, $\times 2$; *b*, paratype, librigena, $\times 3$ (Saito, 1934).

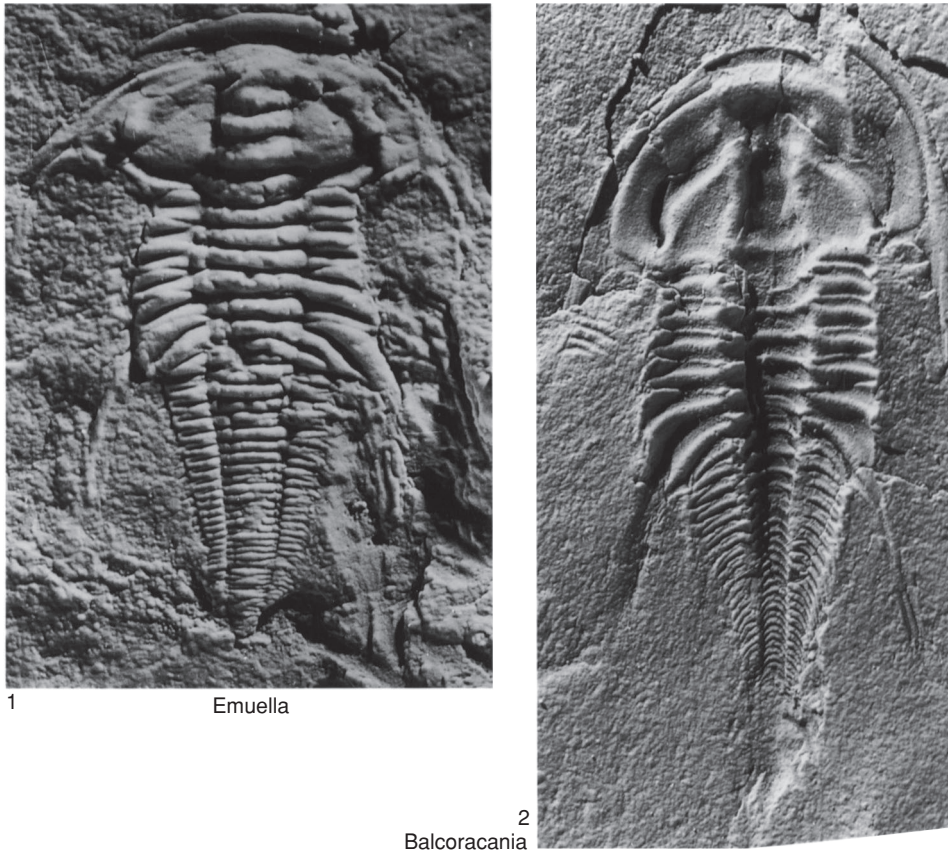


FIG. 271. Emuellidae (p. 429)

R. (Pteroredlichia) W. CHANG, 1966, p. 149 [**R. (P.) lui*; OD; holotype (W. CHANG, 1966, pl. 1, fig. 7), 37606, NIGP, Nanjing] [= *Spinoredlichia* LIU, 1975, p. 14 (type, *S. typicalis*; OD)]. Transverse or almost transverse anterior section of the facial suture extending great distance from glabella (i.e., width of anterior area of fixigenae (tr.) equals at least 1.1 times cranial length). Thorax with 15 to 16 segments; axial spine on the 11th axial ring. Posterior margin of pygidium either entire with continuous doublure or arched upward and forward without doublure. Hypostome of adults without spines. *Lower Cambrian (Longwangmiaoan)*: northern and southwestern China, Korea. *Middle Cambrian (Ordian)*: Australia.—FIG. 273a–c. **R. (P.) lui*, Longwangmiaoan (*Redlichia chinensis* Zone), northern China (western Henan); a, cranidium, $\times 2.5$; b, librigena, $\times 2.5$; c, thorax, $\times 2.5$ (W. Chang, 1966).

Syndianella LU, 1961, p. 302, 313 [**S. yunnanensis*; OD; holotype (LU, 1961, pl. 3, fig. 9), 12678, NIGP, Nanjing]. Similar to *R. (Redlichia)*, but glabellar furrows oblique and horizontal, occipital fur-

row oblique and discontinuous, eye lobe less arcuate, posterior tip of eye lobe distant from the glabella, and preglabellar field longer (sag.). Librigena, thorax, and pygidium unknown. *Lower Cambrian (lower Canglangpuan)*: China (eastern Yunnan), *Drepanuroides* Zone.—FIG. 274. **S. yunnanensis*, eastern Yunnan (Malong); holotype, cranidium, $\times 8$ (Lu, 1961).

Subfamily METAREDLICHIINAE Zhang & Lin, 1980

[Metaredlichiinae ZHANG & LIN in W. ZHANG, LU, & others, 1980, p. 136]

Glabella cylindrical, frontal lobe expanded forward, or broadly conical; up to 5 pairs of glabellar furrows; preglabellar field short (sag.) or absent; intergenal angle present or absent; posterior area of fixigena broad (tr.) and long. Thorax with 15 segments. Pygidium with or without semiankylosed segment; axial lobe convex, transversely broad,

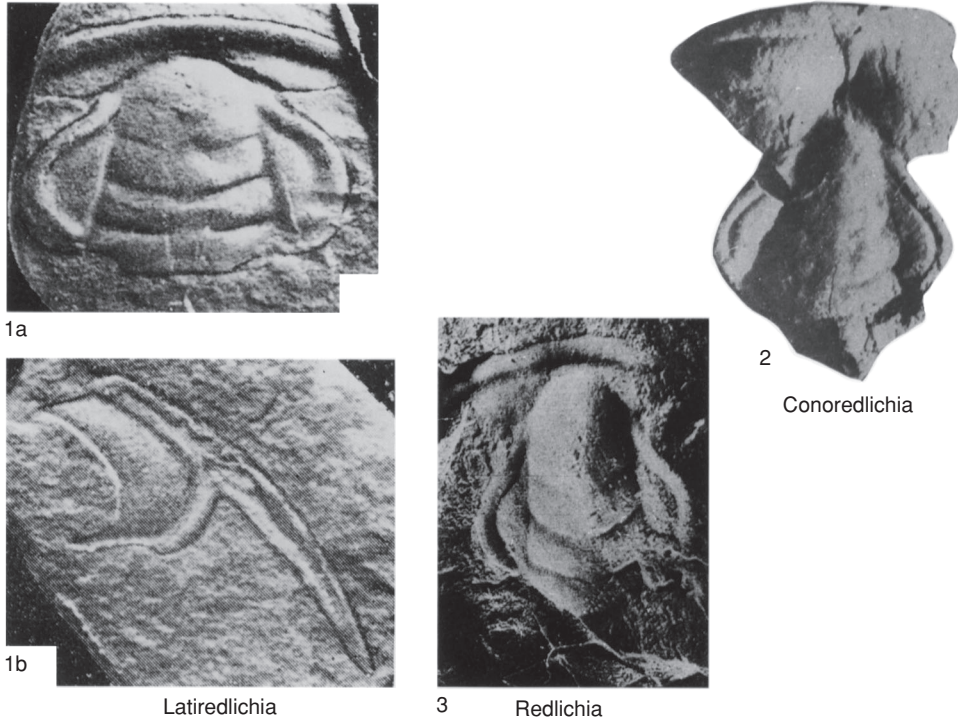


FIG. 272. Redlichiidae (p. 430)

with pair of rounded swellings on terminal portion. *Lower Cambrian*.

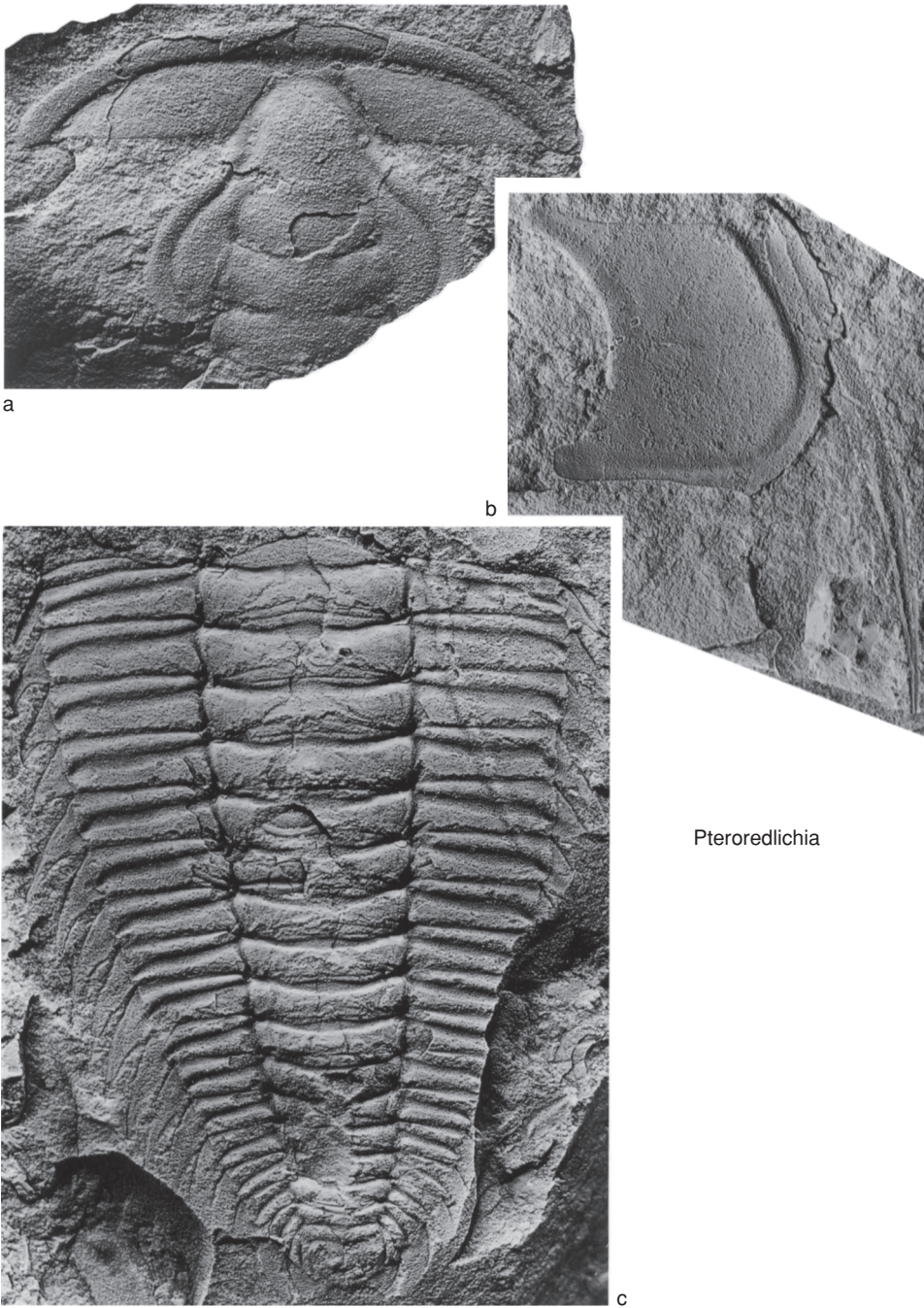
Metaredlichia LU in LU & others, 1965, p. 66 [**Redlichia cylindrica* W. CHANG, 1953, p. 126; OD; holotype (W. CHANG, 1953, pl. 4, fig. 5), 7059a, NIGP, Nanjing]. Glabella broad, with frontal lobe broadly rounded and 4 pairs of glabellar furrows; occipital ring with small node; eye lobe long and arcuate; preglabellar field very short (sag.), border flat; anterior sections of facial sutures short and divergent. Axial lobe of pygidium with anterior ring; pleural region narrow with pair of pleural furrows situated anterolaterally. Librigena and thorax unknown. *Lower Cambrian (Qiongzhusian)*: China (Hubei), *Eoredlichia-Wutingaspis* Zone.—FIG. 275, 1. **M. cylindrica* (CHANG), western Hubei (Yangtze Gorges); holotype, cranium, $\times 5$ (W. Chang, 1953).

Bornemannaspis RASETTI, 1972, p. 52 [**Olenellus solitarius* BORNEMANN, 1888, p. 470(46); OD; holotype (BORNEMANN, 1888, p. 470(46), pl. 39, fig. 9; SD RASETTI, 1972, pl. 13, fig. 5), MLU, Halle]. Glabella very slightly tapering forward, truncate, slightly expanding in frontal lobe, almost reaching anterior border furrow; lateral glabellar furrows connected medially; anterior border fairly wide (sag.) medially; eye ridge short; palpebral lobe about half as long as glabella; anterior sections of

facial sutures directed outward and forward at an angle of about 45° , relatively short. *Lower Cambrian*: Italy (Sardinia), *Dolerolenus longioculatus* Zone to *Dolerolenus bifidus* Zone.—FIG. 276, 2. **B. solitaria* (BORNEMANN), Sardinia (Canalgrande); upper part of *Dolerolenus longioculatus* Zone, holotype, dorsal view of cranium, $\times 2.5$ (new).

Breviredlichia CHANG & LIN in YIN & LI, 1978, p. 403 [**B. granulosa*; OD; holotype (YIN & LI, 1978, pl. 149, fig. 12), 31617, NIGP, Nanjing]. Glabella cylindrical, with frontal lobe large and globular and 2 or 3 pairs of glabellar furrows; occipital furrow narrow (sag.), curved backward; occipital ring bending slightly backward, with small median tubercle; librigena broad; advanced genal spine long and strong. Thorax with 15 or 16 segments, pleurae ending in relatively long spines. Surface granulose. *Lower Cambrian (upper Canglangpuan)*: China (northern Guizhou, eastern Sichuan), *Megapalaeolenus* Zone.—FIG. 276, 1a. **B. granulosa*, northern Guizhou; holotype, cranium, $\times 2$ (W. Zhang, Lu, & others, 1980).—FIG. 276, 1b. *B. gaoqiaoensis*, eastern Sichuan (Pengshui), dorsal exoskeleton, $\times 1.5$ (W. Zhang, Lu, & others, 1980).

Iglesella RASETTI, 1972, p. 54 [**I. ichnusae*; OD; holotype (RASETTI, 1972, pl. 8, fig. 1), 108, SG, Rome]. Glabella nearly parallel sided; occipital furrow and preoccipital furrow (S1) consisting of oblique pairs of deep lateral furrows connected medi-



Pteroredlichia

FIG. 273. Redlichiidae (p. 431)

ally by faint depressions; occipital ring with short spine; S2 and S3 faintly visible; preglabellar field long (sag.) and flat; anterior border short; anterior

sections of facial sutures presumably strongly divergent at anterior ends of eye lobe close to dorsal furrow; eye ridge short, directed backward; eye lobe



Syndianella

FIG. 274. Redlichiiidae (p. 431)

long and narrow; palpebral area of fixigena half as wide as glabella. *Lower Cambrian*: Italy (Sardinia), *Iglesiiella ichnusae* Zone.—FIG. 277,4. **I. ichnusae*; holotype, cranium, $\times 8$ (Rasetti, 1972).

Jingyangia CHANG & ZHANG in LU, CHANG, & others, 1974, p. 88 [**J. zhenbaensis*; OD; holotype (LU, CHANG, & others, 1974, pl. 33, fig. 8), 21476, NIGP, Nanjing]. Cranium subquadrate; glabella expanded forward with 3 pairs of glabellar furrows; occipital furrow discontinuous; occipital ring broad (sag.) medially; cranial border furrow narrow and deep; border narrow and convex; prelabellar field as long (sag.) as border; palpebral area of fixigena broad (tr.); posterior area of fixigena short (exs.) and wide (tr.); anterior sections of facial sutures slightly divergent; librigena with short genal spine. Thorax unknown. Pygidium relatively wide (tr.), subtriangular, with large terminal piece divided into 3 rounded lobes. *Lower Cambrian (Qiongzhusian)*: China (southern Shaanxi), *Eoredlichia-Wutingaspis* Zone.—FIG. 277,2. **J. zhenbaensis*, southern Shaanxi (Zhenba); holotype, cranium, $\times 2$ (W. Zhang, Lu, & others, 1980).

Maopingaspis LIN & YIN in YIN & LI, 1978, p. 409 [**M. guizhouensis*; OD; holotype (YIN & LI, 1978, pl. 148, fig. 7), Gt-079, SMNH, Shanghai]. Similar to *Metaredlichia* and *Ushbaspis*, but having narrower cranium, no prelabellar field, relatively narrow (tr.) palpebral areas and anterior areas of fixigenae, broad (tr.) posterior areas of fixigenae, and broad, flat cranial border. Librigena with broad border and stout, short genal spine. Pygidium elliptical; axial lobe with an anterior axial ring; border flat, broad; posterior margin slightly arched forward. *Lower Cambrian (lower Canglangpuan)*: China (northern Guizhou), *Drepanuroides* Zone.—FIG. 275,4. **M. guizhouensis*, northern Guizhou (Meitan); holotype, cranium, $\times 3$ (Yin & Li, 1978).

?**Nebidella** RASETTI, 1972, p. 51 [**N. limbata*; OD; holotype (RASETTI, 1972, pl. 12, fig. 17), 100, SG, Rome]. Glabella tapering forward, rounded in front; occipital and lateral glabellar furrows shallow, straight, faintly connected medially; prelabellar field long (sag.); border narrow; eye ridge very short; eye lobe long; fixigena with maximum width of palpebral area one-third width of glabella; anterior section of facial sutures directed outward at 45° angle at anterior end of eye lobe close to dorsal furrow. Librigenae wide, flat, with narrow border; facial suture cutting margin at some distance from genal angle, which extends into a short spine. *Lower Cambrian*: Italy (Sardinia), *Dolerolenus longioculatus* Zone.—FIG. 277,6. **N. limbata*; holotype, cranium, $\times 1.5$ (Rasetti, 1972).

Parazhenbaspis ZHU & LIN, 1983, p. 24, 28 [**P. mohershanensis*; OD; holotype (ZHU & LIN, 1983, pl. 1, fig. 8), 69526, NIGP, Nanjing]. Glabella cylindrical, broad and slightly waisted, rounded in front and reaching the border furrow, with 3 or 4 pairs of faint glabellar furrows; eye ridge short; eye lobe long and reaching the posterior border furrow; posterior border narrow and broad (tr.); anterior border convex and arched forward; anterior sections of facial sutures short and divergent, posterior sections long and extending transversely outwards; hypostome ovate, with narrow border and small and triangular anterior wings. Pygidium with wide axial lobe, 1 axial ring; pleural region narrow, with pair of pleural and interpleural furrows. *Lower Cambrian (lower Canglangpuan)*: China (eastern Xinjiang, Uygur Autonomous Region), *Tianshanocephalus* Zone.—FIG. 275,3. **P. mohershanensis*, eastern Xinjiang (Kuluketage), *Tianshanocephalus* Zone; holotype, cranium, $\times 3$ (Zhu & Lin, 1983).

Pseudoredlichia CHANG & LIN in YIN & LI, 1978, p. 404 [**P. hepingensis*; OD; holotype (W. ZHANG, LU, & others, 1980, pl. 28, fig. 9), 37630, NIGP, Nanjing]. Similar to *R. (Redlichia)*, but having 4 or 5 pairs of discontinuous glabellar furrows, occipital furrow, broad librigena, less advanced genal spine, and pair of highly elevated swellings behind pygidial axial ring. Thorax unknown. *Lower Cambrian (lower Canglangpuan)*: China (southern Shaanxi). —FIG. 276,3. **P. hepingensis*, southern Shaanxi (Zhenba); holotype, cranium, $\times 2$ (W. Zhang, Lu, & others, 1980).

Sardoredlichia RASETTI, 1972, p. 48 [**S. praespinosa*; OD; holotype (RASETTI, 1972, pl. 9, fig. 1), 80, SG, Rome]. Glabella moderately tapered; occipital furrow and 3 pairs of lateral glabellar furrows straight and transverse; prelabellar field moderately long, with median prelabellar ridge; border rather narrow; palpebral lobe about half as long as glabella, straight in anterior portion and widening posteriorly; maximum width of palpebral area of fixigena half the glabellar width; anterior sections of facial sutures strongly divergent; librigena with long, advanced genal spine in front of level of glabellar midpoint; hypostome with 2 pairs of lateral and posterior spines and small and triangular anterior wings; rostral plate long (tr.), narrow, and slightly arched

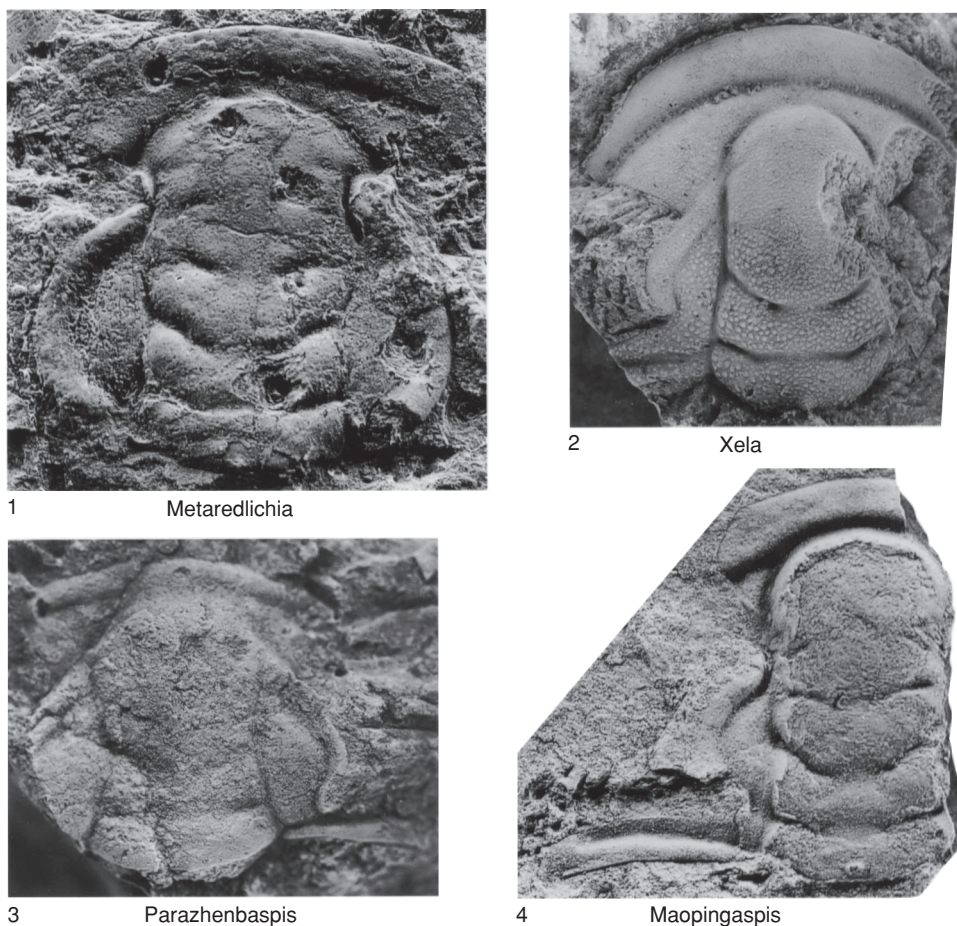


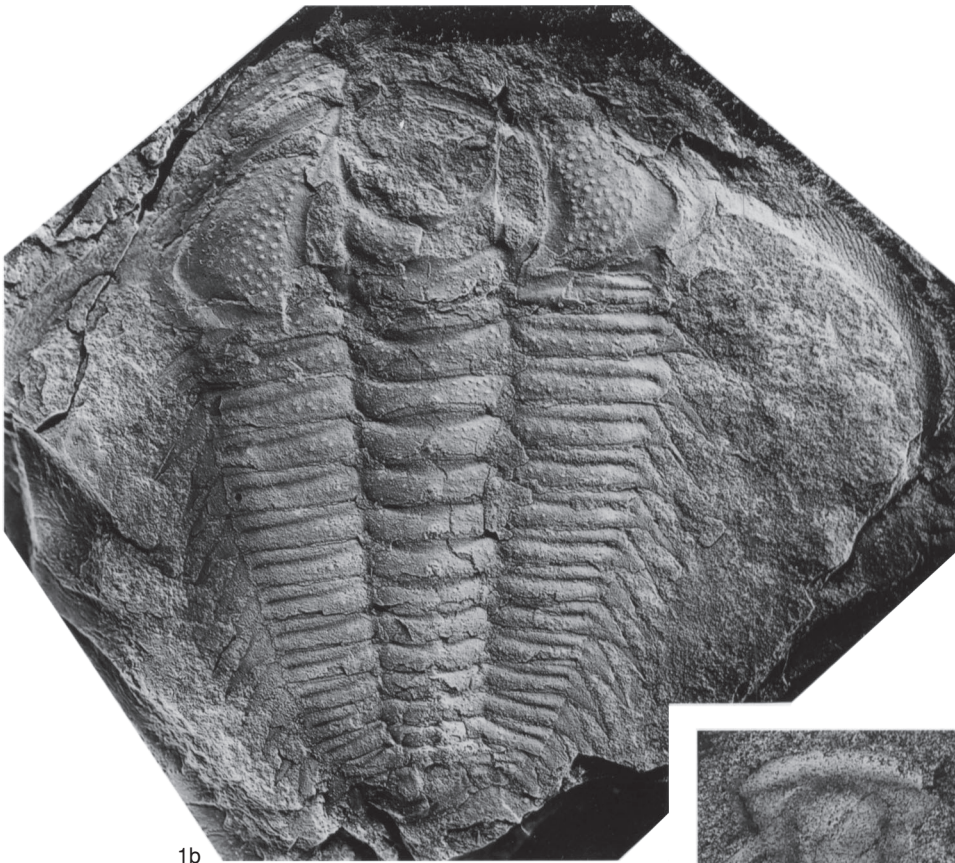
FIG. 275. Redlichiidae (p. 432–437)

forward. Thoracic pleura with long pleural spines. Pygidium with prominent axis and narrow (tr.) pleural region. *Lower Cambrian*: Italy (Sardinia), *Iglesiiella ichnusae* Zone to *Dolerolenus bifidus* Zone.—FIG. 277, 5. **S. praespinosa*; holotype, cranidium, $\times 3$ (Rasetti, 1972).

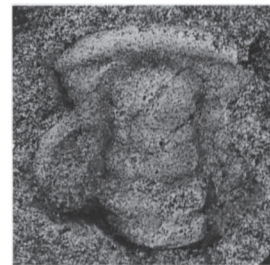
Ushbaspis POKROVSKAYA in KELLER & POKROVSKAYA, 1965, p. 81 [**U. granulata*; OD; holotype (KELLER & POKROVSKAYA, 1965, pl. 3, fig. 2), 3579/2, GIN, Moscow] [= *Metaredlichioides* CHIEN & YAO in LU, CHANG, & others, 1974, p. 90 (type, *M. constrictus*; OD)]. Glabella cylindrical, with frontal lobe expanded forward, and 4 pairs of glabellar furrows; occipital ring with a median node; preglabellar field as long (sag.) as cranial border; posterior border furrow broad (exs.); librigena with stout genal spine. Thorax with 15 segments. Pygidium transversely subelliptical, axis with anterior axial ring and a large terminal piece having a pair of swellings, pleural region narrow (tr.) and with a pair of pleu-

ral furrows. Surface finely granulate or smooth. *Lower Cambrian* (lower Botoman, lower Canglangpuan); Kazakhstan, *Ushbaspis limbata* Zone; China (Hubei, Guizhou, Sichuan, Xinjiang Uygur Autonomous Region), *Drepanuroides* Zone.—FIG. 277, 1a. **U. granulata*; southern Kazakhstan (Ushbas); holotype, cranidium, $\times 2.5$ (Keller & Pokrovskaya, 1965).—FIG. 277, 1b, c. *U. constrictus* (CHIEN & YAO); b, northern Sichuan (Chengkou), cranidium, $\times 3$; c, northern Guizhou (Meitan), exoskeleton, $\times 2$ (W. Zhang, Lu, & others, 1980).

Xela JELL in BENGTON & others, 1990, p. 285 [**X. drenea*; OD; holotype (BENGTON & others, 1990, fig. 187e), 127161, NMVP, Melbourne]. Large, coarsely tuberculate, with anteriorly rounded glabella terminating anteriorly before border furrow; anterior section of facial suture at 45° to sagittal line and isolating larger anterior area of fixigena; fixigena extremely small; palpebral lobe short; eye



1b

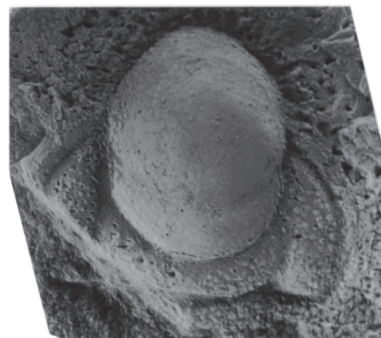


2 Bornemannaspis



3

Pseudoredlichia



1a

Breviredlichia

FIG. 276. Redlichiidae (p. 432–434)

ridge meeting axial furrow behind S3; genal spine not advanced, with broad base, relatively short. Pygidium with 3 short rings and distinctly bilobed terminus; posterior margin excavated; pleural area of 3 segments, each with pleural furrow and the 1st with marginal spine. *Lower Cambrian*: Australia (South Australia, Wirrealpa Mine), *Pararaia janeae* Zone.—FIG. 275,2. **X. drenea*; holotype, cranidium, $\times 2$ (Bengtson & others, 1990).

Zhenbaspis W. CHANG & ZHU in LU, CHANG, & others, 1974, p. 89 [**Z. lata*; OD; holotype (LU, CHANG, & others, 1974, pl. 34, fig. 1), 21478, NIGP, Nanjing] [= *Yankongia* ZHOU in LU, CHANG, & others, 1974, p. 91 (type, *Y. dashapoensis*; OD); *Zhenbaspis (Zhenxiongaspis)* LIN & YIN in YIN & LI, 1978, p. 411 (type, *Z. (Z.) cylindrica*; OD)]. Cranidium subquadrate; glabella large, broadly cylindrical, with frontal lobe well rounded and 3 pairs of glabellar furrows; prelabellar field gently convex, same length (sag.) as the cranial border; anterior sections of facial sutures subparallel or slightly divergent; librigena with short and stout genal spine. Thorax and pygidium unknown. *Lower Cambrian (Qiongzhusian)*: China (southern Shaanxi, Guizhou, northeastern Yunnan), *Eoredlichia-Wutingaspis* Zone.—FIG. 277,3. **Z. lata*, southern Shaanxi (Zhenba); holotype, cranidium, $\times 4$ (Chang in Lu, Chang, & others, 1974).

Subfamily NEOREDILICHIINAE Hupé, 1953

[*nom. transl.* W. CHANG, 1966, p. 152, ex Neoredilichidae HUPÉ, 1953a, p. 149]

Glabella conical; eye lobe long and arcuate; librigena with advanced genal spine; proximal end of anterior section of facial suture and posterior extremity of eye lobe distant from axial furrow. *Lower Cambrian*.

Neoredlichia SAITO, 1936, p. 363 [**Redlichia nakamurai* SAITO, 1934, p. 224; OD; holotype (SAITO, 1934, pl. 26, fig. 15), 312, UMUT, Tokyo]. Frontal glabellar lobe short, with 3 pairs of transglabellar furrows slightly bent backward; occipital furrow deep and connected sagittally; occipital ring of uniform length (sag. and exs.) or slightly longer sagittally; eye lobe reaching level of mid-length of occipital ring, posterior tip of eye lobe distant from glabella, prelabellar field absent or slightly depressed; posterior area of fixigena slender; anterior sections of facial sutures divergent; librigena with slightly advanced genal spine. Thorax and pygidium unknown. *Lower Cambrian (Longwangmiaoan)*: China (Shandong), northwestern Korea, *Redlichia chinensis* Zone.—FIG. 278,3a–c. **N. nakamurai* (SAITO), northwestern Korea (Chungwha); *a*, holotype, cranidium, $\times 3$; *b*, paratype, cranidium, $\times 3$; *c*, paratype, librigena, $\times 2$ (Saito, 1934).

Leptoredlichia W. CHANG, 1966, p. 152, 166 [**L. tumidolimbata*; OD; holotype (W. CHANG, 1966,

pl. 1, fig. 10), 18146, NIGP, Nanjing] [= *Leptoredlichia (Paraleptoredlichia)* QIU in QIU & others, 1983, p. 51 (type, *L. (P.) wushangensis*; OD)]. Three pairs of glabellar furrows; eye lobe reaching posterior border furrow and distant from glabella; anterior sections of facial sutures slightly divergent; cranial border with slightly developed plectrum. *Lower Cambrian (Longwangmiaoan)*: China.

L. (Leptoredlichia). Characters of the genus. *Lower Cambrian (Longwangmiaoan)*: northern China (northern Anhui, northern Jiangsu), *Redlichia chinensis* Zone.—FIG. 278,2. **L. tumidolimbata*, northern Anhui; holotype, cranidium, $\times 5$ (W. Chang, 1966).

L. (Xenoredlichia) ZHANG in QIU & others, 1983, p. 51 [**L. (X.) suiheensis*; OD; holotype (QIU & others, 1983, pl. 17, fig. 5), HIT3009, NIGMR, Nanjing]. Similar to *L. (Leptoredlichia)*, but having short and conical glabella and prominent plectrum. Librigena like *R. (Redlichia)*, with short advanced genal spine. *Lower Cambrian (Longwangmiaoan)*: China (northern Anhui), *Redlichia chinensis* Zone.—FIG. 278,1a,b. **L. (X.) suiheensis*; *a*, holotype, cranidium, $\times 6$; *b*, librigena, $\times 3.5$ (Qiu & others, 1983).

?**Olgaspis** KOROBEINIKOVA, 1966, p. 75 [**O. accepta*; OD; holotype (KOROBEINIKOVA, 1966, pl. 1), 879/1, CSGM, Novosibirsk]. Glabella tapering forward, with 3 pairs of glabellar furrows; occipital furrow deep; occipital ring convex, long (sag.) in the middle; anterior border convex, thickened sagittally; prelabellar field depressed; palpebral lobe narrow (tr.), arcuate, and long (exs.); palpebral furrow deep; eye ridge oblique; fixigena convex; anterior section of facial suture slightly divergent. Surface of cranidium weakly granulose. Pygidium small, with wide axis gradually tapering backward; pleural region subtriangular, flat or slightly concave. *Lower Cambrian (Botoman or lower Toyonian)*: Russia (eastern Sayan Mountains), *Poliellina-Laticephalus* Zone.—FIG. 278,4. **O. accepta*; holotype, cranidium, $\times 6$ (Korobeinikova, 1966).

Subfamily PARAREDILICHIINAE Hupé, 1953

[Pararedilichinae HUPÉ, 1953a, p. 313]

Proximal end of anterior section of facial suture and posterior extremity of eye lobe distant from axial furrow. Thorax of 14 to 15 segments, axial spine on the 9th segment. Pygidium with semiankylosed segment and large terminal piece, reaching posterior pygidial margin. *Lower Cambrian–Middle Cambrian*.

Eoredlichia CHANG in LU & DONG, 1952, p. 186 [**Redlichia intermedia* LU, 1940, p. 333; OD; lectotype (LU, 1940, pl. 1, fig. 10); SD W. CHANG, 1962, p. 42), 7061b, NIGP, Nanjing] [= *Archaeops* HUPÉ, 1953a, p. 194 (type, *A. lui*; OD); = *Redlichia*

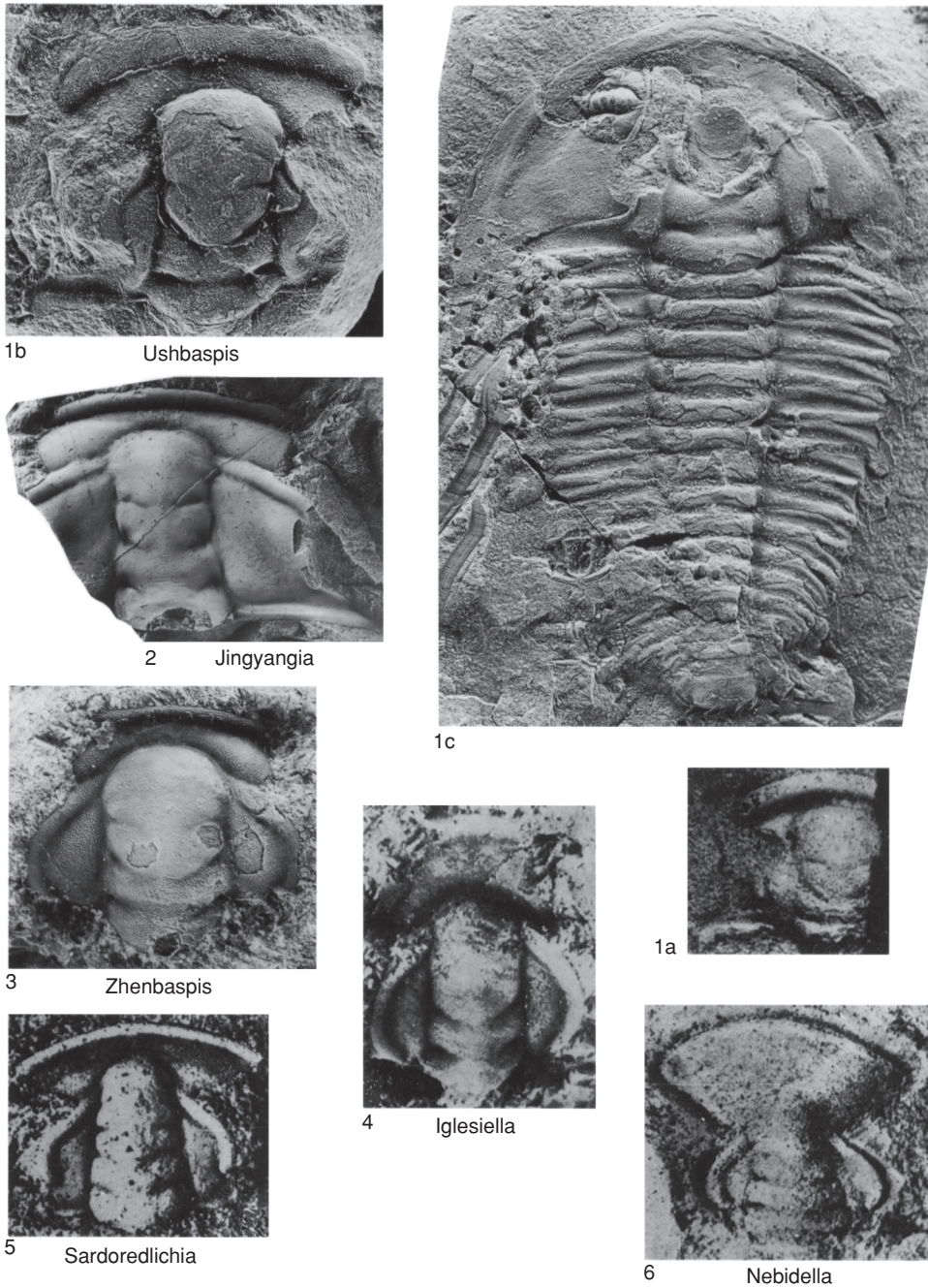


FIG. 277. Redlichiidae (p. 434–437)

walcotti LU, 1941, p. 79, *non* MANSUY, 1912); *Saukiandops* HUPÉ, 1953a, p. 151 (type, *Redlichia walcotti* MANSUY, 1912 p. 26; OD); *Pararedlichia* HUPÉ, 1953a, p. 164 (type, *P. pulchella*; OD);

Galloredlichia JAGO in COURTESOLE & JAGO, 1980, p. 15 (type, *G. noiri*; OD)]. Glabella tapering forward, frontal lobe well rounded; S1 and S2 long, deep, and backward-oblique proximally; S3 shallow,

narrow (tr.), and indistinct; occipital ring longer sagittally and slightly trisegmented longitudinally in well-preserved specimens; prelabellar field same length (sag.) as or slightly shorter or longer than cranial border; anterior sections of facial sutures divergent; facial line near and parallel to the anterior sections of facial suture; slightly advanced genal spine. Hypostome with 2 pairs of small posterolateral marginal spines. Thorax with 15 segments. Pygidium small, transversely ovate, with anteriorly ankylosed segment and large, ovate or subrounded terminal piece having 1 or 2 pairs of pits. *Lower Cambrian*: China (Yunnan, Sichuan, southern Shaanxi), Qiongzhusian (*Eoredlichia-Wutingaspis* Zone); Morocco, northern Spain, southern France, *Fallotaspis tazemmourtensis* Zone.

E. (*Eoredlichia*). Characters of genus. *Lower Cambrian*: Morocco, northern Spain, southern France, Sous-étage Amouslekién (basal part of *Fallotaspis tazemmourtensis* Zone or *Eofallotaspis* Zone of GEYER, 1990a); China (eastern Yunnan, Sichuan, southern Shaanxi), Qiongzhusian (*Eoredlichia-Wutingaspis* Zone).—FIG. 279, 1a, b. **E. (E.) intermedia* (LU), eastern Yunnan (Kunming); *a*, lectotype, cranidium, $\times 3$; *b*, paratype, nearly complete dorsal exoskeleton, $\times 5$ (W. Chang, 1962).

E. (*Pachyredlichia*) W. CHANG, 1966, p. 153 [**E. (P.) shensiensis*; OD; holotype (W. CHANG, 1966, pl. 1, fig. 5), 18143, NIGP, Nanjing]. Cranidium subquadrate. Glabella cylindrical or cylindro-conical, broadly rounded in front; occipital ring convex, with or without a short spine; prelabellar field very short (sag.) or absent; eye lobe medium-sized, slightly shorter (exs.) than that of *E. (Eoredlichia)*; border convex; anterior sections of facial sutures slightly divergent; surface with fine granules. *Lower Cambrian (Qiongzhusian)*: China (northern Sichuan, southern Shaanxi), *Eoredlichia-Wutingaspis* Zone.—FIG. 279, 2. **E. (P.) shensiensis*, southern Shaanxi (Nanzheng); holotype, cranidium, $\times 3$ (W. Chang, 1966).

?**Irgitkhemia** TCHERNYSHEVA, 1977, p. 61 [**I. insolita*; OD; holotype (TCHERNYSHEVA, 1977, pl. 14, fig. 9), 10802/9, CNIGR, St. Petersburg]. Cranidium flattened, subquadrate, with gently curved to almost straight anterior border. Glabella elongate, narrowing towards anterior end, with slight keel; glabellar furrows clear cut, short, numbering 4 pairs; occipital ring wide; fixigena flat; palpebral lobe medium-sized, raised above fixigena, transitional into stout eye ridge; prelabellar field flat, lower than front of glabella, with radial sculpture; anterior border weakly convex. Librigena, thorax, and pygidium unknown. *Lower Cambrian (Toyonian)*—*Middle Cambrian (Amgaian)*, Russia (eastern Sayan Mountains, Tuva, Batenevskii Ridge).—FIG. 280, 2. **I. insolita*, eastern Sayan; holotype, cranidium, $\times 4$ (Tchernysheva, 1977).

Lemdadella SDZUY, 1978, p. 92 [**L. spectabilis*; OD; holotype (SDZUY, 1978, pl. 1, fig. 10), 28571, SMF, Frankfurt am Main]. Glabella tapering forward, with parafrontal band; eye lobe long and arcuate,

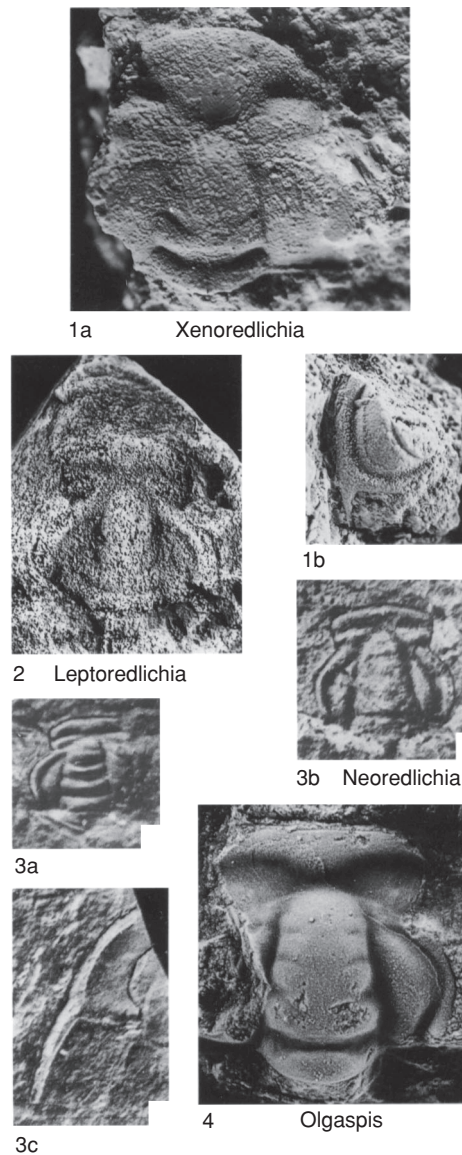


FIG. 278. Redlichidae (p. 437)

with ocular striga; prelabellar field long (sag.) to moderately long, with plectrum; anterior area of fixigena with facial line. *Lower Cambrian*: Spain; Morocco, *Fallotaspis tazemmourtensis* Zone.—FIG. 279, 3a, b. **L. spectabilis*, Morocco (Lemdad syncline, Ouncin area in the High Atlas); *a*, composite picture of holotype and silicon cast of counterpart, dorsal view of cranidium, $\times 5$; *b*, dorsal view of pygidium, $\times 4$ (photographs courtesy of G. Geyer).

Ningqiangaspis ZHANG & LIN in W. ZHANG, LU, & others, 1980, p. 158, 429 [**N. ningqiangensis*; OD;

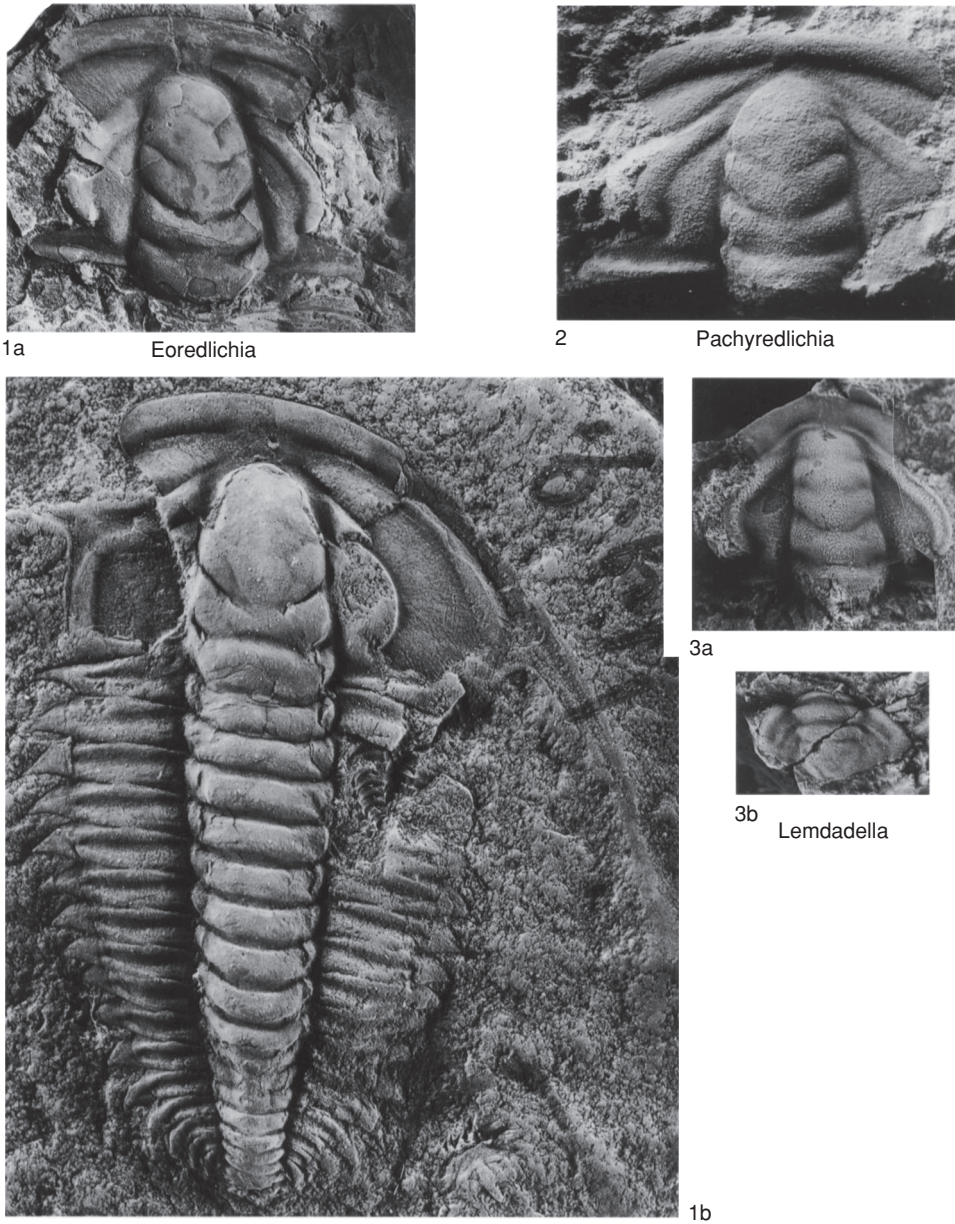


FIG. 279. Redlichiidae (p. 439)

holotype (ZHANG & LIN in W. ZHANG, LU, & others, 1980, pl. 39, fig. 6), 37743, NIGP, Nanjing]. Differing from *Eoredlichia* in having longer eye lobe, less divergent anterior section of facial suture, shorter (sag.) cranial border, and no preglabellar field. Librigena, thorax, and pygidium unknown. *Lower Cambrian (Qiongzhusian)*: China (southern Shaanxi), *Eoredlichia-Wutingaspis* Zone.—FIG.

280,3. **N. ningqiangensis*; holotype, cranium, $\times 6$ (W. Zhang, Lu, & others, 1980).

?*Redlichops* RICHTER & RICHTER, 1941b, p. 13 [**Redlichia (Redlichops) blanckenhorni*; OD; holotype (RICHTER & RICHTER, 1941b, pl. 2, fig. 1), X1287a, SMF, Frankfurt am Main]. Glabella tapering forward; frontal lobe narrow; S3 furrows slightly directed forward; occipital furrow disconnected

medially; occipital node small; anterior section of facial suture relatively short; eye lobe long and arcuate, widening anteriorly and extending back to level of midlength of occipital ring; palpebral area of fixigenae very wide; surface finely granulose. *Lower Cambrian*: Jordan.—FIG. 280, 1. **R. (R.) blanckenhorni*, Jordan (Chirbet el-Burj); holotype, dorsal view of cranial fragment, $\times 3$ (photograph courtesy of G. Geyer).

Subfamily WUTINGASPINAE Chang, 1966

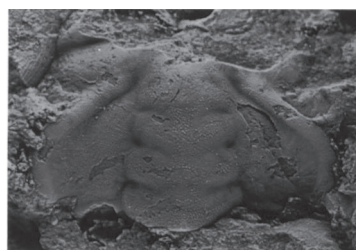
[Wutingaspinae W. CHANG, 1966, p. 153]

Glabella broadly conical; preglabellar field short (sag.) or absent; eye ridge slightly oblique, long; eye lobe short or of medium length; palpebral area of fixigena broad (tr.); posterior area of fixigena broad (tr.) and relatively long (exs.). Thorax with 15 to 19 segments, thoracic axial spines absent. Pygidium small. *Lower Cambrian*.

Wutingaspis KOBAYASHI, 1944c, p. 130 [**W. tingi*; OD; holotype (KOBAYASHI, 1944c, pl. 10, fig. 7), Y338, UMUT, Tokyo]. Similar to *Eoredlichia*, but having relatively short eye lobe, broad cylindroconical glabella, longer (exs.) and broader posterior area of fixigena, slightly arcuate and more divergent facial lines, and no thoracic axial spine. *Lower Cambrian (Qiongzhusian)*: China (eastern Yunnan, Sichuan, Guizhou, southern Shaanxi), *Eoredlichia-Wutingaspis* Zone.—FIG. 281, 2. **W. tingi*, eastern Yunnan (Wuting); holotype, cranidium, $\times 2$ (Kobayashi, 1944c).

Chaoaspis W. CHANG, 1966, p. 154, 167 [**C. ovatus*; OD; holotype (W. CHANG, 1966, pl. 1, fig. 13), 18149, NIGP, Nanjing]. Similar to *Wutingaspis*, but having short (sag.) and ovate glabella, relatively small eye lobe, broad (sag.) preglabellar field, broad but relatively short (exs.) posterior area of fixigena, and more divergent anterior sections of facial sutures. Librigena, thorax, and pygidium unknown. *Lower Cambrian (Qiongzhusian)*: China (western Sichuan), *Eoredlichia-Wutingaspis* Zone.—FIG. 282, 1. **C. ovatus*, western Sichuan (Emei); holotype, cranidium, $\times 4$ (W. Chang, 1966).

Chengjiangaspis ZHANG & LIN in W. ZHANG, LU, & others, 1980, p. 169 [**C. chengjiangensis*; OD; holotype (ZHANG & LIN in W. ZHANG, LU, & others, 1980, pl. 44, fig. 10), 37792, NIGP, Nanjing]. Similar to *Wutingaspis*, but having more conical glabella, long (sag.) and depressed preglabellar field, very shallow anterior border furrow, less divergent anterior sections of facial sutures, deep and broad (sag., exs.) occipital furrow, no occipital node, and narrow librigena. Complete thorax and pygidium unknown. *Lower Cambrian (Qiongzhusian)*: China (eastern Yunnan), *Eoredlichia-Wutingaspis* Zone.—FIG. 281, 3. **C. chengjiangensis*; eastern Yun-



1 Redlichops



2 Irgitkhemia



3 Ningqiangaspis

FIG. 280. Redlichiidae (p. 439–441)

nan, (Chengjiang); holotype, cranidium, $\times 6$ (W. Zhang, Lu, & others, 1980).

Kepingaspis T. CHANG, 1965, p. 154, 156 [**K. kepingensis*; OD; holotype (T. CHANG, 1965, pl. 1, fig. 1), K-01, XIGMR, Urumqi]. Cranidium subtrapezoidal; glabella tapering forward, with well-rounded frontal lobe and oblique glabellar furrows; eye lobe long and arcuate; posterior area of fixigena subtriangular; preglabellar field absent; cranial border flat; librigena broad (tr.), with advanced genal spine small and short; anterior sections of facial sutures slightly divergent. Thorax with 19 segments; pleural spines short. Pygidium small, with axial ring and terminal piece divided into 2 small swellings. *Lower Cambrian (Canglangpuan)*: China (western Xinjiang), *Kepingaspis-Tianshanocephalus* Zone.—FIG. 281, 4. **K. kepingensis*, western

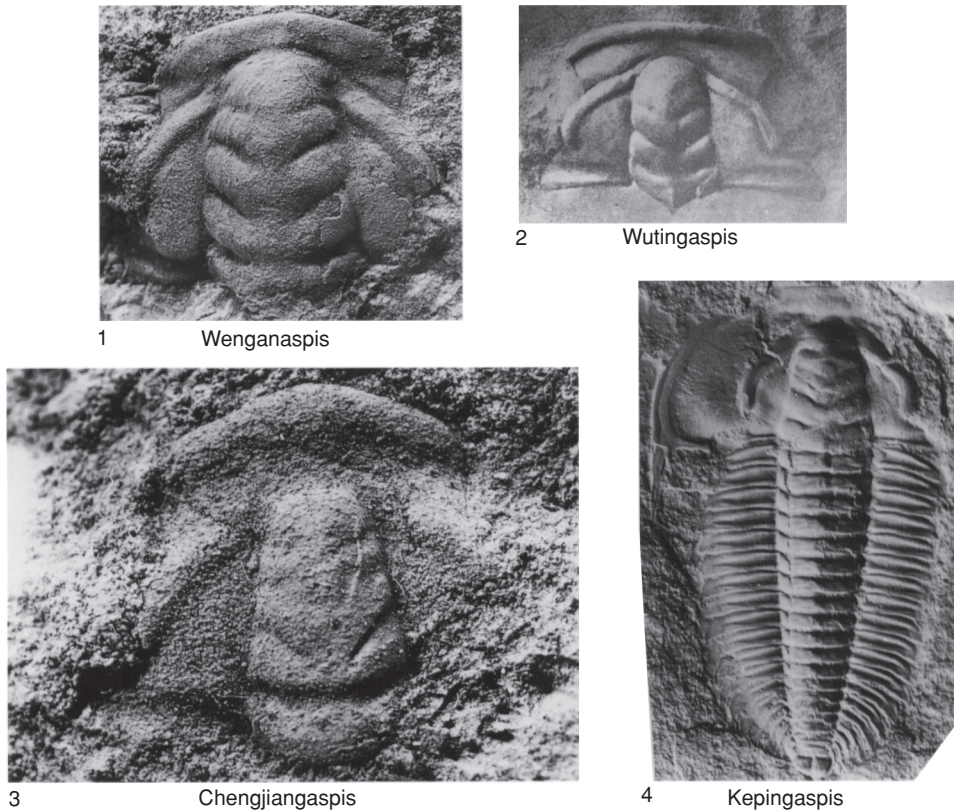


FIG. 281. Redlichiidae (p. 441–444)

Xinjiang (Keping); incomplete dorsal exoskeleton, $\times 3$ (Chang, 1965).

Kuanyangia HUPÉ, 1953a, p. 195 [**Redlichia pustulosa* LU, 1941, p. 78; OD; holotype (LU, 1941, pl. 1, fig. 5), No. 2007, specimen lost during World War II]. Cranidium subquadrate; glabella broad, conical; 3 pairs of oblique glabellar furrows continuous or discontinuous; occipital furrow shallow, with deeper lateral portions; preglabellar field absent or very short (sag.); anterior border convex and slightly arcuate forward; eye ridge stout; eye lobe medium-sized; thorax with 16 segments; surface pustulose. *Lower Cambrian (Qiongzhusian)*: China (eastern Yunnan), *Eoredlichia-Wutingaspis* Zone.

K. (**Kuanyangia**). Characters of the genus. *Lower Cambrian (Qiongzhusian)*: China (eastern Yunnan), *Eoredlichia-Wutingaspis* Zone.—FIG. 282,3. **K. (K.) pustulosa* (LU), eastern Yunnan (Kunming); topotype, cranidium, $\times 3$ (W. Zhang, Lu, & others, 1980).

K. (**Sapushania**) W. CHANG, 1966, p. 155, 167 [**Sapushania granulosa*; OD; holotype (W. CHANG, 1966, pl. 1, fig. 14), 18150, NIGP, Nanjing]. Similar to *K. (Kuanyangia)*, but having smaller eye lobe and longer (exs.) triangular

posterior area of fixigena. Pygidial axial lobe composed of 2 axial rings and large terminal piece and reaching posterior margin; prominent, longitudinal, depressed area on terminal piece. Surface pustulose. *Lower Cambrian (Qiongzhusian)*: China (eastern Yunnan: Wuting, Kunming), *Eoredlichia-Wutingaspis* Zone.—FIG. 282,2. **K. (S.) granulosa* (CHANG), eastern Yunnan (Wuting); holotype, incomplete cranidium, $\times 1.5$ (W. Chang, 1966).

Sardaspis BRASIER, 1976, p. 273 [**S. papillosa*; OD; holotype (BRASIER, 1976, pl. 25, fig. 1), AZ.51a,b, OUM, Oxford; =*Ptychoparia laticeps* BORNEMANN, 1891, p. 23; holotype (BORNEMANN, 1891, p. 47(147), pl. 39, fig. 12; RASETTI, 1972, pl. 13, fig. 11), MLU, Halle]. Glabella conical, S1 continuous; occipital furrow arcuate backward; occipital ring broad (sag.) medially, with or without occipital spine; preglabellar field absent or very short (sag.); border furrow deep; border convex; eye ridge oblique, eye lobe medium-sized; surface pustulose. Librigena, thorax, and pygidium unknown. *Lower Cambrian*: Italy (Sardinia), *Dolerolenus longioculatus* Zone; China (Guizhou, southern Shaanxi), lower Canglangpuan, ?*Yiliangella* or *Yunnanaspis* Zone.

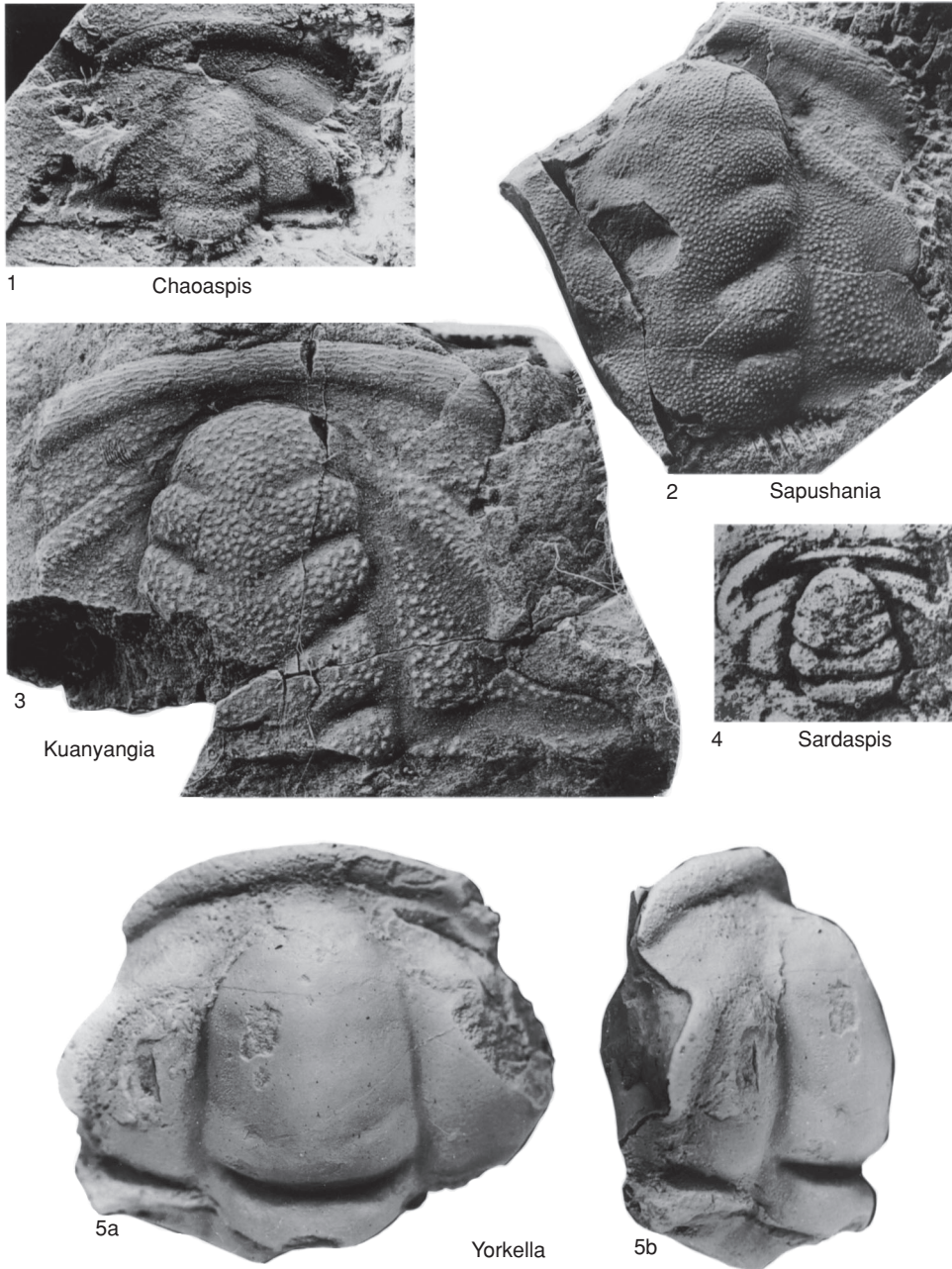


FIG. 282. Redlichiidae (p. 441–444)

—FIG. 282.4. **S. laticeps* (BORNEMANN), Sardinia, *Dolerolenus longioculatus* Zone; holotype, cranium, $\times 2$ (Rasetti, 1972).
 ?*Wenganaspis* YIN in YIN & LI, 1978, p. 415 [**W. baiyanensis*; OD; holotype (YIN in YIN & LI, 1978,

pl. 150, fig. 11), Gt-105, SMNH, Shanghai]. Similar to *Kepingaspis*, but having longer (sag.) cranial border, 4 pairs of glabellar furrows, broader (tr.) palpebral area of fixigena, less divergent anterior sections of facial sutures, and outward- and

forward-bent posterior area of fixigena. Librigena, thorax, and pygidium unknown. *Lower Cambrian (Canglangpuan)*: China (Guizhou).—FIG. 281, *J.* **W. baiyanensis*, northern Guizhou (Wengan); holotype, cranidium, $\times 3$ (Yin & Li, 1978).

?*Yorkella* KOBAYASHI, 1942c, p. 492 [**Conocephalites australis* WOODWARD, 1884, p. 372; OD; holotype (WOODWARD, 1884, pl. 11, fig. 2), I.2349, BMNH, London]. Similar to *Wutingaspis* but having large, strongly convex glabella two-thirds to four-fifths as wide as long, with lateral margins either parallel or gently converging in anterior part; broadly rounded glabella anterior in anterior border furrow; glabellar furrows incomplete across axis; and ornament of coarse, pointed tubercles. Pygidium occupied mainly by axis extending to posterior margin without doublure; small pleurae of 1 segment having expanded anterior pleural band and pair of marginal spines elevated above margin of axis. *Lower Cambrian*: South Australia (Horse Gully), *Pararaia vatei* Zone.—FIG. 282, *5a, b.* **Y. australis* (WOODWARD); holotype, *a*, dorsal and *b*, lateral views of cranidium, $\times 3.6$ (new).

Family DOLEROLENIDAE Kobayashi, 1951

[*nom. subst.* KOBAYASHI in KOBAYASHI & KATO, 1951, p. 103, *pro* Olenopsidae KOBAYASHI, 1955, p. 120, invalid name based on junior homonym]

Glabella long, tapering forward, with 3 pairs of faint, evenly spaced, lateral glabellar furrows; occipital furrow straight; anterior border long (sag. and exs.), flat; anterior sections of facial sutures on genal field moderately divergent (less than 45°), on border curved outwards; palpebral lobe arcuate; eye ridge wide, faint; posterior areas of fixigena subtriangular; librigena wide, with stout genal spine. Thorax with 11 to 15 segments. Pygidium small, with 1 to 2 pairs of pygidial spines. *Lower Cambrian*.

Subfamily DOLEROLENINAE Kobayashi, 1951

[*nom. transl.* ZHANG & LIN in W. ZHANG, LU, & others, 1980, p. 80, *ex* Dolerolenidae KOBAYASHI in KOBAYASHI & KATO, 1951, p. 103]

Palpebral lobe long, posterior; fixigena wide. Thorax with 14 to 15 segments; axis narrower than pleural regions; pleural spines progressively curved backward; fulcrum proximal. Pygidium small; axis short with 1 or 2 rings; posterior border with pair of small or large spines. *Lower Cambrian*.

Dolerolenus LEANZA, 1949, p. 36, *nom. subst. pro* *Olenopsis* BORNEMANN, 1891, p. 459, *non*

AMEGHINO, 1889 [**Olenus zoppii* MENEGHINI, 1882, p. 163; SD WALCOTT, 1912d, p. 240; lectotype (MENEGHINI, 1882, pl. 1, fig. 5, 5a; SD NICOSIA & RASETTI, 1970, p. 8, 17), 1, SG, Rome]. Characters of subfamily. *lower Lower Cambrian*: southwestern China, Spain, Italy (Sardinia).

D. (*Dolerolenus*). Glabella rounded in front; preglabellar field as long (sag.) as border; plectrum faintly defined; posterior extremities of facial sutures distant from axial furrows; palpebral lobe extending between level of midlength of L3 and midlength of L1, with curvature increasing rearward. Thorax with 15 segments; pleural spines long, the posterior ones enveloping pygidium. Pygidium subrectangular; axis not tapered, composed of 1 ring and a terminal axial piece; with a median notch; pleural lobes rather long (sag.), with 1 furrow, truncate or extended into a pair of short spines; border indistinct. *Lower Cambrian*: Italy (Sardinia), *Dolerolenus* Zone.—FIG. 283, *1a–c.* **D. zoppii* (MENEGHINI); *a*, lectotype, distorted dorsal shield, $\times 2.2$ (Rasetti, 1972); *b*, topotype, dorsal shield, $\times 2$ (Pillola, 1991); *c*, topotype, well-preserved cranidium showing facial line, $\times 1.75$ (Pillola, 1991).

D. (*Malungia*) LU, 1961, p. 307 [**Malungia laevigata*; OD; holotype (LU, 1961, pl. 3, fig. 1), 12670, NIGP, Nanjing]. Differs from *D. (*Dolerolenus*)* in having 14 thoracic segments and scissors-shaped pygidium. Hypostome as in *D. (*Dolerolenus*)* with median body ovate, maculae deeply depressed, posterior lobe short (sag.), border narrow, posterior margin straight or bending backward, anterior margin forward arcuate, and anterior wing triangular. *Lower Cambrian (upper Qiongzhusian to lower Canglangpuan)*: China (eastern Yunnan, northern Sichuan), *Eoredlichia-Wutingaspis* Zone to *Malungia* Zone.—FIG. 283, *2a, b.* **D. (M.) laevigata* (LU), eastern Yunnan (Yiliang); *a*, holotype, incomplete dorsal exoskeleton, $\times 2.65$; *b*, paratype, cranidium, $\times 1.75$ (LU, 1961).

?Subfamily PARAMALUNGIINAE Zhang & Lin, 1980

[Paramalungiinae ZHANG & LIN in W. ZHANG, LU, & others, 1980, p. 184]

Glabellar furrows effaced; eye lobe small; border furrow faint, only slightly depressed. Thorax of 11 segments. Pygidium with 2 pairs of small marginal spines. *Lower Cambrian*.

Paramalungia W. CHANG, 1966, p. 155 [**P. lubrica*; OD; holotype (W. CHANG, 1966, pl. 2, fig. 5), 18155, NIGP, Nanjing]. Cranidium similar to *Dolerolenus (Malungia)*, but having relatively large, smooth glabella, smooth cranidium, occipital ring with small occipital tubercle, relatively short and

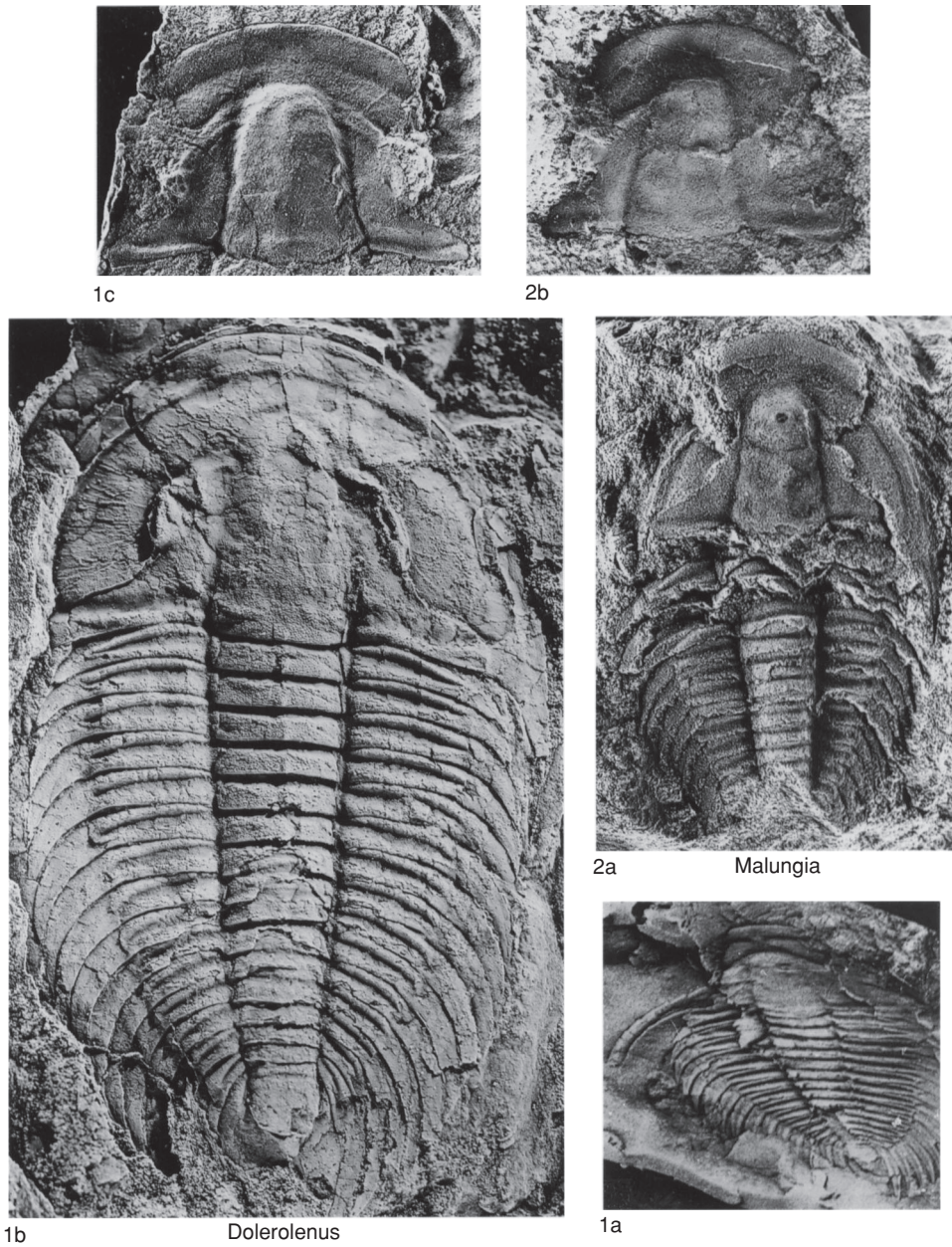
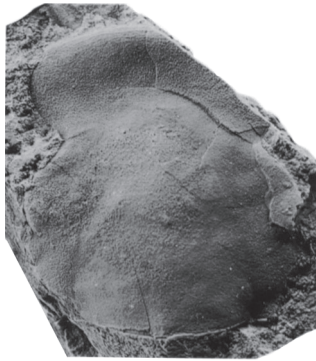


FIG. 283. Dolerolenidae (p. 444)

faint eye ridges, and relatively longer eye lobes. Thorax with 11 segments. Pygidium trapezoidal, with pair of anterior pleural segments extending into a pair of short, anterior, lateral pygidial spines and with a pair of short, slender, and posterior py-

gidial spines. *Lower Cambrian (lower Canglangpuan):* China (eastern Yunnan), *Drepanuroides* Zone.—FIG. 284. **P. lubrica*, eastern Yunnan (Yiliang); holotype, cranidium, $\times 2$ (W. Chang, 1966).



Paramalungia

FIG. 284. Dolerolenidae (p. 445)

Family YINITIDAE Hupé, 1953

[Yinitidae HUPE, 1953a, p. 160]

Glabella broadly conical; preglabellar field short (sag.) or absent. Thorax with 9 to 13 segments. Pygidium large and spinose (except in *Parapaokannia*), usually with 3 to 6 pairs of spines. *Lower Cambrian*.

Yinites LU, 1946, p. 188 [**Y. typicalis*; OD; lectotype (LU, 1946, pl. 1, fig. 1a; W. ZHANG, LU, & others, 1980, p. 206, pl. 60, fig. 1), AB126, NIGP, Nanjing]. Glabella long and rounded in front; pre-occipital and occipital furrows gently curved backward; occipital ring of uniform width; proximal end of anterior section of facial suture near axial furrow; posterior area of fixigena triangular; librigena with long and slightly advanced genal spine. Thorax with 13 segments. Pygidium with 3 or 4 axial rings, large terminal axial piece, 3 pleurae, 2 pairs of short, lateral pygidial spines, and a pair of long, backwardly directed posterior spines. Hypostome subtrapezoidal; median body large and ovate; posterior lobe narrow (sag.); posterior border very narrow and distinct; anterior wings triangular. *Lower Cambrian (lower Canglangpuan)*: China (northern Guizhou, southeastern Yunnan, northern Sichuan, southern Shaanxi), *Yiliangella* Zone to *Drepanuroides* Zone. —FIG. 285, 1a, b. **Y. typicalis*, northern Guizhou (Gaotai in Meitan); a, holotype, cranidium, $\times 4$; b, paratype, pygidium, $\times 10$ (W. Zhang, Lu, & others, 1980).

Drepanopyge LU, 1961, p. 303, 314 [**D. mirabilis*; OD; holotype (LU, 1961, pl. 2, fig. 2), 12659, NIGP, Nanjing]. Cranidium subrectangular; glabella broad, slightly tapering forward, and rounded in front; S1–S3 are transglabellar furrows, S3 weak; occipital furrow deeper than glabellar furrows; occipital ring uniform in length (sag. and exs.), with a small median node; preglabellar field very short (sag.); border of cranidium convex; border furrow narrow, marked by a row of small pits; eye lobe

medium-sized; eye ridge distinct; fixigena wide (tr.), nearly half glabellar width; posterior area of fixigena subtriangular; posterolateral furrow broad (exs.) and shallow; librigena with slightly advanced genal spine. Thorax with 10 segments. Pygidial axis convex, with 5 or 6 rings and a large terminal piece; pleural region with 5 pleurae, each ending in a short and stout spine; posterior pair of pygidial pleurae fused behind the terminal piece; posterior margin entire and bent backward. Hypostome broadly ovate; medium body large and elongately ovate, with transverse striations; posterior lobe narrow (sag.); posterior border narrow and distinct; anterior wings triangular. Rostral plate very wide (tr.). *Lower Cambrian (lower Canglangpuan)*: China (eastern Yunnan: Malong, Yiliang), *Drepanuroides* Zone. —FIG. 285, 4a, b. **D. mirabilis*; eastern Yunnan (Yiliang); a, holotype, cranidium, $\times 2$; b, paratype, librigena, $\times 2$ (Lu, 1961).

Drepanuroides W. CHANG, 1966, p. 157 [**D. latilimbata*; OD; holotype (W. CHANG, 1966, pl. 2, fig. 8), 18158, NIGP, Nanjing] [= *Mayiella (Xishuiella)* YIN in YIN & LI, 1978, p. 421 (type, *M. (X. xishuiensis)*; OD)]. Differs from *Drepanopyge* in having broad and shallow glabellar furrows, long (sag., exs.) anterior border, and distinct paradoublural line in front of glabella; prominent occipital spine. Librigena with broad (tr.) border and narrower (tr.) genal spine. Thorax with 10 segments and longer pleural spines increasing in size regularly toward posterior. Pygidium with 5 pairs of broad based marginal spines of variable length, anterior pair enlarged or continuing into long spines. Doublure broad. *Lower Cambrian (lower Canglangpuan)*: China (eastern Yunnan, northern Guizhou), *Drepanuroides* Zone. —FIG. 286, 2. **D. latilimbata*; eastern Yunnan (Yiliang); cranidium, $\times 1$ (W. Chang, 1966).

Meitanella LIN & YIN in YIN & LI, 1978, p. 417 [**M. hastata*; OD; holotype (YIN & LI, 1978, pl. 150, fig. 14; W. ZHANG, LU, & others, 1980, pl. 58, fig. 9), 37909, NIGP, Nanjing]. Glabella long (sag.), broad (tr.), and slightly constricted at middle; frontal lobe acutely pointed. All furrows on the cranidium narrow and deep; anterior border long (sag. and exs.) and cranial border furrow strongly arched forward sagittally; eye ridge short and oblique; eye lobe of medium size, strongly bending outward, and close to the axial furrow; palpebral area of fixigena narrow (tr.); anterior section of facial suture divergent. Librigena, thorax, and pygidium unknown. *Lower Cambrian (lower Canglangpuan)*: China (northern Guizhou), *Drepanuroides* Zone. —FIG. 286, 3. **M. hastata*; northern Guizhou (Meitan); holotype, cranidium, $\times 2$ (W. Zhang, Lu, & others, 1980).

Paokannia HO & LI, 1959, p. 156 [**P. chinensis*; OD; holotype (HO & LI, 1959, pl. 1, fig. 3a), 5803, CUGB, Beijing]. Similar to *Drepanopyge*, but having relatively narrower (tr.) cranidium and palpebral area of fixigena, a very small and short genal spine, and 6 to 7 small pygidial border spines. *Lower Cambrian (Canglangpuan)*: Kashmir (Anantnag); China (western Hubei, Sichuan, Guizhou, Jiangsu), *?Drepanuroides* Zone. —FIG. 285, 3. **P. chinensis*;

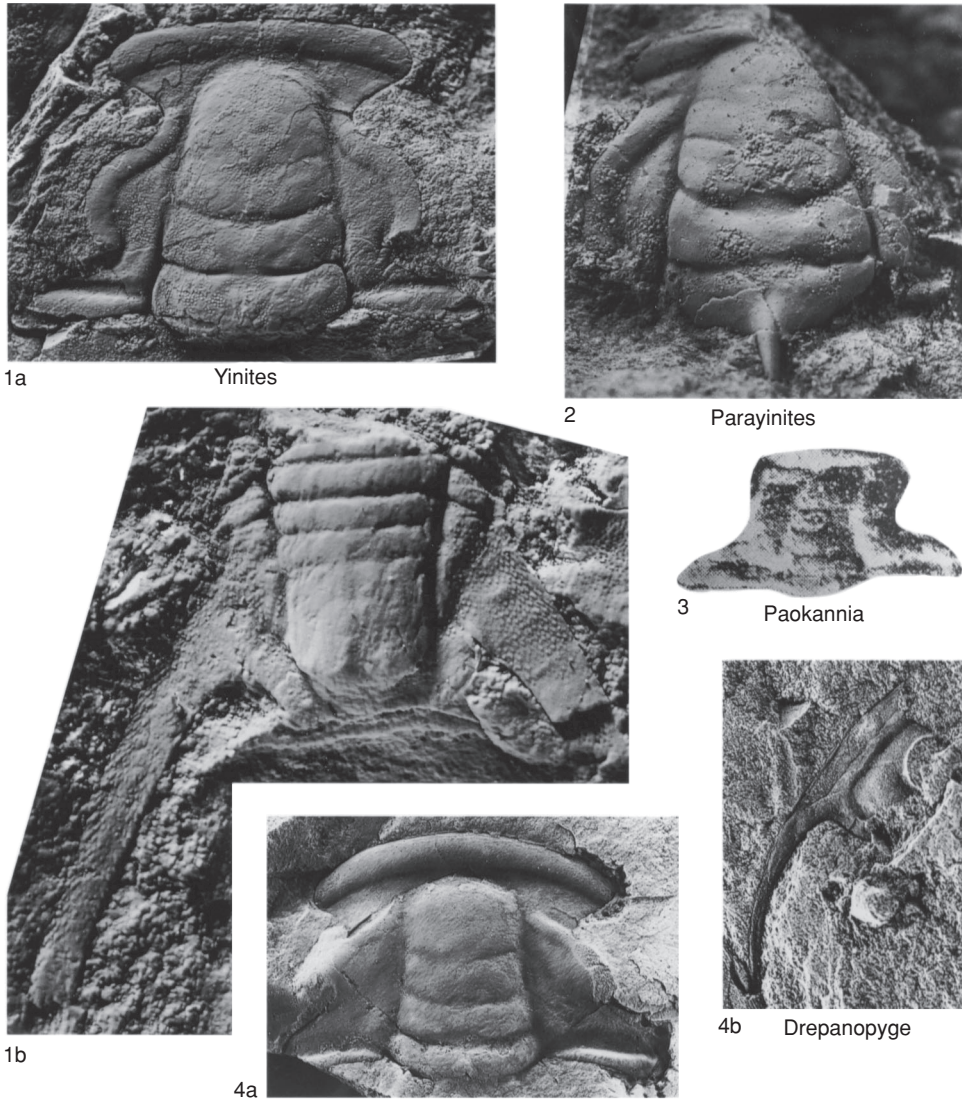


FIG. 285. Yinitidae (p. 446–448)

northwest Hupei (Baokang), holotype, cranium, $\times 2$ (Ho & Li, 1959).

Parapaokannia ZHANG & LIN in W. ZHANG, LU, & others, 1980, p. 198, 431 [**P. sichuanensis*; OD; holotype (W. ZHANG, LU, & others, 1980, pl. 56, fig. 6), 37890, NIGP, Nanjing]. Cranium subtrapezoidal; glabella broad, long, tapering forward, with frontal lobe broadly rounded and 3 pairs of weak glabellar furrows; preglabellar field absent; occipital ring of uniform length (sag. and exs.); eye ridge stout; eye lobe of moderate length, situated at mid-length of cranium; anterior sections of facial su-

tures short, subparallel or slightly divergent; posterior area of fixigena broad (tr.) and long; librigena narrow, genal spine long. Thorax with 11 segments. Pygidium with prominent axial lobe; pleural field narrow, with 2 or 3 pleural furrows; doublure broadening posteriorly; border spines absent. *Lower Cambrian (lower Canglangpuan)*: China (northern Sichuan), ?*Drepanuroides* Zone.—FIG. 286, 1a, b. **P. sichuanensis*, northern Sichuan (Nanjiang); a, holotype, cranium; b, paratype, incomplete dorsal exoskeleton, $\times 5$ (W. Zhang, Lu, & others, 1980).

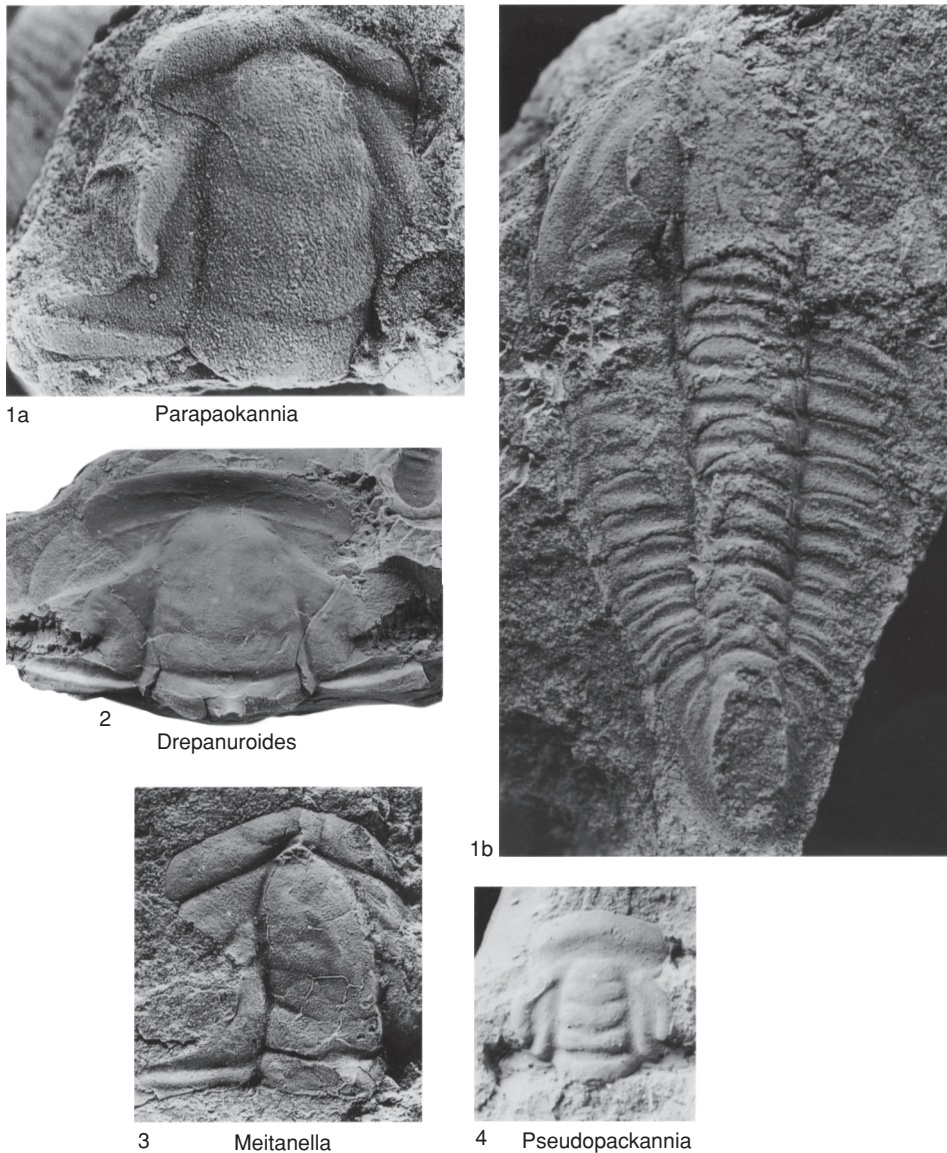


FIG. 286. Yinitidae (p. 446–449)

Parayinites ZHANG & LIN in W. ZHANG, LU, & others, 1980, p. 209 [**P. spinosus*; OD; holotype (W. ZHANG, LU, & others, 1980, pl. 62, fig. 10), 37941, NIGP, Nanjing]. Differing from *Yinites* in having broader (tr.), conical glabella, longer eye lobe, large occipital spine, very small anterior area of fixigena, and shorter and less divergent anterior sections of facial sutures. Librigena, thorax, and pygidium unknown. *Lower Cambrian (Canglangpuan)*: China (northern Guizhou), ?*Drepanuroides* Zone.—FIG.

285.2. **P. spinosus*; northern Guizhou (Yuqing), holotype, cranidium, $\times 4$ (W. Zhang, Lu, & others, 1980).

Pseudopaokannia YIN in YIN & LI, 1978, p. 416 [**P. kaiyangensis*; OD; holotype (YIN & LI, 1978, pl. 149, fig. 2), Gr-087, SMNH, Shanghai]. Cranium broad (tr.), short (sag.), and subtrapezoidal; anterior border gently convex and long (sag., exs.); glabella short (sag.), tapering forward, with frontal lobe well rounded; preglabellar field long (sag.) and

depressed; anterior area of fixigena broad (tr.); eye lobe long (exs.), its posterior tip reaching the level of occipital furrow; posterior area of fixigena narrow (tr.) and short (exs.). Librigena, thorax, and pygidium unknown. *Lower Cambrian (upper Canglangpuan)*: China (northern Guizhou), *Palaeolenus* Zone.—FIG. 286,4. **P. kaiyangensis*; northern Guizhou (Kaiyang); holotype, cranidium, $\times 2$ (Yin & Li, 1978).

Qingkouia ZHANG, LIN, & ZHOU in W. ZHANG, LU, & others, 1980, p. 190 [**Q. zhangyangouensis*; OD; holotype (W. ZHANG, LU, & others, 1980, pl. 53, fig. 2), 37862, NIGP, Nanjing] [= *Drepanuroides (Paradrepanuroides)* ZHAO, HUANG, & MAO in ZHAO & others, 1984, p. 759 (type, *D. (P.) robusta*)]. Glabella broad, tapering forward, with 3 pairs of very weak glabellar furrows; occipital furrow broad (sag.) medially; occipital ring with small node; anterior sections of facial sutures strongly divergent; border narrow and convex; preglabellar field short (sag.); librigena with long genal spine. Thorax with 9 segments; each axial ring with a small median keel; pleural spines longer posteriorly. Pygidium large; axial lobe with 4 to 5 rings and terminal piece; 5 pairs of broad pleural furrows, interpleural furrows narrow and very shallow; 6 pairs of large marginal spines. *Lower Cambrian (Canglangpuan)*: China (northern Guizhou), ?*Drepanuroides* Zone.—FIG. 287,2a,b. **Q. zhangyangouensis*; a, holotype, incomplete exoskeleton, $\times 0.95$; b, complete exoskeleton, $\times 0.95$ (W. Zhang, Lu, & others, 1980).

Yunnanaspidella W. CHANG, 1966, p. 159, 169 [**Y. spinocaudata*; OD; holotype (W. CHANG, 1966, pl. 4, fig. 7), 18177, NIGP, Nanjing]. Similar to *Yunnanaspis*, but preglabellar field shorter (sag.) or absent, eye lobe longer, and posterior area of fixigena shorter (exs.). Thorax with 13 segments. Pygidium with 4 pairs of relatively small border spines and a 5th pair of long, outwardly and backwardly directed spines. *Lower Cambrian (lower Canglangpuan)*: China (eastern Yunnan), *Drepanuroides* Zone.—FIG. 288a,b. **Y. spinocaudata*, eastern Yunnan (Malong); a, incomplete thorax and pygidium, $\times 8$; b, topotype, incomplete exoskeleton, $\times 2$ (W. Chang, 1966).

Yunnanaspis W. CHANG, 1966, p. 159, 169 [**Y. bilongispinus*; OD; holotype (W. CHANG, 1966, pl. 4, fig. 4), 18174, NIGP, Nanjing]. Glabella broad, tapering forward, frontal lobe well rounded, and glabellar furrows obsolete; border furrow shallow; preglabellar field short (sag.); eye ridge distinct; eye lobe small; posterior area of fixigena broad (tr.) and long; librigena with long genal spine. Thorax with 9 segments. Pygidium with 5 rings, large terminal piece, 5 pleurae ending with 5 pairs of short border spines, and a rear pair of long, backward-directed spines. *Lower Cambrian (lower Canglangpuan)*: China (eastern Yunnan), *Yunnanaspis* Zone.—FIG. 287,1a,b. **Y. bilongispinus*, eastern Yunnan (Malong); a, holotype, pygidium, $\times 4.7$; b, incomplete dorsal exoskeleton, $\times 4.7$ (W. Chang, 1966).

Family MAYIELLIDAE Chang, 1966

[Mayiellidae W. CHANG, 1966, p. 162]

Cranidium quadrate or subquadrate; glabella cylindrical or broadly conical, with or without glabellar furrows; preglabellar field absent or short (sag.); anterior sections of facial sutures short, subparallel to slightly divergent. Thorax with 10 segments. Pygidium medium sized; axial lobe cylindrical and long (sag.), with 1 to 4 axial tubercles and 3 pairs of pleural furrows. *Lower Cambrian*.

Mayiella W. CHANG, 1966, p. 162, 170 [**M. tuberculata*; OD; holotype (W. CHANG, 1966, pl. 5, fig. 5), 18182, NIGP, Nanjing]. Cranidium trapezoidal, with rounded front; glabella tapering forward, frontal lobe rounded; glabellar furrows absent; occipital furrow shallow; occipital ring of uniform length (sag. and exs.); anterior border furrow shallow and long (sag. and exs.), within which a row of small tubercles may be present; anterior border gently convex, longer sagittally; eye lobe long and arcuate distally; librigena unknown. Thorax with 10 segments, articulating facets well developed on the anterior 3 or 4 thoracic pleurae; pleural spines short. Pygidium semielliptical; border flat; no border spines. *Lower Cambrian (lower Canglangpuan)*: China (eastern Yunnan), *Drepanuroides* Zone.—FIG. 289,1. **M. tuberculata*, eastern Yunnan (Malong); holotype, cranidium, thorax, and pygidium, $\times 6$ (W. Chang, 1966).

Qiaodiella ZHANG, LIN, & ZHOU in W. ZHANG, LU, & others, 1980, p. 222 [**Q. qiaodiensis*; OD; holotype (W. ZHANG, LU, & others, 1980, pl. 68, fig. 10), 37995, NIGP, Nanjing]. Cranidium subtrapezoidal, with strongly arched front; preglabellar area inflated, preglabellar field and anterior border undivided; anterior border furrow long (sag. and exs.) and shallow, curving adaxially to meet extremity of preglabellar furrow. Glabella convex, slightly tapering toward the front, anterior margin of frontal lobe flat, rounded, with 3 pairs of weak glabellar furrows; posterior border furrow and occipital furrow long (sag. and exs.) and deep; anterior section of facial suture subparallel. Librigena, thorax, and pygidium unknown. *Lower Cambrian (lower Canglangpuan)*: China (northern Guizhou), *Drepanuroides* Zone.—FIG. 289,3. **Q. qiaodiensis*, northern Guizhou (Yuqing); holotype, cranidium, $\times 4$ (W. Zhang, Lu, & others, 1980).

Qiaotingaspis W. CHANG, 1966, p. 163 [**Q. quadratus*; OD; holotype (W. CHANG, 1966, pl. 6, fig. 7), 18190, NIGP, Nanjing]. Cranidium quadrate; glabella oblong, with 3 pairs of weak glabellar furrows, a pair of pits in front of anterolateral margin; anterior border furrow shallow, lacking row of tubercles seen in *Mayiella*; anterior border long (sag. and



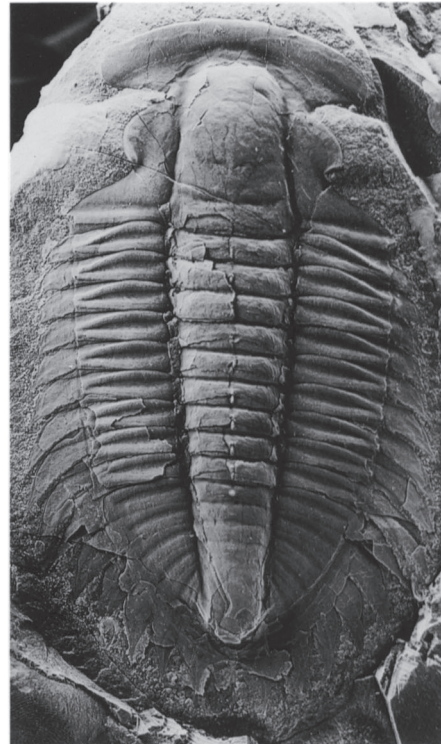
1a



2a Qingkouia



1b Yunnanaspis



2b

FIG. 287. Yinitidae (p. 449)

exs.), of uniform length and gently convex; eye lobe small. Librigena, thorax, and pygidium unknown. Lower Cambrian (lower Canglangpuan): China

(northern Sichuan), *Drepanuroides* Zone.—FIG. 289.2. **Q. quadratus*; northern Sichuan (Nanjiang); holotype, cranidium, $\times 3$ (W. Chang, 1966).

Family GIGANTOPYGIDAE
Harrington, 1959

[Gigantopygidae HARRINGTON in MOORE, 1959, p. 204]

Glabella tapering slightly forward, with 3 or 4 pairs of glabellar furrows; preglabellar field absent or present; anterior section of facial sutures short, subparallel or moderately divergent; posterior areas of fixigenae wide (tr.) and narrow or long (exs.); librigena with genal spine. Thorax with 14 to 16 segments and long pleural spines. Pygidial axial lobe composed of 1 to 4 rings and large or small terminal piece; pleural regions produced backward into 1 or 2 pairs of spines. *Lower Cambrian.*

Subfamily GIGANTOPYGINAE
Harrington, 1959

[*nom. transl.* ZHANG & LIN in W. ZHANG, LU, & others, 1980, p. 81, ex Gigantopygidae HARRINGTON in MOORE, 1959, p. 204]

Glabella subtruncate in front, with 4 pairs of glabellar furrows; occipital ring of uniform length (sag. and exs.); preglabellar field absent; anterior border long (sag. and exs.), flat; anterior pit present, transversely elongated; eye ridge long, curving forward beside frontal and anterior glabellar lobes; eye lobe strongly arcuate, extending to level of occipital furrow; anterior sections of facial sutures moderately divergent, subparallel across border; librigenae wide. Thorax with 14 (or ?15) segments. Pygidium long, narrow; axis short, with 3 rings. *Lower Cambrian.*

Gigantopygus HUPÉ, 1953a, p. 181 [**G. papillatus*; OD; holotype (HUPÉ, 1953a, pl. 7, fig. 2), G76 (R50882), MNHN, Paris]. Anterior (S4) lateral glabellar furrows faint; S2 and S1 almost transglabellar; occipital furrow discontinuous at midpoint; palpebral area of fixigena wide (tr.); posterior area of fixigena short (exs.) and broad (tr.). *Lower Cambrian*: Spain, Morocco.—FIG. 290,3. **G. papillatus*, Morocco, *Longianda* and *Gigantopygus* Zones; holotype, cranium, $\times 0.9$ (Hupé, 1953a).

Subfamily YILIANGELLINAE
Zhang & Lin, 1980

[Yiliangellinae ZHANG & LIN in W. ZHANG, LU, & others, 1980, p. 211]

Glabella with 3 pairs of glabellar furrows; eye lobe medium-sized or slightly longer; posterior areas of fixigenae broad (tr.) and long (exs.). Thorax with 14 to 16 segments.



a



b

Yunnanaspidella

FIG. 288. Yinitidae (p. 449)

Axial lobe of pygidium with 1 to 4 rings and long (sag.) or small terminal piece; posterior margin deeply notched, or rounded, between inner pair of border spines. *Lower Cambrian.*

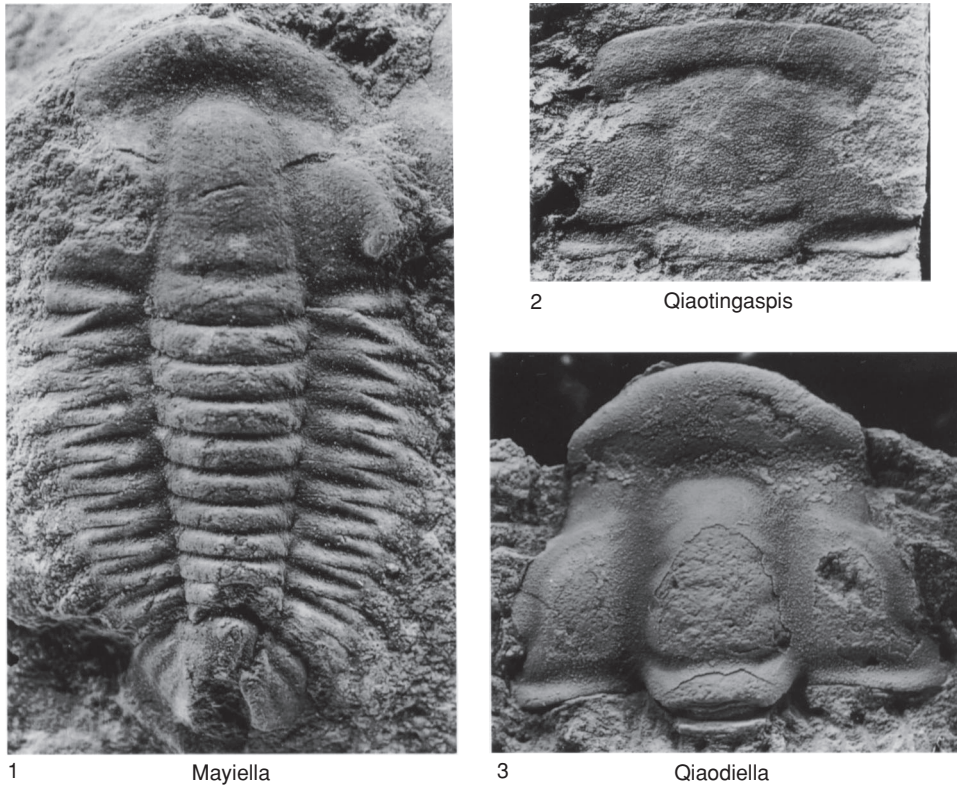


FIG. 289. Mayiellidae (p. 449–450)

Yiliangella W. CHANG, 1966, p. 161 [**Y. forficula*; OD; holotype (W. CHANG, 1966, pl. 6, fig. 1), 18184, NIGP, Nanjing] [=Palaeoaspis YANG, 1981, p. 78 (type, *P. barbatus*; OD)]. Glabella tapering forward, with frontal lobe rounded; preglabellar field absent; eye lobe relatively small; anterior cranial border short (sag. and exs.) and convex. Thorax with 16 segments. Pygidium small, with 2 pairs of pygidial spines; pygidial axial lobe with an anterior ring and long (sag.), cylindrical terminal piece. Hypostome subtriangular, medial body ovate, border furrow well developed anterolaterally, posterior margin with 11 or 12 small spines. *Lower Cambrian (lower Canglangpuan)*: China (eastern Yunnan, western Sichuan), *Yiliangella* Zone.—FIG. 290,2. **Y. forficula*, eastern Yunnan (Yiliang); holotype, cephalon and thorax, $\times 2.7$ (W. Chang, 1966).

Yiliangellina W. CHANG, 1966, p. 162, 170 [**Y. formosa*; OD; holotype (W. CHANG, 1966, pl. 6, fig. 4), 18187, NIGP, Nanjing]. Differs from *Yiliangella* in having broad, smooth glabella and long (sag.), slightly depressed preglabellar field, a longer eye lobe, and shorter (exs.) posterior area of fixigena. *Lower Cambrian (lower Canglangpuan)*: China (eastern Yunnan), *Drepanuroides* Zone.—FIG.

290,1. **Y. formosa*, eastern Yunnan (Yiliang); holotype, cranidium, thorax, and pygidium, $\times 6$ (W. Chang, 1966).

Zhangshania LI & ZHANG in S. LI, KANG, & ZHANG, 1990, p. 44 [**Z. typica*; OD; holotype (S. LI, KANG, & ZHANG, 1990, pl. 2, fig. 1), Ly-312, CIGMR, Chengdu]. Similar to *Yiliangella*, but having 14 thoracic segments, relatively larger pygidium with 4 axial rings and small terminal piece, pair of lateral pygidial spines, and broad doublure. Posterior margin of hypostome rounded, without marginal spines. *Lower Cambrian (lower Canglangpuan)*: China (western Sichuan: Leshan), *Yiliangella* Zone.—FIG. 290,4. **Z. typica*; complete dorsal exoskeleton, holotype, $\times 1.8$ (S. Li, Kang, & Zhang, 1990).

Family SAUKIANDIDAE HUPÉ, 1953

[Saukiandidae HUPÉ, 1953a, p. 152]

Glabella long, cylindrical or constricted posteriorly, with 3 pairs of lateral glabellar furrows; occipital furrow deep; preglabellar field short (sag.) or absent; anterior border

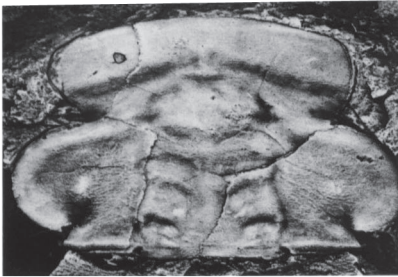


1 Yiliangellina



2

Yiliangella



3 Gigantopygus



4

Zhangshania

FIG. 290. Gigantopygidae (p. 451–452)

wide; anterior sections of facial sutures moderately divergent to border furrow, gently curved outward across border; eye lobe arcuate, long, reaching level of occipital furrow; palpebral area of fixigena swollen posteriorly; librigena wide. Thorax with 12 to 15 segments; fulcrum proximal. Pygidium with more segments and larger than in Redlich-iidae; pygidial border well developed. *Lower Cambrian*.

Subfamily SAUKIANDINAE Hupé, 1953

[*nom. transl.* W. CHANG, herein, ex Saukiandidae HUPÉ, 1953a, p. 152]

Glabella furrow S3 commonly obsolete but short and oblique backward when present; S2 similar to S3; S1 transglabellar, oblique backward abaxially and normal to axis medially; occipital furrow deep. Thorax with 15 segments. Border of pygidium very wide, flat. Surface finely granulose. *Lower Cambrian*.

Saukianda RICHTER & RICHTER, 1940, p. 23 [**S. andalusiae*; OD; holotype (RICHTER & RICHTER, 1940, pl. 1, fig. 1), 1034r, SMF, Frankfurt am Main]. Glabella subtruncate to slightly rounded in front; S3 obsolete; S2 very short; S1 deep, broad; occipital furrow slightly curved backwards; occipital ring of uniform length (sag. and exs.), with short median spine; preglabellar field short (sag. and exs.); genal spines advanced. Pygidium rounded, with wide axis containing 1 to 2 rings and broadly rounded terminal axial piece; pleural fields narrow, connected behind axis; posterior margin slightly inclined. *Lower Cambrian*: Spain, Morocco.

S. (Saukianda). Glabella subtruncate in front. Genal spines of medium size, clearly differentiated from border. *Lower Cambrian*: Spain, Morocco.—FIG. 291,2a,b. **S. (S.) andalusiae* RICHTER & RICHTER, Spain (Alanís, Andalusia); *a*, holotype, cranidium, dorsal view, $\times 1.7$ (new); *b*, nearly complete dorsal shield, PMO A27.035, $\times 1.36$ (Henningsmoen, 1957b, pl. 36, fig. 2).

S. (Pseudosaukianda) HUPÉ, 1953a, p. 196 [**P. lata*; OD; holotype (HUPÉ, 1953a, pl. 8, fig. 7), G236 (R50867), MNHN, Paris]. Glabella short, broadly conical, and rounded in front; S2 and S3 short; occipital furrow with slight forward bend; genal spine not advanced but a short and very stout continuation of border. *Lower Cambrian*: Morocco, *Longianda* and *Gigantopygus* Zones.—FIG. 291,1. **S. (P.) lata* (HUPÉ); holotype, cephalon and incomplete thorax, $\times 2.1$ (Hupé, 1953a).

Longianda HUPÉ, 1953a, p. 201 [**Callavia termieri* NELTNER & POCTEY, 1949, pl. 1, fig 2-4; OD; holotype (HUPÉ, 1953a, pl. 8, fig. 2), G68 (R50913),

MNHN, Paris]. Differs from *Saukianda* in having longer and narrower glabella constricted at level of S1 and rounded in front, occipital furrow bent forward at middle, no occipital spine. Preglabellar field absent; anterior pit present. Thorax with backward curvature of pleural spines progressively increasing posteriorly. Pygidium with 3 axial rings, short terminal axial piece, and 4 ribs. *Lower Cambrian*: Spain; Morocco, *Longianda* and *Gigantopygus* Zones.—FIG. 291,3. **L. termieri* (NELTNER & POCTEY), Morocco (Issafène); holotype, incomplete cephalon and thorax, $\times 1.7$ (Hupé, 1953a).

Subfamily DESPUJOLSIINAE Harrington, 1959

[*nom. transl.* W. CHANG, 1966, p. 148, ex Despujolsiidae HARRINGTON in MOORE, 1959, p. 204]

Cranidium long; glabella long, constricted at level of L2, with 3 pairs of faint, short, lateral glabellar furrows separated from axial furrow; occipital ring wide (sag.); preglabellar field as long (sag.) as anterior border; palpebro-ocular ridge arcuate, expanded in front, tapering backward, extending from anterolateral corner of glabella to level of occipital furrow; anterior sections of facial sutures moderately divergent. Thorax narrow, with 14 segments; pleurae narrower than axis and spinose, with 11th segment macrospinose and fulcrum distal. Pygidium small, with 4 pairs of tiny marginal spines; axis narrow, unsegmented; pleural regions smooth, wide. *Lower Cambrian*.

Despujolsia NELTNER & POCTEY, 1949, p. 78 [**D. rochi*; OD; holotype (NELTNER & POCTEY, 1949, pl. 2, fig. 3; HUPÉ, 1953a, pl. 8, fig. 3-4), G53 (R50820), MNHN, Paris]. Pseudopalpebral furrow present. Posterior area of fixigena triangular. First 6 thoracic pleurae ending in short, subequal spines; spines increasing rapidly in size between 7th and 11th pleurae; last pleurae having short spines. *Lower Cambrian*: Morocco (Amouslek), ?*Daguinaspis-Resserops* Zone.—FIG. 292. **D. rochi*; holotype, incomplete exoskeleton, $\times 3$ (Hupé, 1953a).

Subfamily RESSEROPINAE Chang, 1966

[*Resseropinae* W. CHANG, 1966, p. 148]

Glabella tapering slightly forward; preglabellar field moderately long (sag. and exs.), short, or absent; posterior extremity of palpebral lobe distant from axial furrow; advanced genal spine. Thorax with 12 to 14

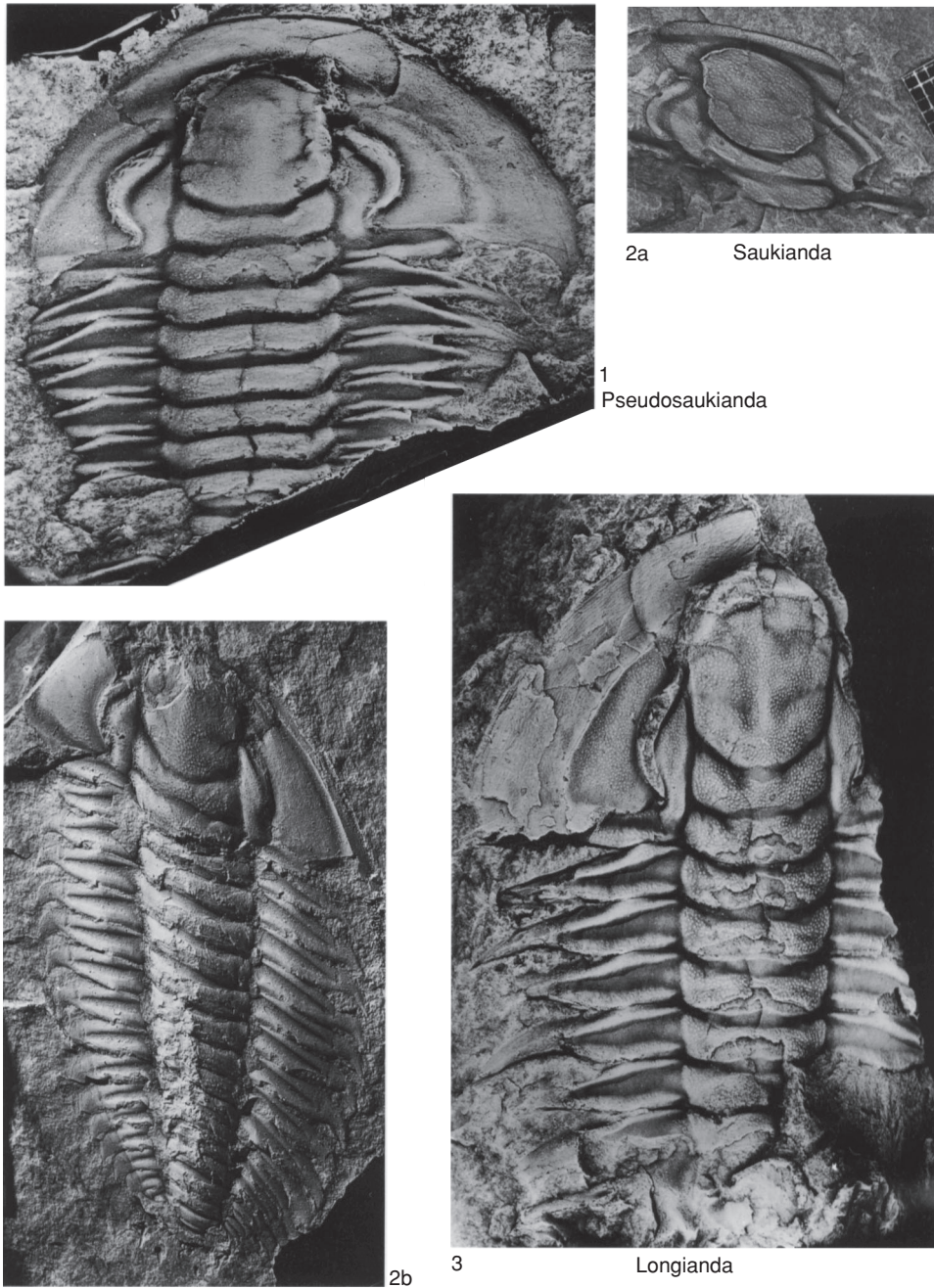


FIG. 291. Saukiandidae (p. 454)

segments; 9th or 11th segment macrospinose, or macrospinose segment absent. Pygidium parabolical; axis broad, conical,

with 3 to 10 rings; pleural regions with 2 to 8 pleurae, not delimited by border furrow. *Lower Cambrian.*



Despujolsia

FIG. 292. Saukiandidae (p. 454)

Perrector RICHTER & RICHTER, 1940, p. 30 [**P. perrectus*; OD; holotype (RICHTER & RICHTER, 1940, pl. 2, fig. 23), X1145a, SMF, Frankfurt am Main] [= *Resserops (Rawops)* HUPÉ, 1953a, p. 173 (type, *Resserops dubius*; OD)]. Lateral glabellar and occipital furrows discontinuous; preglabellar field absent; genal spine well advanced. Pygidium relatively large; both axis and pleural regions multi-segmented. *Lower Cambrian*: Spain, Morocco.

P. (Perrector). Lateral glabellar and occipital furrows slightly oblique backward; eye lobe reaching level of midlength of occipital ring. Thorax with 12? segments; macrospinose segment absent; pleurae slightly narrower than axis. Pygidium with 6 or 7 axial rings, large terminal axial piece, and 6 to 7 pleurae. *Lower Cambrian*: Spain.—FIG. 293,5a,b. **P. (P.) perrectus*, Andalusia (Alanis); a, holotype, dorsal view of cranium, $\times 3$; b, paratype, dorsal view of pygidium, $\times 3$ (new).

P. (Resserops) RICHTER & RICHTER, 1940, p. 33 [**P. (R.) resserianus*; OD; holotype (RICHTER & RICHTER, 1940, pl. 2, fig. 37), X1140a, SMF, Frankfurt am Main]. Similar to *P. (Perrector)* but

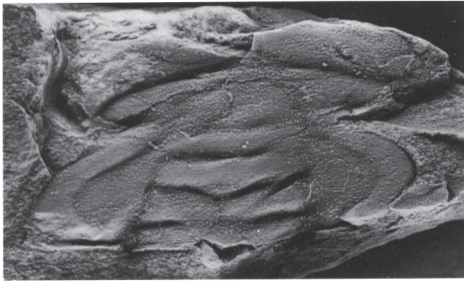
having stouter genal spines and macrospinose 9th thoracic pleura. *Lower Cambrian*: Spain.—FIG. 293,2. **P. (R.) resserianus* RICHTER & RICHTER; reconstruction of exoskeleton, $\times 3$ (Richter & Richter, 1940).

P. (Richterops) HUPÉ, 1953a, p. 173 [**Resserops (Richterops) falloti* HUPÉ, 1953a, p. 176; OD; holotype (HUPÉ, 1953a, p. 346, pl. 6, fig. 1), G74 (R50854), MNHN, Paris (on p. 177 HUPÉ also referred to MNHN G202 as the holotype)] [= *Marsaisia* HUPÉ, 1953a, p. 149 (type, *M. robauxi*; OD)]. Differs from *P. (Perrector)* in having 14 thoracic segments, with 11th segment macrospinose. *Lower Cambrian*: Morocco, *Daguinaspis* and *Resserops* Zones.—FIG. 293,3. **P. (R.) falloti* (HUPÉ), Morocco (Tazemmourt); exoskeleton, $\times 2$ (Hupé, 1953a).

Australaspis PALMER & GATEHOUSE, 1972, p. 12 [**A. magnus*; OD; holotype (PALMER & GATEHOUSE, 1972, pl. 1, fig. 2), 169058, USNM, Washington, D.C.]. Glabella bluntly rounded anteriorly, reaching to anterior border; eye lobe stout, elongate, strongly curved; palpebro-ocular ridge bifurcated toward glabella with anterior ridge continuous around and abaxial to anterolateral corner of glabella; posterior area of fixigena moderately long, slender; librigena with broad-based genal spine continuing curvature of lateral margin. Pygidium with broad axis reaching nearly to posterior margin and 4 narrow axial rings; pleural regions less than half width of axis; margin smoothly curved. *Lower Cambrian*: Antarctica.—FIG. 294,2a-c. **A. magnus*; a, holotype, boulders from moraine on Mount Spann, cranium, $\times 2$; b, paratype, cranium, $\times 2$; c, paratype, pygidium, $\times 2$ (Palmer & Gatehouse, 1972).

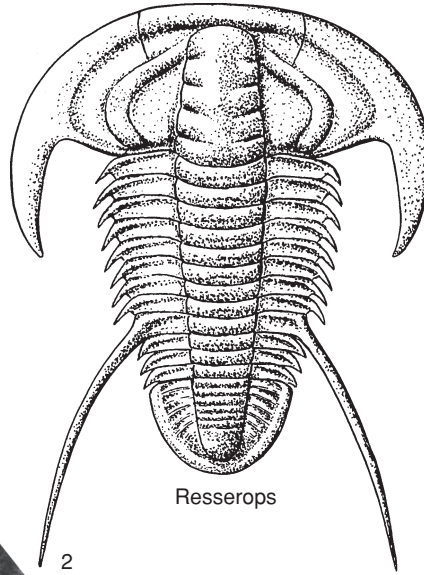
Clariondia HUPÉ, 1953a, p. 188 [**C. chazani*; OD; holotype (HUPÉ, 1953a, p. 187, fig. 44.1,3), G54, MNHN, Paris]. Glabella narrow; lateral glabellar and occipital furrows oblique backward, discontinuous medially; posterior edge of occipital ring semicircular; preglabellar field moderately wide; eye lobe reaching level of occipital furrow. Pygidium with 5 axial rings, short terminal axial piece, and 5 pleurae. *Lower Cambrian*: Morocco, *Antatlasia* Zone. [The type species of this genus is based on HUPÉ's description and a line drawing. G. GEYER reports that no specimens have been traced, and the exact type locality is unknown.]—FIG. 294,3a,b. **C. chazani*; a, holotype, cranium, $\times 2$; b, paratype, pygidium, $\times 3$ (Hupé, 1953a).

Dolerolichia SDZUY, 1962a, p. 1089 [**D. pretiosa*; OD; holotype (SDZUY, 1962a, pl. 1, fig. 1), X151a, SMF, Frankfurt am Main]. Anterior glabellar furrows normal to axis; occipital furrow and S1 well-marked laterally, slightly bent backward; all furrows disconnected medially; frontal lobe connected with border by wide (tr.) plectrum; preglabellar field narrow, with facial lines; palpebral lobe long, nearly reaching posterior border furrow; posterior facial suture strongly divergent. Pygidium of roundish shape; axis with 2 rings and large terminal piece; pleural field with 4 or 5 ribs. *Lower Cambrian*:



1

Eops



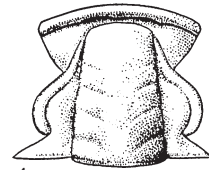
2

Resserops



3

Richterops



4

Pareops



5a



5b

Perrector

FIG. 293. Saukiandidae (p. 456–458)

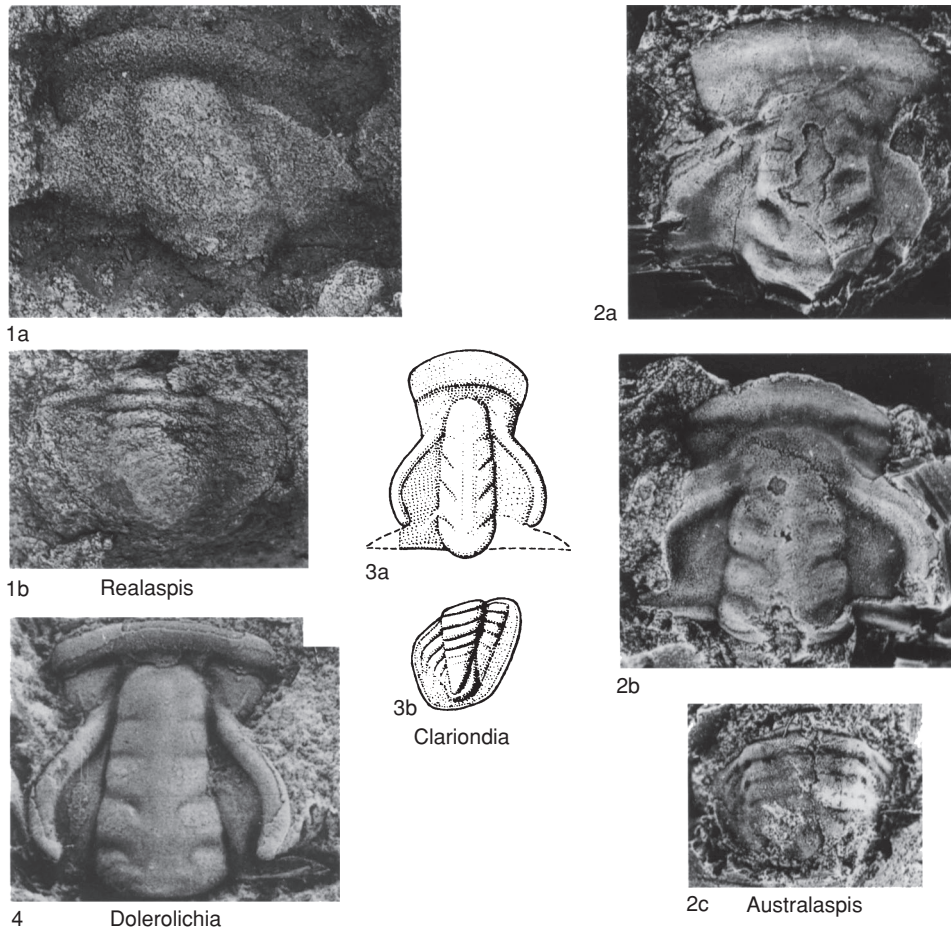


FIG. 294. Saukiandidae (p. 456–458)

Germany.——FIG. 294,4. **D. pretiosa*, Germany (Doberlug); holotype, cranium, $\times 3$ (Sdzuy, 1962a).

Eops RICHTER & RICHTER, 1940, p. 36 [**E. eo*; OD; holotype (RICHTER & RICHTER, 1940, pl. 2, fig. 45), X1000b, SMF, Frankfurt am Main]. Glabella with S2 and S3 discontinuous medially; S1 chevron shaped; preglabellar field moderately long (sag.); occipital node or spine absent; anterior border long (sag. and exs.); anterior sections of facial sutures diverging at about 45° . *Lower Cambrian*: Spain, ?Morocco.——FIG. 293,1. **E. eo*, Andalusia (Alanís); holotype, dorsal view of cranium, $\times 2.5$ (photographs courtesy of G. Geyer).

Pareops HUPÉ, 1953a, p. 180 [**P. transitans*; OD; holotype (HUPÉ, 1953a, p. 180, fig. 42), G315, repository unknown]. Glabella anteriorly truncate; lateral glabellar furrows slightly directed backwards, disconnected medially; occipital furrow nearly completely effaced medially; occipital ring straight; an-

terior border of moderate width. *Lower Cambrian*: Morocco, *Antatlasia* Zone. [The type species of this genus is based on HUPÉ's description and a line drawing. G. GEYER reports that no specimens have been traced, and the exact type locality is unknown.]——FIG. 293,4. **P. transitans*; holotype, cranium, $\times 1$ (Hupé, 1953a).

Realaspis SDZUY, 1961, p. 535 [**R. strenoides*; OD; holotype (SDZUY, 1961, pl. 4, fig. 6), L3082, UMU, Münster]. S1 and S2 directed obliquely backwards; S3 very faint; palpebral lobe less than one-third as long as cranium, with posterior end widely distant from posterior border furrow; eye ridge faint; preglabellar field very short. Librigena with strong genal spine. Pygidium semielliptical, with 3 axial rings and 2 to 3 ribs. *Lower Cambrian*: Spain.——FIG. 294,1a,b. **R. strenoides*, Spain (Los Cortijos); a, holotype, dorsal view of cranium, $\times 3.5$; b, dorsal view of pygidium, $\times 3$ (photographs courtesy of G. Geyer).

Family METADOXIDIDAE
Whitehouse, 1939

[Metadoxididae WHITEHOUSE, 1939, p. 196] [=Anadoxididae NICOSIA & RASETTI, 1970, p. 9]

Glabella strongly tapering forward; anterior and palpebral areas of fixigenae wide, with well-defined eye ridge and relatively small eye lobe. Thorax with 12 to 22 segments and wide (exs.) pleural furrows; pleural spines present or absent. Pygidium small. *Lower Cambrian*.

Metadoxides BORNEMANN, 1891, p. 462 [**Paradoxides torosus* MENEGHINI, 1888, p. 20; SD VOGDES, 1925, p. 105; =*P. armatus* MENEGHINI, 1881, p. 307; lectotype and paratype (MENEGHINI, 1888, pl. 2, fig. 1–2; pl. 3, fig. 4; SD NICOSIA & RASETTI, 1970, p. 9), SG 19 (lectotype), SG 20–21 (paratype); lectotype for *Paradoxides armatus* MENEGHINI, 1881, p. 307 (NICOSIA & RASETTI, 1970, p. 10, pl. 2, fig. 4; SD RASETTI, 1972, p. 61), 17, SG, Rome] [=*Anadoxides* MATTHEW, 1899b, p. 142 (type, *P. armatus* MENEGHINI, 1881, p. 307; SD VOGDES, 1925, p. 105)]. Cephalon broad (tr.), cephalic width (tr.) about 3 times length (sag.). Cranium broad (tr.), subtrapezoidal in outline. Glabella rounded in front, reaching anterior border; anterior area of fixigena broad (tr.) and short (exs.); eye ridge long, extending outward and backward; ocular striga distinct proximally; eye lobe small or medium-sized; palpebral area of fixigena as wide as glabella; anterior section of facial sutures subparallel. Librigena wide; border flat, extending into a stout and very short genal spine. Thorax with 22 segments; axial node present on at least some of axial rings; pleurae without spines. Pygidium subtriangular; axis wider than pleural regions, almost reaching posterior margin; with few, faint pleural and interpleural furrows; border indistinct. Surface finely granulose. *Lower Cambrian*: China; Spain; ?Siberia; Italy (Sardinia), *Dolerolenus courtessolei* to *D. zoppii* Zone.—FIG. 295, 1a, b. **M. armatus* (MENEGHINI), *D. zoppii* Zone, Sardinia; a, lectotype, cranium and incomplete thorax, $\times 1.45$ (Nicosia & Rasetti, 1970); b, dorsal exoskeleton, $\times 1.45$ (Pillola, 1991).

?**Churkinia** PALMER, 1968, p. 39 [**C. yukonensis*; OD; holotype (PALMER, 1968, pl. 1, fig. 7), 146649, USNM, Washington, D.C.]. Cranium subtrapezoidal; glabella with 3 pairs of transglabellar furrows; L1 divided into a median and 2 lateral lobes; anterior sections of facial sutures subparallel; facial line oblique; anterior ends of eye lobes widely separated from glabella; eye lobe relatively short, terminating opposite S1; posterior area of fixigenae broad (tr.) and long (exs.). Thorax with slender pleural spine developed only from anterior pleural band. Pygidium small; axis broad, with 2 axial rings and bilobed terminal piece. Hypostome elongately ovate. *Lower Cambrian*: USA (Alaska).—FIG.

295, 2a–d. **C. yukonensis*; a, holotype, cranium, $\times 2.9$; b, librigena, $\times 2.9$; c, pygidium, $\times 3.88$; d, hypostome, $\times 4.85$ (Palmer, 1968).

Enantiaspis RASETTI, 1972, p. 69 [**Ptychoparia enantiopa* BORNEMANN, 1891, p. 422; OD; lectotype (BORNEMANN, 1891, pl. 39, fig. 14; SD RASETTI, 1972, pl. 11, fig. 1), specimen number not recorded, MLU, Halle]. Glabella with 3 pairs of broad, shallow, transglabellar furrows; eye ridge directed forward from axial furrow, so that anterior end of palpebral lobe is farther forward than front end of glabella; palpebral lobe semicircular, posterior end opposite S2; anterior border of cranium almost straight. Librigena with sharp genal angle; border almost flat. Thorax with 16? segments; pleural terminations spinelike. Pygidium with long, parallel-sided axis having a posterior median notch; postaxial portion with a slight median notch; posterior margin ending in a pair of short spines. *Lower Cambrian*: Italy (Sardinia), *Dolerolenus longioculatus* Zone.—FIG. 296, 1. **E. enantiopa* (BORNEMANN), Sardinia (Canalgrande); lectotype, dorsal view of cranium, $\times 1.5$ (photograph courtesy of G. Geyer).

Fuminaspis ZHANG & LIN in W. ZHANG, LU, & others, 1980, p. 172 [**Metadoxides yunnanensis* W. CHANG & LIN in LU, CHANG, & others, 1974, p. 86; OD; holotype (LU, CHANG, & others, 1974, pl. 31, fig. 16), 37797, NIGP, Nanjing]. Similar to *Metadoxides* and *Hongshiyanspis*, but with narrower (tr.) cranium, shorter (tr.) and forwardly arcuate glabellar furrows, relatively longer eye lobe, narrow (tr.) palpebral area of fixigena, and lacking intergenal angle and fixigenal spine. Librigena, thorax, and pygidium unknown. *Lower Cambrian* (*Qiongzhusian*): China (eastern Yunnan), *Eoredlichia-Wutingaspis* Zone.—FIG. 295, 3. **F. yunnanensis* (ZHANG & LIN), eastern Yunnan (Fumin); holotype, cranium, $\times 4.85$ (W. Zhang, Lu, & others, 1980).

Hongshiyanspis ZHANG & LIN in W. ZHANG, LU, & others, 1980, p. 171 [**H. yiliangensis*; OD; holotype (W. ZHANG, LU, & others, 1980, pl. 45, fig. 6), 37799, NIGP, Nanjing]. Cranium trapezoidal, with anterior border short (sag. and exs.) and convex; glabella frontal lobe well rounded, with 3 pairs of glabellar furrows; preglabellar field absent; occipital ring convex, broad in the middle, with a small median tubercle; eye ridge divided by ocular striga; eye lobe small; posterior area of fixigena broad (tr.) and long (exs.); posterior border with intergenal angle and distal fixigenal spine; anterior sections of facial sutures short and subparallel. Thorax having no less than 14 segments. Pygidium and librigena unknown. *Lower Cambrian* (*Qiongzhusian*): China (eastern Yunnan), *Eoredlichia-Wutingaspis* Zone.—FIG. 296, 4. **H. yiliangensis*, eastern Yunnan (Yiliang); holotype, cranium, $\times 8$ (W. Zhang, Lu, & others, 1980).

Minusinella REPINA in KHALFIN, 1960, p. 174 [**M. lochmanae*; OD; holotype (REPINA in KHALFIN, 1960, pl. 19, fig. 11), 3356/267, CSGM, Novosibirsk] [=*Minusella* REPINA, 1966, p. 83, incorrect spelling]. Cranium subtrapezoidal; glabella with 3

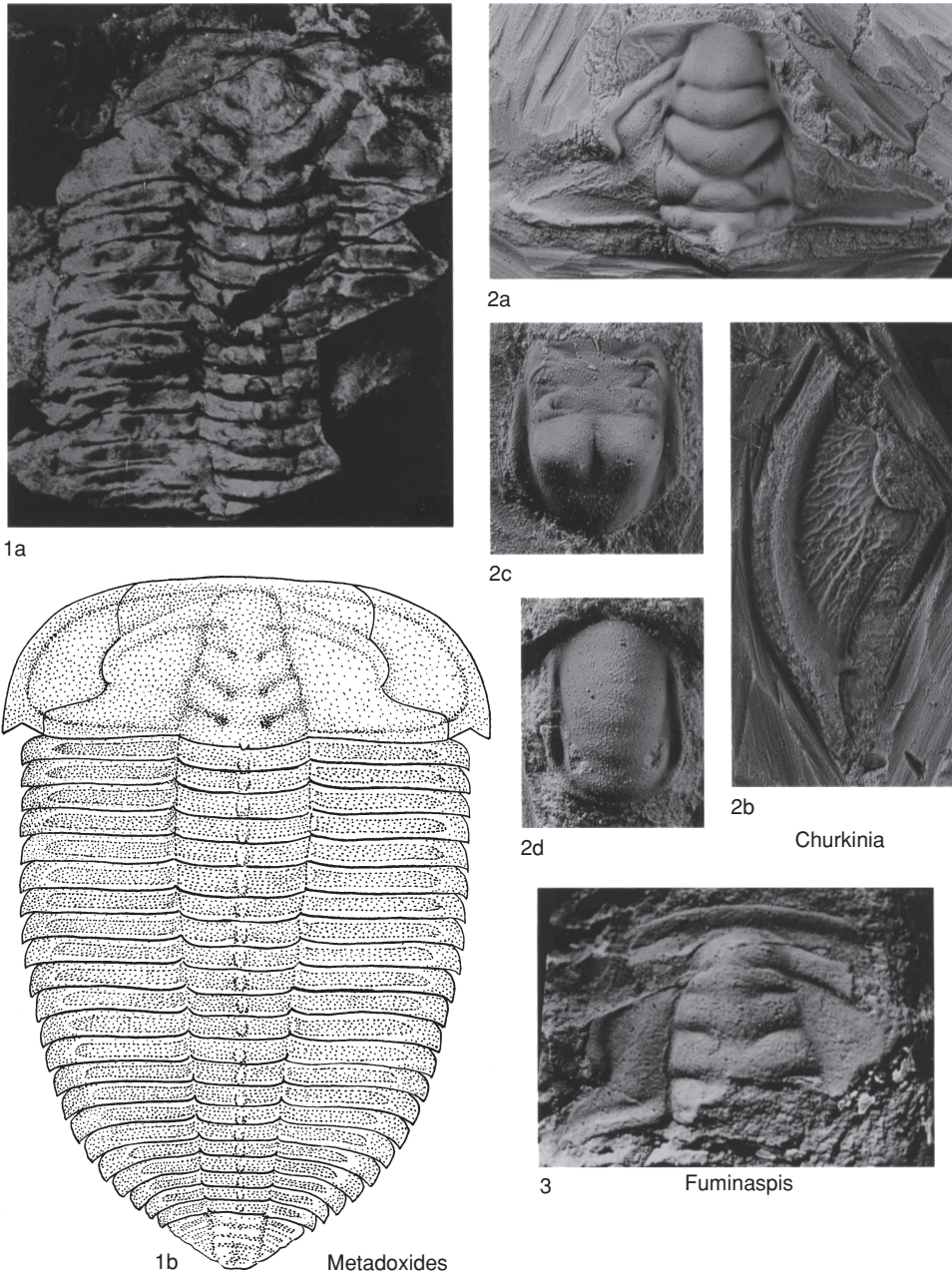


FIG. 295. Metadoxididae (p. 459)

pairs of glabellar furrows; S1 bifurcate proximally; occipital ring longer (sag.) medially; eye ridge long and stout; eye lobe medium-sized; preglabellar field absent; anterior border narrow (sag., exs.); anterior sections of facial sutures short, subparallel to slightly divergent. Librigena, thorax, and pygidium un-

known. *Lower Cambrian*: Russia (Kuznetsk Alatau), *Resimopsis* Zone.—FIG. 296.3. **M. lochmanae*; holotype, cranium, $\times 2.5$ (Khalfin, 1960). ?*Onaraspis* ÖPIK, 1968, p. 151 [**O. somniurna*; OD; holotype (ÖPIK, 1968, pl. 19, fig. 3), CPC 7165, AGSO, Canberra]. Similar to *Metadoxides*, but hav-

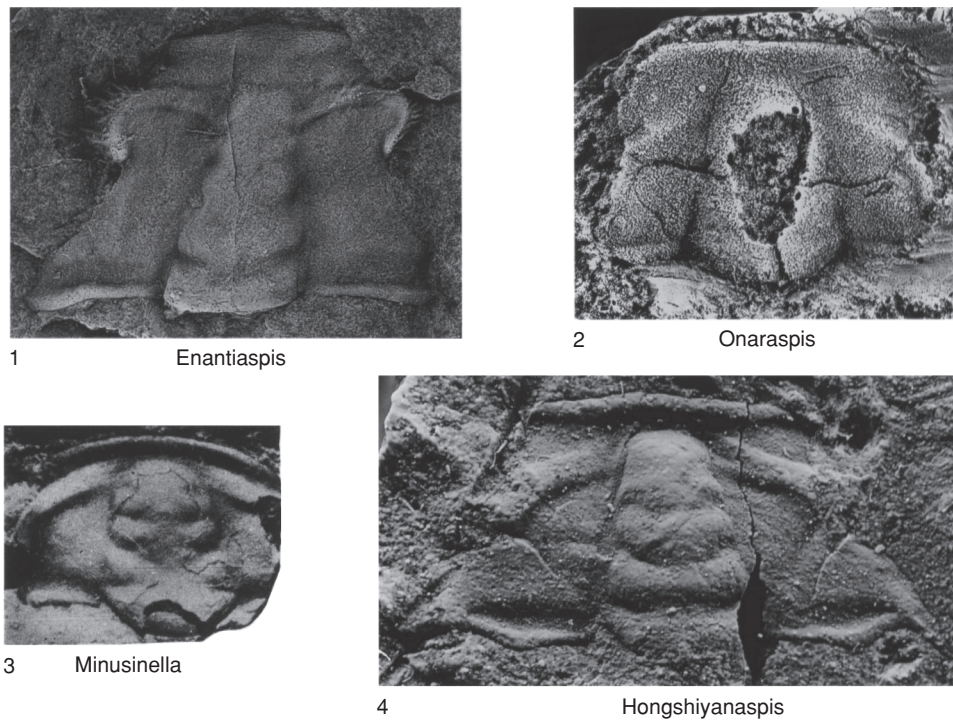


FIG. 296. Metadoxididae (p. 459–461)

ing fewer thoracic segments (12 in the type species), macropleural 11th segment, relatively larger pygidium with a concave flange, and slightly tapering glabella. *lower Middle Cambrian*: Australia (Northern Territory), ?*Redlichia chinensis* Zone.—FIG. 296.2. **O. somniurna*, Northern Territory (Rodinga area); holotype, cranidium, $\times 2$ (Öpik, 1968).

Family ABADIELLIDAE Hupé, 1953

[Abadiellidae HUPÉ, 1953a, p. 152]

Glabella conical to subovate, with 3 or 4 pairs of glabellar furrows directed obliquely backward, though S3 and S2 may be obsolete; occipital furrow slightly curved backward; occipital ring produced into stout median spine; preglabellar field long (sag.); anterior sections of facial sutures moderately divergent (generally less than 45°), proximal extremities distant from axial furrows; eye lobe arcuate, extending from anterolateral corner of glabella to level of anterior one-third of L1. Thorax with 15 to 17 segments. Pygidium small. *Lower Cambrian*.

Abadiella HUPÉ, 1953a, p. 204 [**A. bourgini*; OD; holotype (HUPÉ, 1953a, p. 204, fig. 45.2), G318, MNHN, Paris]. Cranidium subquadrate; glabella tapering forward, acutely rounded in front; frontal lobe small and subrounded; S3 shallow, short and indistinct; S2, S1 narrow, deep, and steeply oblique backward; occipital ring longer sagittally and produced backward into a strong and longer occipital spine; preglabellar field with low plectrum; anterior area of fixigena and facial line similar to that of *Eoredlichia*; anterior border gently convex, longer sagittally and gradually narrower (exs.) toward distal extremities; eye ridge and eye lobe stout, eye lobe longer (exs.) than in *Parabadiella*, its posterior tip reaching the midlength of L1; posterior area of fixigena long (exs.) and broad (tr.); fulcrum distinct. *Lower Cambrian*: Morocco (Oujjane), *Daguinaspis* and *Resserops* Zone.—FIG. 297.1. **A. bourgini*; holotype, cranidium, $\times 6$ (new).

Guangyuanaspis CHANG & QIAN in LU, CHANG, & others, 1974, p. 88 [**G. modaoyaensis*; OD; holotype (LU, CHANG, & others, 1974, pl. 33, fig. 7), 21475, NIGP, Nanjing]. Similar to *Parabadiella*, but differs in absence of plectrum, parafrontal band, facial line, and occipital spine. Proximal part of eye ridge not visible; glabellar and occipital furrows very shallow. Eye lobe short (exs.), and posterior area of fixigenae long (exs.). *Lower Cambrian* (*Qiongzhusian*): China (northern Sichuan),

- Eoredlichia-Wutingaspis* Zone.—FIG. 297,2. **G. modaoyaensis*, northern Sichuan (Guangyuan); holotype, cranium and incomplete thorax, $\times 4$ (Lu, Chang, & others, 1974).
- Lunolenus** SDZUY, 1961, p. 549 [**L. lunae*; OD; holotype (SDZUY, 1961, pl. 7, fig. 9), L3110, UMU, Münster]. Glabella with up to 4 pairs of lateral glabellar furrows; occipital ring with long spine; palpebro-ocular ridge extending around glabella into plectrum; preglabellar field short (sag.); anterior border long (sag. and exs.); anterior sections of facial sutures long, diverging at about 45°. Librigena with long, slender genal spine. Pygidium consisting almost entirely of wide axis with 3 rings and a faintly bilobate terminal axial piece. *Lower Cambrian*: Spain.—FIG. 297,3a,b. **L. lunae*, Spain (Los Barrios de Luna); *a*, holotype, dorsal view of cranium, $\times 3$; *b*, paratype, dorsal view of pygidium, $\times 5$ (photographs courtesy of G. Geyer).
- Malongocephalus** ZHANG & LIN in W. ZHANG, LU, & others, 1980, p. 179 [**M. yunnanensis*; OD; holotype (W. ZHANG, LU, & others, 1980, pl. 48, fig. 5), 37826, NIGP, Nanjing]. Glabella long; preglabellar field very short (sag.); anterior sections of facial sutures subparallel to slightly divergent, posterior sections short; posterior area of fixigena narrow (tr.). Thorax with 15 segments. Pygidium small; axial lobe rounded; pleural regions narrow (tr.), with pair of faint pleural furrows. *Lower Cambrian (Qiongzhusian)*: China (eastern Yunnan), *Eoredlichia-Wutingaspis* Zone.—FIG. 298,3. **M. yunnanensis*, eastern Yunnan (Malong); holotype, exoskeleton, $\times 2.85$ (W. Zhang, Lu, & others, 1980).
- Parabadiella** W. CHANG, 1966, p. 163, 184 [**P. huoi*; OD; holotype (W. CHANG, 1966, pl. 1, fig. 1), 18139, NIGP, Nanjing] [= *Parabadiella (Danagouia)* CHEN, 1985, p. 333 (type, *P. (D.) transversa*; OD)]. Cranium gently convex, rectangular in outline, broad (tr.); eye lobe medium-sized; eye ridge long and oblique; fixigena broad (tr.); anterior area of fixigena with an oblique and slightly arcuate facial line; median plectrum connected to parafrontal band, which extends obliquely backward and joins anterior band of eye ridge; border furrow distinct; anterior border gently convex and slightly arcuate forward; posterior area of fixigena protruding slightly beyond eye lobe; anterior sections of facial sutures slightly divergent from eye lobe; librigena with long genal spine. Thorax with axial spine on the 6th and 9th axial rings. Pygidium similar to that of *Eoredlichia*. *Lower Cambrian (Qiongzhusian)*: China (northern Sichuan, eastern Yunnan, southern Shaanxi), *Parabadiella* Zone.—FIG. 298,1a,b. **P. huoi*, southern Shaanxi (Nanzheng); *a*, holotype, cranium, $\times 2.85$ (W. Chang, 1966); *b*, topotype, exoskeleton, $\times 2.85$ (W. Zhang, Lu, & others, 1980).
- Shaanxia** ZHANG & LIN in W. ZHANG, LU, & others, 1980, p. 176, 430 [**S. curvata*; OD; holotype (W. ZHANG, LU, & others, 1980, pl. 47, fig. 7), 37815, NIGP, Nanjing]. Similar to *Parabadiella*, but anterior border strongly forwardly curved, preglabellar field longer (sag.), glabella narrow and small, plectrum absent, border and posterolateral furrows broader, and genal spine longer. Hypostome ovate, with median body ovate, posterior lobe lunate, border narrow, and anterior wing spinulelike. Thorax and pygidium unknown. *Lower Cambrian (Qiongzhusian)*: China (southern Shaanxi), *Eoredlichia-Wutingaspis* Zone.—FIG. 298,2. **S. curvata*; holotype, cranium, $\times 7.6$ (W. Zhang, Lu, & others, 1980).
- Sibiriaspis** REPINA in KHALFIN, 1960, p. 252 [**S. chomentovskii*; OD; holotype (REPINA in KHALFIN, 1960, pl. 23, fig. 19; 1966, pl. 16, fig. 4), 3356/10, CSGM, Novosibirsk]. Cranium subquadrate; occipital spine slender; preglabellar field long (sag.); palpebro-ocular ridge stout; posterior area of fixigena narrow (tr.). *Lower Cambrian*: Russia (Kuznetsk Alatau), Atdabanian (*Resimopsis* Zone); western Mongolia, *Tologoia subquadrata-Sajanaspis modesta* Zone.—FIG. 297,4a,b. **S. chomentovskii*, Kuznetsk Alatau, *Resimopsis* Zone; *a*, holotype, cranium, $\times 3.5$ (Khalfin, 1960); *b*, paratype, cranium, $\times 7$ (Repina, 1966).

Family KUEICHOWIIDAE Lu, 1965

[Kueichowiidae Lu in Lu & others, 1965, p. 91]

Cranidium subquadrate, glabella cylindrical, with 3 pairs of narrow and oblique glabellar furrows; eye lobe medium to long and arcuate; anterior sections of facial sutures divergent; posterior area of fixigena short (exs.), extending a very short distance (tr.) beyond posterior tip of palpebral lobe; preglabellar field long (sag.); paradoublural line generally distinct. Thorax with no less than 15 segments. Surface granulose. *Lower Cambrian*.

Kueichowia LU, 1942, p. 182 [**K. liui*; OD; holotype (LU, 1942, pl. 1, fig. 5a), Lu16, NIGP, Nanjing]. Glabella slightly tapering forward, with frontal lobe well rounded; occipital furrow narrow, deep, and continuous; eye ridge stout and oblique; eye lobe medium-sized; posterior cranial border furrow narrow and deep; anterior cranial border furrow shallow; anterior border slightly convex; preglabellar field longer (sag.) than anterior border. Surface pustulose. Librigena, thorax, and pygidium unknown. *Lower Cambrian (lower Canglangpuan)*: China (northern Guizhou), *Drepanuroides* Zone.—FIG. 299,1. **K. liui*, northern Guizhou (Zunyi); holotype, cranium, $\times 5.75$ (W. Zhang, Lu, & others, 1980).

Shatania W. CHANG & LIN in LU, CHANG, & others, 1974, p. 90 [**S. shatanensis*; OD; holotype (LU, CHANG, & others, 1974, pl. 34, fig. 7), 38003, NIGP, Nanjing]. Cranial border and border furrow faint; preglabellar area gently convex; eye lobe long and arcuate, its posterior tip reaching posterior border furrow and distant from glabella;

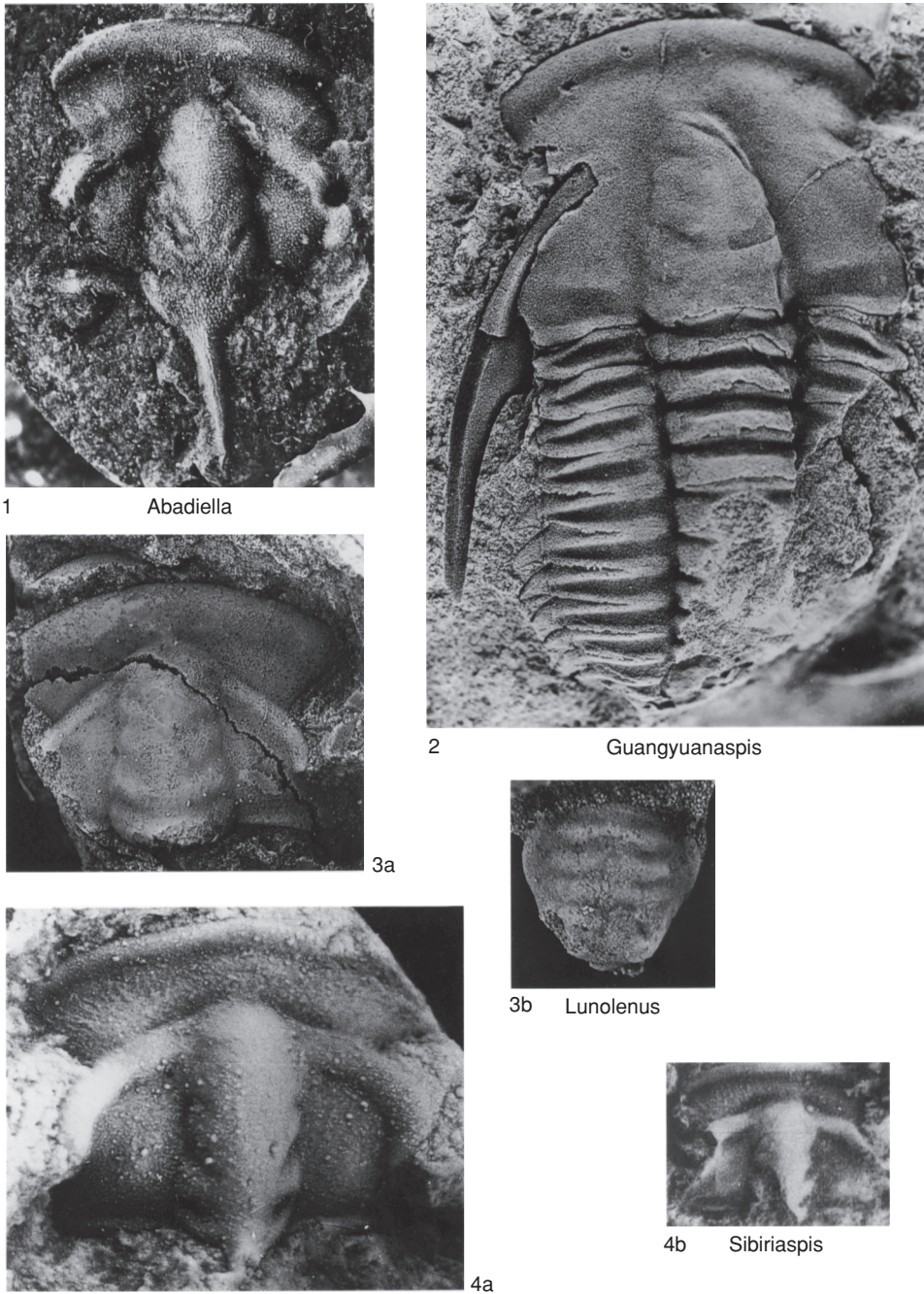


FIG. 297. Abadiellidae (p. 461–462)

paradoublural line faint. Librigena and pygidium unknown. Lower Cambrian (lower Canglangpuan): China (northern Sichuan).—FIG. 299,3. *S.

shatanensis, northern Sichuan (Shatan, Nanjiang); holotype, cranidium, $\times 5.75$ (Lu, Chang, & others, 1974).

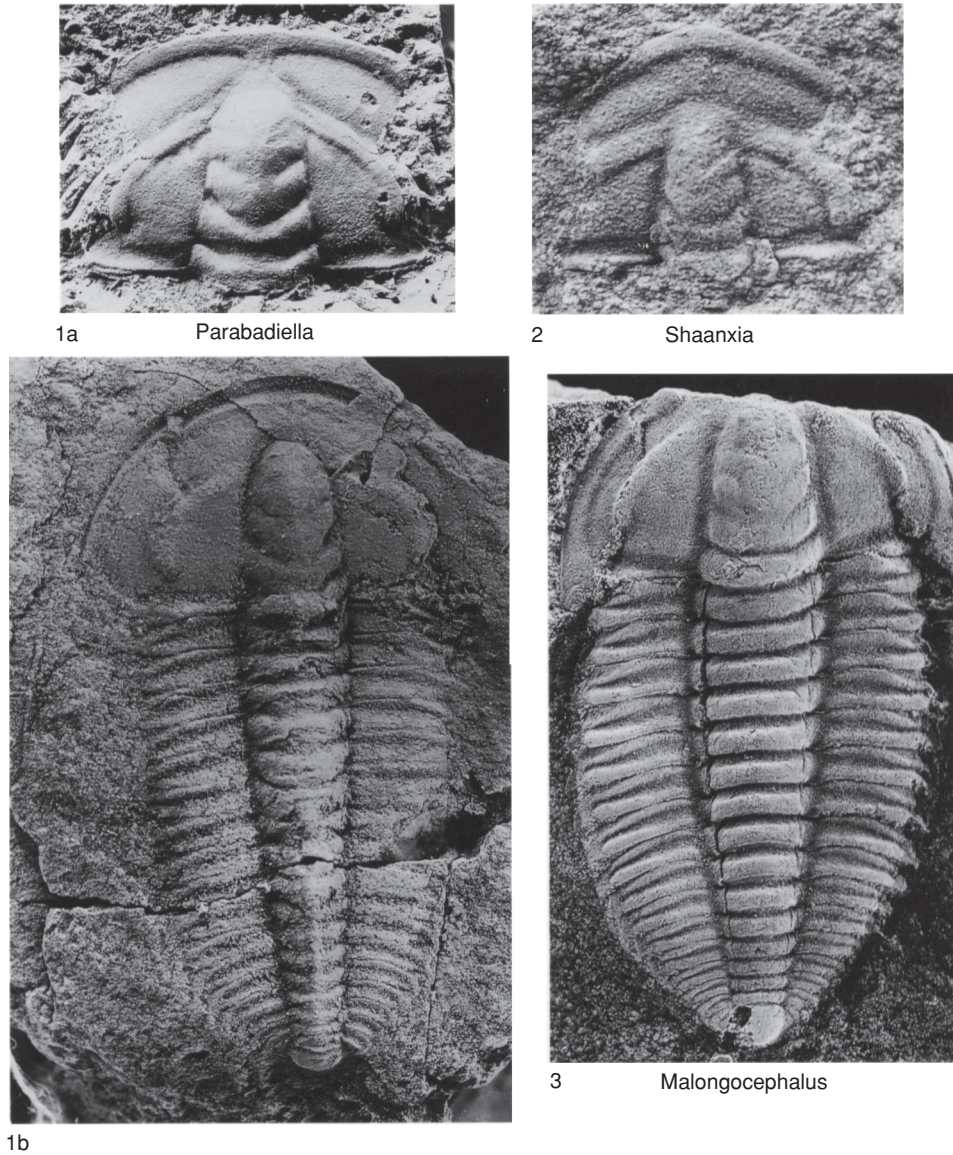


FIG. 298. Abadiellidae (p. 462)

Family MENNERASPIDAE
Pokrovskaya, 1959

[Menneraspidae POKROVSKAYA, 1959, p. 84]

Glabella broadly cylindrical, large, and slightly expanded forward, with 3 or 4 pairs of glabellar furrows; anterior cranial border short (sag.), convex, and arched forward; no

preglabellar field; anterior area of fixigena narrow (tr.); palpebral area of fixigena also narrow (tr.), about one-sixth width (tr.) of basal glabella; anterior sections of facial sutures subparallel; librigena very narrow (tr.), with advanced genal spine. Thorax with 13 segments; axial lobe broader (tr.) than pleural regions. Pygidium small, semielliptical,

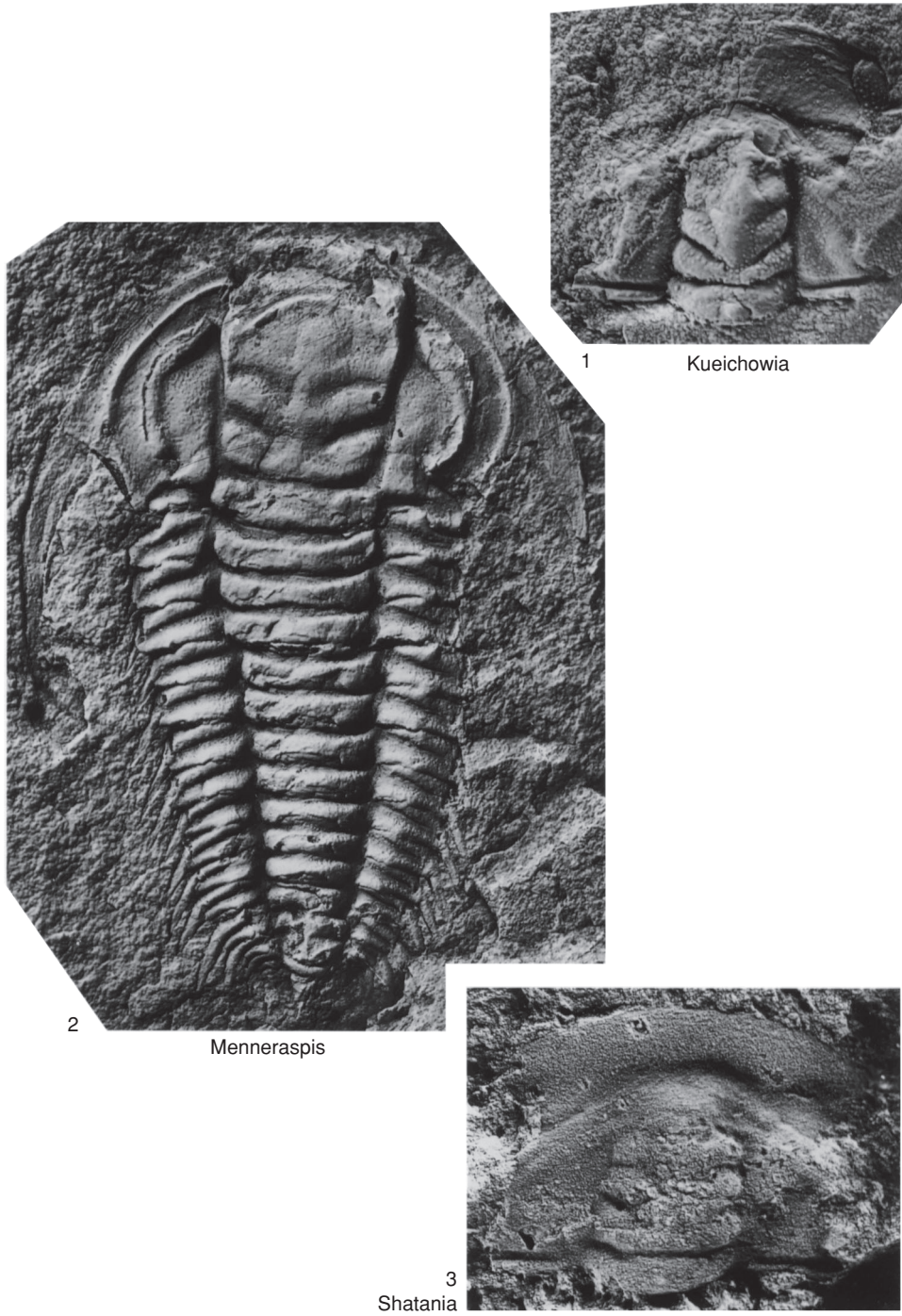


FIG. 299. Kueichowiidae and Menneraspidae (p. 462–466)

with broad axial lobe and broad pleural regions; posterior margin rounded. *Lower Cambrian*.

Menneraspis POKROVSKAYA, 1959, p. 84 [**M. striatus*; OD; holotype (POKROVSKAYA, 1959, pl. 3, fig. 2), 3536/70, repository unknown]. Characters of the family. *Lower Cambrian*: Russia (Tuva), Toyonian (*Kooteniella* to *Edelsteinaspis* Zones); northwestern Siberia (northeastern Krasnoyarsk Basin), *Lermontovia grandis-Paramicamacca petropavlovskii* Zone. —FIG. 299,2. **M. striatus*, Tuva; holotype, incomplete dorsal exoskeleton, $\times 5.75$ (Pokrovskaya, 1959).

Family REDLICHINIDAE Zhang & Lin, 1980

[Redlichinidae ZHANG & LIN in W. ZHANG, LU, & others, 1980, p. 81]

Cephalon without intergenal angle; genal spine not advanced; glabella conical, with frontal lobe well rounded and 3 pairs of glabellar furrows; occipital ring with or without occipital spine; preglabellar field long (sag.); eye lobe long to medium-sized; posterior area of fixigena usually broad (tr.) and long (exs.). Pygidium with large axial lobe having 1 to 5 rings and terminal piece; pleural regions usually flat, broad; pleural furrow absent or with 1 to 2 pairs of furrows; posterior margin arched forward. *Lower Cambrian*.

Redlichina LERMONTOVA, 1940, p. 133 [**R. vologdini*; OD; holotype (LERMONTOVA, 1940, pl. 39, fig. 4; SD REPINA, 1966, p. 50), 9182/127, CNIGR, St. Petersburg]. Similar to *Redlichia*, but having shorter eye lobe, longer (sag.) preglabellar field, longer eye ridge, longer (exs.) posterior area of fixigena and occipital spine. Pygidium with large axis, consisting of 2 to 3 rings and flat, narrow pleurae. *Lower Cambrian (Atdabanian)*: Russia (Sayan-Altay). —FIG. 300,5. **R. vologdini*; lectotype, cranidium, $\times 2$ (Lermontova, 1940).

Asthenaspis SUVOROVA, 1959, p. 74, non *Asthenaspis* SUVOROVA, 1959, p. 70; REPINA, 1960, 1966b, in error [**A. tenuis*; OD; holotype (SUVOROVA, 1959, p. 74, pl. 6, fig. 10), 711/350, PIN, Moscow]. Palpebral area of fixigena one-third width of basal glabella; eye ridge short; eye lobe long and arcuate, reaching posterior border furrow; anterior border furrow faint; border narrow (sag.); narrow plectrum present; anterior sections of facial sutures divergent; librigena with short genal spine. Pygidial axial lobe broadly rounded, faintly segmented; pleural region bilobed. *Lower Cambrian*: southeastern Siberia, Botomian (*Bergeroniaspis ornata* Zone); southwestern Siberia, *Bathyuriscellus* Zone. —FIG. 300,2. **A. tenuis*, southeastern Siberia; holotype, cranidium, $\times 8$ (Suvorova, 1959).

Kolbaspis REPINA in ZHURAVLEVA & others, 1979, p. 29 [**K. sajanica*; OD; holotype (ZHURAVLEVA & others, 1979, pl. 1, fig. 12), 403/40, CSGM, Novosibirsk]. Glabella subcylindrical, with faint glabellar furrows; occipital ring feebly separated; anterior border of medium length (sag.); plectrum narrow (tr.); fixigena narrow (tr.), raised towards long, feebly arcuate palpebral lobe; eye ridge short; anterior branch of facial suture slightly divergent; librigenal spine not advanced. Pygidium small, with semielliptical axial lobe and pleural region not segmented. *Lower Cambrian (Botomian)*: Russia (eastern Sayan), *Bathyuriscellus robustus-Jakutus quadriceps* Zone. —FIG. 300,3. **K. sajanica*; holotype, cranidium, $\times 9$ (Zhuravleva & others, 1979).

Parasajanaspis TCHERNYSHEVA 1972, p. 212 [**P. lauta*; OD; holotype (TCHERNYSHEVA 1972, pl. 53, fig. 6), 10319/3, CNIGR, St. Petersburg]. Dorsal shield flattened. Cranidium slightly widened transversely. Glabella tapering forward, with 3 pairs of glabellar furrows; occipital ring with medial node; fixigena flat; palpebral lobe long (exs.) merging into oblique eye ridge; preglabellar field of same length (sag.) as slightly convex anterior border. Thorax with at least 12 segments; pleural region narrower (tr.) than axis; pleurae with slightly oblique pleural furrows and slender spines. *Lower Cambrian (?Atdabanian)*: Russia (Pamir). —FIG. 300,1. **P. lauta*; holotype, incomplete dorsal shield, $\times 1$ (Tchernysheva, 1972).

Sajanaspis REPINA, 1960a, p. 196 [**S. pokrovskayae*; OD; holotype (REPINA, 1960, pl. 11, fig. 1), 3548/46, CSGM, Novosibirsk]. Anterior area of fixigena narrow (tr.); anterior border short (sag. and exs.); eye lobe long (exs.) and arcuate; posterior areas of fixigena very broad (tr.) and long (exs.); librigena with narrow border and short genal spine. Thorax with 15 segments. Pygidium small, with broad (tr.) axial lobe and broad pleural regions. *Lower Cambrian*: Russia (eastern and western Sayan, Altay, Gornaja Shoria, Tuva, Kuznetsk Alatau), Atdabanian (*Sajanaspis* Zone); western Mongolia, *Tologoja subquadrata-Sajanaspis modesta* Zone; northern Mongolia, *Tologoja subquadrata-Margodiscus rackovskii-Sajanaspis* Zone. —FIG. 300,6. **S. pokrovskayae*, eastern and western Sayan mountains; holotype, cranidium, $\times 5$ (Repina, 1960).

Tungusella REPINA, 1960, p. 178 [**T. manica*; OD; holotype (REPINA, 1960, pl. 4, fig. 6), 3544/290, CSGM, Novosibirsk]. Occipital furrow very shallow medially; occipital ring with a small median node; anterior border short (sag. and exs.); preglabellar field longer (sag.) than anterior border, with radiating striations; eye ridge oblique; eye lobe medium-sized; anterior sections of facial sutures divergent. Thorax with no less than 14 segments. Pygidium with 1 to 2 pairs of pygidial spines; posterior margin rounded or slightly arched forward. Librigena unknown. *Lower Cambrian*: western Krasnoyarsk Territory (Irkutsk region, eastern Sayan), Atdabanian—lower Botoman (*Tungusella* Zone); southwestern Yakutia, Botoman (*Bergeroniellus micmacciiformis-Erbiella* Zone). —FIG. 300,4a,b. **T. manica*, western Krasnoyarsk Terri-

tory; *a*, holotype, cranidium, $\times 3$; *b*, paratype, pygidium, $\times 5$ (Repina, 1960).

Family CHENGKOUASPIDAE Zhang & Lin, 1980

[Chengkouaspidae ZHANG & LIN in W. ZHANG, LU, & others, 1980, p. 227]

Glabella long, convex, parallel sided, or tapering forward, with 2 to 3 pairs of glabellar furrows; anterior field of fixigena absent or short (exs.); preglabellar field absent or short (sag.); eye lobe stout and very long, not differentiated from eye ridge. Pygidium relatively large; axial lobe long and broad (tr.); pleural region broad, with or without pleural furrows; border narrow. *Lower Cambrian*.

Chengkouaspis ZHANG & LIN in W. ZHANG, LU, & others, 1980, p. 227, 432 [**C. longioculus*; OD; holotype (W. ZHANG, LU, & others, 1980, pl. 70, fig. 4), 38008, NIGP, Nanjing]. Differs from *Terechaspis*, *Belliceps*, *Pseudoresserops*, and *Inella* in having longer (sag.) glabella, backward-bent transglabellar and occipital furrows, and very small anterior field of fixigena. *Lower Cambrian (Canglangpuan)*: China (northern Sichuan), *Drepanuroides* Zone or *Palaeolenus* Zone.—FIG. 301,3. **C. longioculus*, *Drepanuroides* Zone, holotype, cranidium, $\times 5$ (W. Zhang, Lu, & others, 1980).

Belliceps REPINA, 1966, p. 77 [**B. simplex*; OD; holotype (REPINA, 1966, pl. 13, fig. 5), 3354/500, CSGM, Novosibirsk]. Cranidium subcircular; axial furrow shallow; glabella convex, tapering forward; frontal lobe bluntly rounded; 3 pairs of pitlike glabellar furrows; occipital furrow deeper distally, not connected in middle; occipital ring longer sagittally and produced backward into occipital spine; anterior border convex and slightly longer sagittally and shorter exsagittally; eye ridge and lobe convex and arcuate; palpebral area of fixigena flat or slightly depressed, about one-half the basal width (tr.) of glabella. Librigena, thorax, and pygidium unknown. Surface finely granulose. *Lower Cambrian (Atdabanian)*: Russia (Gornaya Shoria), *Resimopsis* Zone.—FIG. 301,4. **B. simplex*; holotype, cranidium, $\times 3$ (Repina, 1966).

Bulaiaspis LERMONTOVA in REPINA, 1956, p. 145 [**B. vologdini*; OD; holotype (REPINA, 1956, pl. 28, fig. 1), 3544/45, CNIGR, St. Petersburg]. Cranidium subtrapezoidal; glabella tapering forward; proximal end of eye ridge trifid; librigena narrow (tr.), with advanced genal spine; eye lobe medium-sized or very long. Thorax with 17 segments; axial spine on 11th segment. Pygidium semicircular, with axial rings and terminal piece; pleural regions with pleural furrows; border narrow. *Lower Cambrian*: Russia (southwestern Yakutia, Irkutsk, southern Krasnoyarsk Territory, Transbaikal region, eastern Sayan mountains, Kuznetsk Alatau), *Bulaiaspis* and *Tungusella* Zones; northern Mongolia, *Tologoja*

subquadrata-*Margodiscus rackovskii*-*Sajanaspis* Zone and *Fallotaspidella-Bulaiaspis* Zone.—FIG. 301,1a,b. **B. vologdini*, Irkutsk, late Atdabanian stage, *Bulaiaspis* Zone; *a*, holotype, cranidium, $\times 5$; *b*, paratype, pygidium, $\times 11$ (Repina, 1956).

Inella REPINA in REPINA & others, 1964, p. 269 [**I. monstrabilica*; holotype (REPINA & others, 1964, pl. 35, fig. 4), 252/4, CSGM, Novosibirsk]. Cranidium semielliptical; axial furrow deep and broad (tr.); glabella subparallel behind S2, then rapidly tapering in front of S2; frontal lobe of glabella acutely rounded; 3 pairs of narrow and shallow glabellar furrows; occipital furrow deeper distally, but not connected in middle; anterior border short (sag., exs.) and convex; eye ridge bifid proximally; palpebral furrow broad (tr.) and deep; palpebral areas of fixigenae convex, about one-third glabellar width (tr.); posterior areas of fixigenae well developed and wide (tr.); posterior border furrow long (exs.) and wide (tr.). Librigena, thorax, and pygidium unknown. *Lower Cambrian (Atdabanian)*: Russia (Sayan-Altay), *Pagetiellus* Zone.—FIG. 302. **I. monstrabilica*; holotype, cranidium, $\times 5$ (Repina & others, 1964).

Pseudoresserops REPINA in KHOMENTOVSKII & REPINA, 1965, p. 126 [**P. oculatus*; OD; holotype (KHOMENTOVSKII & REPINA, 1965, pl. 5, fig. 2), 265/537, CSGM, Novosibirsk (although the catalog number of holotype is given as "265/537, pl. 5, fig. 1" in the text, in the plate explanation, the specimen illustrated on pl. 5, fig. 2 is 265/537)]. Cranidium subtrapezoidal; glabella convex, slightly contracted at the middle, tapering rapidly in front of S3; frontal lobe acutely rounded; S1 bifurcate proximally; occipital furrow shallow and narrow (sag., exs.), bending slightly backward; posterior margin of occipital ring rounded; anterior border flat, becoming shorter (exs.) distally; eye ridge and lobe convex, stout, feebly arcuate, its posterior tip reaching level of occipital furrow; palpebral area of fixigena about one-third basal glabellar width (tr.); posterior areas of fixigenae long (exs.) and wide (tr.). Librigena, thorax, and pygidium unknown. *Lower Cambrian (Atdabanian)*: Russia (southern and western Yakutia), *Pagetiellus anabarus* Zone; northern Mongolia, *Tologoja subquadrata*-*Margodiscus rackovskii*-*Sajanaspis* Zone and *Elganellus-Malykania* Zone.—FIG. 301,2. **P. oculatus*, south bank of Lena River, about 300 km west of Yakutsk; holotype, cranidium, $\times 5$ (Khomentovskii & Repina, 1965).

Terechaspis REPINA, 1960, p. 208 [**T. coronaria*; OD; holotype (REPINA, 1960, pl. 13, fig. 6), 3548/382, CSGM, Novosibirsk] [= *Nellina* POKROVSKAYA, 1967, p. 115 (type, *N. miranda*; OD)]. Cranidium semicircular; axial furrow shallow; glabella (except occipital ring) as wide as long, tapering forward; S3 and S2 deep and near transverse; S1 longer and oblique proximally backward; occipital furrow slightly bending backward; occipital ring of uniform length (sag. and exs.); anterior border rimlike; preglabellar field and anterior areas of fixigenae absent; eye ridge and lobe arcuate; posterior area of fixigena very short (exs.) and narrow (tr.).

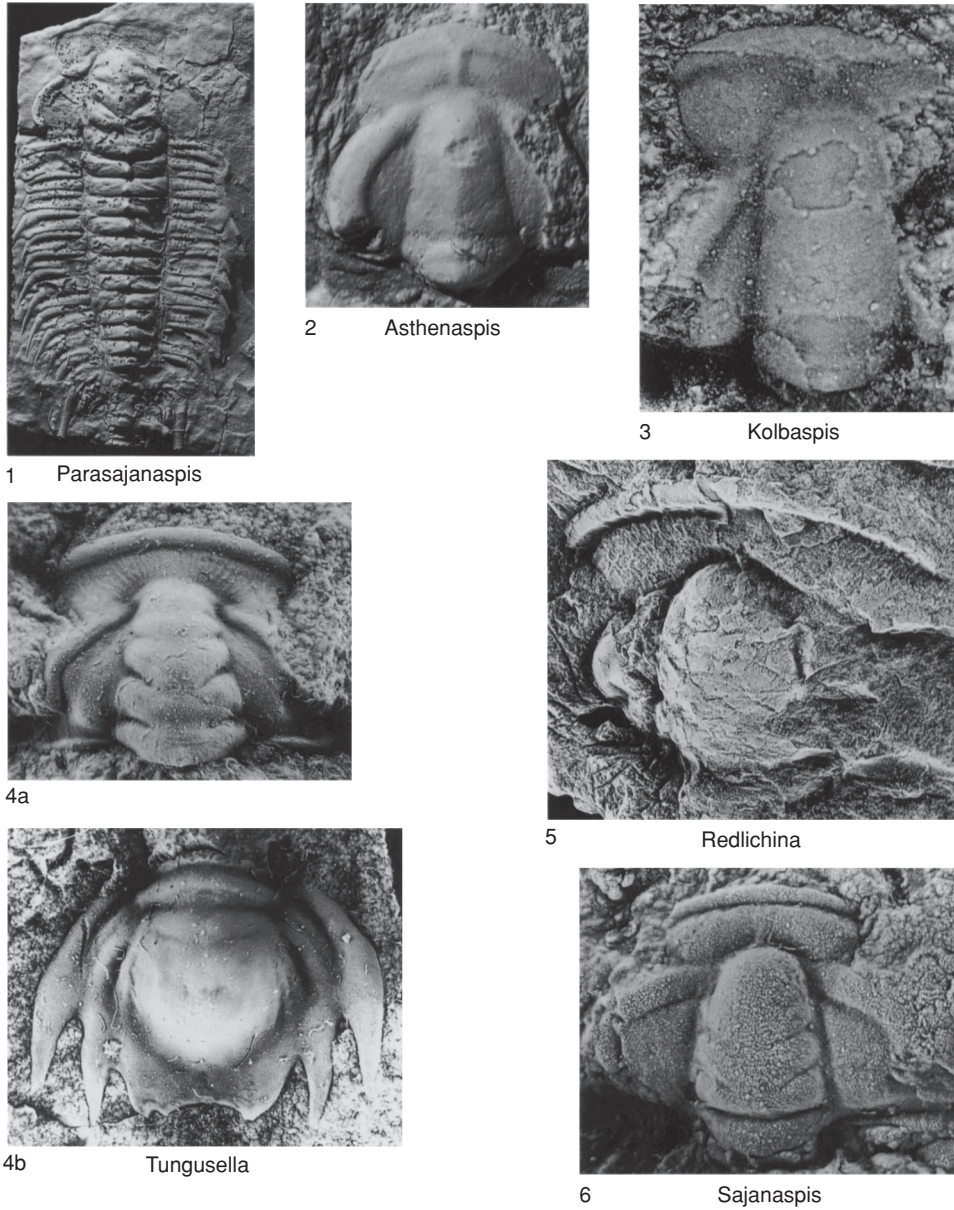


FIG. 300. Redlichinidae (p. 466–467)

Librigena, thorax, and pygidium unknown. *Lower Cambrian (Atdabanian–lower Botoman)*: Russia (eastern and western Sayan, Tuva), *Sajanaspis* and *Poliellina-Serrodiscus* Zones.—FIG. 301, 5. **T. coronaria*; eastern Sayan, holotype, cranidium, $\times 4.5$ (Repina, 1960).

Family UNCERTAIN

Akbashichia KOROBV, 1989, p. 75 [**A. plana*; OD; holotype (KOROBV, 1989, pl. 3, fig. 5), 4726/39, GIN, Moscow]. Similar to *Redlichia* in conical glabella, in long (exs.) and arcuate palpebral lobe, and

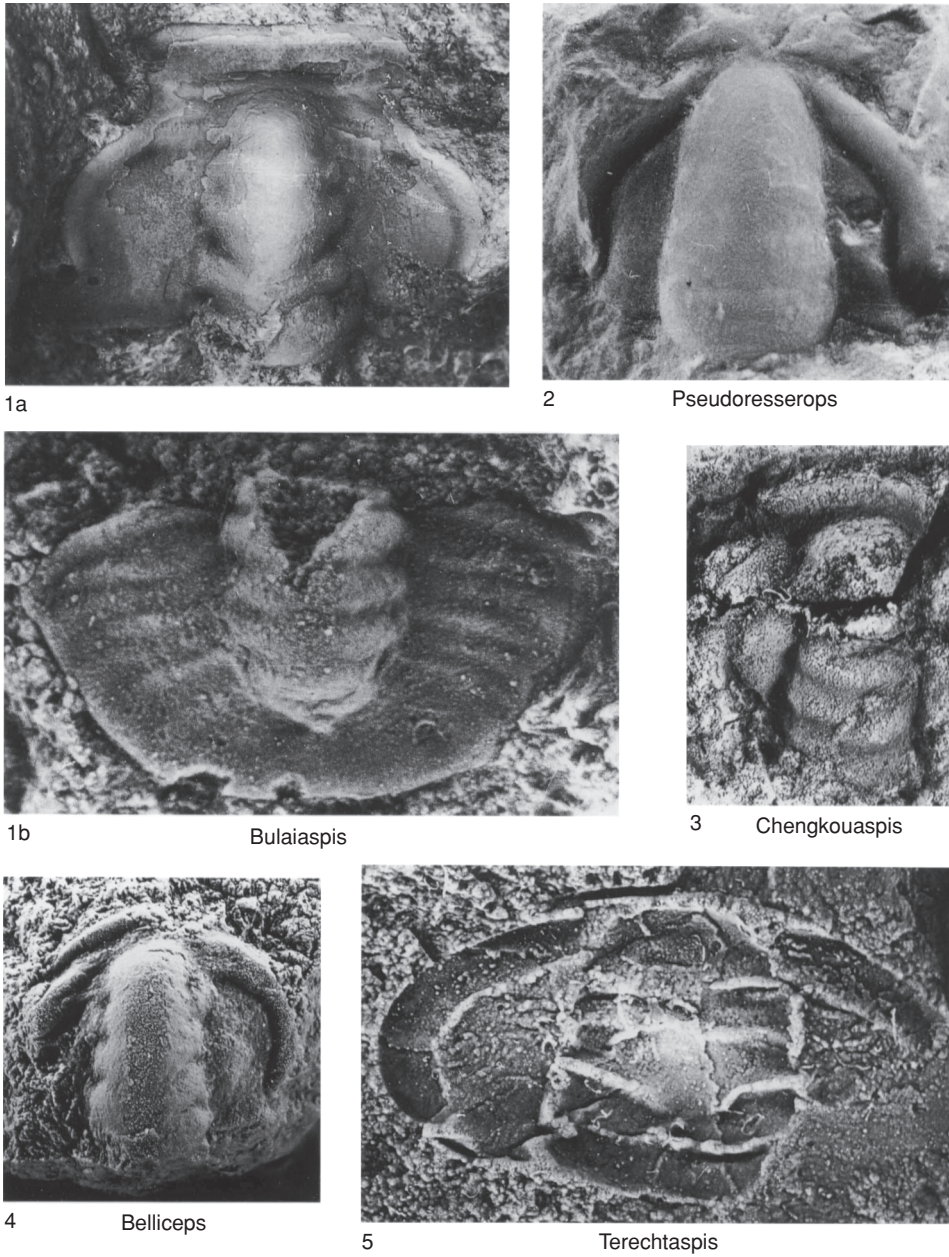
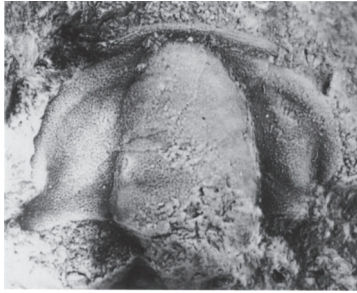


FIG. 301. Chengkouaspidae (p. 467–468)

in course of anterior section of facial suture, but frontal area longer (sag.) and cranial border furrow and glabellar furrows less distinct. Librigena, thorax, and pygidium unknown. *Lower Cambrian (upper Atadabanian)*: western Mongolia (Akbashi, 40

km northeast of Kobodo).—FIG. 303, I. **A. plana*; holotype, cranidium, $\times 2$ (Korobov, 1989). *Elegestina* POKROVSKAYA, 1959, p. 63 [**E. antiqua*; OD; holotype (POKROVSKAYA, 1959, pl. 1, fig. 11), 3536/18, GIN, Moscow]. Glabella convex, short



Inella

FIG. 302. Chengkouaspidae (p. 467)

(sag.), and broad (tr.); anterior margin of frontal lobe more or less acutely rounded; glabellar furrows indistinct; preglabellar field very short (sag.); border furrow narrow; border convex and long (sag.); occipital furrow narrow and nearly straight; occipital ring longer (sag.) medially; oblique eye ridge narrow; palpebral lobe close to glabella. *Lower Cambrian (Botomian)*: Russia (Tuva), *Poliella-Laticephalus* Zone.—FIG. 303,5. **E. antiqua*; holotype, cranidium, $\times 1.5$ (Pokrovskaya, 1959).

Elganellus SUVOROVA, 1958, p. 918 [**E. probus*; OD; holotype (SUVOROVA, 1958, fig. 4d), 711/3, PIN, Moscow]. Cranidium subquadrate, strongly convex; glabella broad, tapering forward, with well-rounded frontal lobe; eye lobe medium-sized; parafrontal band prominent; anterior border short (sag. and exs.); preglabellar field same length (sag.) as border; anterior sections of facial sutures slightly divergent; occipital node distinct; librigena with short genal spine. *Lower Cambrian*: Russia (southwestern Siberia), Atdabanian, *Elganellus* Zone, (Kuznetsk Alatau, Batenevskiy Ridge, Gorniy Altai), *Resimopsis* Zone; northwestern Mongolia, *Elganellus-Mabkhanian* Zone.—FIG. 303,4. **E. probus*, southwestern Siberia; holotype, cranidium, $\times 4$ (Suvorova, 1958).

Iolgia KRAEVSKY, 1965, p. 50 [**I. prima*; OD; holotype (KRAEVSKY, 1965, pl. 1, fig. 13a), 871/13, CSGM, Novosibirsk]. Cranidium small; palpebral lobe upturned over fixigena; preglabellar field concave, with narrow median ridges connecting glabella with narrow anterior border; anterior branch of facial suture divergent (about 45°); librigena with long genal spine. *Lower Cambrian (Botomian)*: Russia (Gorniy Altai), *Poliella-Laticephalus* Zone.—FIG. 303,6. **I. prima*; holotype, cranidium, $\times 6$ (Kraevsky, 1965).

Paratungusella REPINA & others, 1964, p. 71 [**P. triangulata*; OD; holotype (REPINA & others, 1964, pl. 1, fig. 9), 246/11, CSGM, Novosibirsk]. Cranidium subtrapezoidal; glabella conical, with well-rounded frontal lobe; occipital ring with small median node; eye ridge long (tr.); eye lobe medium-sized; palpebral area of fixigena broad (tr.); border convex; plectrum prominent; anterior sections of facial sutures slightly divergent. *Lower Cambrian*

(*Botomian*): Russia (Kuznetsk Alatau), *Poliellina-Serrodiscus* Zone.—FIG. 303,3. **P. triangulata*; holotype, cranidium, $\times 2$ (Repina & others, 1964).

Sarassina ROMANENKO in POSPELOV & ROMANENKO, 1980, p. 69 [**S. alutacea*; OD; holotype (POSPELOV & ROMANENKO, 1980, pl. 13, fig. 8), 1931/16, MWSGPC, Novokuznetsk]. Cranidium subquadrate, flattened, with broadly rounded anterior margin; glabella faintly tapered to anterior end, with 3 pairs of glabellar furrows; occipital ring with node or spine; palpebral lobe moderately curved, widened in posterior half; eye ridge bifid, the anterior branches embracing glabella anteriorly, and connected with anterior border by median plectrum; border distinct; preglabellar field relatively long (sag.). Surface densely anastomosing. *Lower Cambrian (Atdabanian)*: Russia (Siberia, Altay). —FIG. 303,2. **S. alutacea*; holotype, cranidium, $\times 7$ (Pospelov & Romanenko, 1980).

UNRECOGNIZABLE REDLICHIOID GENERA

Eomalungia S. LI, 1978, p. 197 [**E. latilimbata*; OD]. *Lower Cambrian*: southwestern China (Sichuan).

Fandianaspis S. LI, 1978, p. 213 [**F. fandianensis*; OD]. *Lower Cambrian*: southwestern China (Sichuan).

Guangyuania S. LI, 1978, p. 209 [**G. conica*; OD]. *Lower Cambrian*: southwestern China (northern Sichuan).

Longmenshan S. LI, 1978, p. 198 [**L. longmenshanensis*; OD]. *Lower Cambrian*: southwestern China (northern Sichuan).

Micangshania ZHOU in Y. LI & others, 1975, p. 140 [**M. gracilis*; OD]. *Lower Cambrian*: China (southern Shaanxi).

Parawutingaspis S. LI, 1978, p. 191 [**P. convexa*; OD]. *Lower Cambrian*: China (northern Sichuan).

Pseudowutingaspis S. LI, 1978, p. 190 [**P. longmenshanensis*; OD]. *Lower Cambrian*: China (northern Sichuan).

Runnan LI in YIN & LI, 1978, p. 413 [**R. runnansensis*; OD]. *Lower Cambrian*: southwestern China (northern Guizhou).

Shangsiaspis S. LI, 1978, p. 214 [**S. shangsiensis*; OD]. *Lower Cambrian*: China (northern Sichuan).

Xingzishania ZHOU in Y. LI & others, 1975, p. 139 [**X. lata*; OD]. *Lower Cambrian*: China (southern Shaanxi).

Yiliangella (Pseudoyiliangella) YIN in YIN & LI, 1978, p. 420 [**Y. (P.) xishuiensis*; OD]. *Lower Cambrian*: southwestern China (northern Guizhou).

Superfamily PARADOXIDOIDEA Hawle & Corda, 1847

W. T. DEAN and A. W. A. RUSHTON

[*nom. correct.* DEAN & RUSHTON, herein, pro Paradoxioidea POULSEN in MOORE, 1959, p. 212, pro Paradoxides HAWLE & CORDA, 1847, p. 15]

Opisthoptarian, often large; cephalon subsemicircular with long librigenal spine;

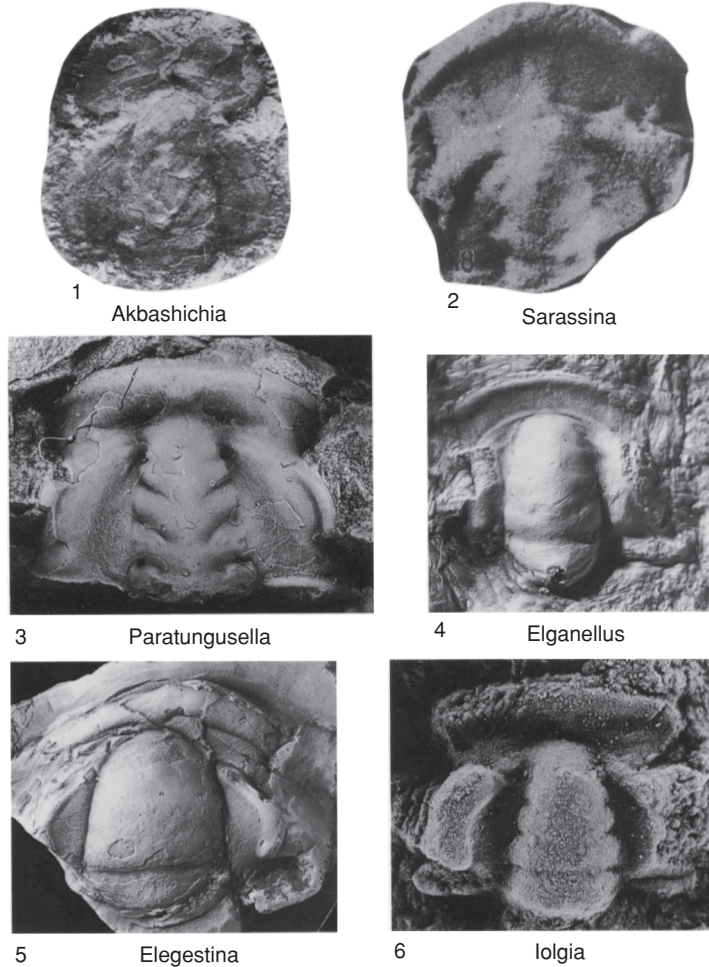


FIG. 303. Family Uncertain (p. 468–470)

glabella widening anteriorly to rounded or bluntly pointed frontal lobe or may be parallel sided in early forms; L1 to L4 of equal or subequal length; S1 generally transglabellar, shallower medially; S2 long (tr.), subparallel to S1, may be transglabellar; S3 and S4 short (tr.), less deep; preglabellar field typically absent in adult stage; eye short to long (exs.), gently to strongly curved; anterior section of facial suture moderately divergent to retrodivergent (Centropleuridae); rostral suture long (tr.) and curved, delimiting rostral plate that may be fused with large hypostome to form rostral-hypostomal plate. Thorax with 14 to 21 segments ending in

short to long pleural spines directed progressively more strongly backwards from front to rear (Paradoxididae) or in bluntly truncated tips (Centropleuridae); first and second segments may be macropleural. Pygidium typically small in Paradoxididae, may be medium sized in Centropleuridae. *Lower Cambrian–Middle Cambrian.*

Family PARADOXIDIDAE Hawle & Corda, 1847

[Paradoxides HAWLE & CORDA, 1847, p. 15; ICZN Opinion 496, 1957, Family-Group Name No. 204]

Glabella widest across L3 or L4; S3 and S4 may be defined abaxially; palpebral lobe

oblique and short (exs., extending from opposite S1 to S3) to semicircular and long (from LO to L4); visual surface apparently low, with circumocular suture; preglabellar field absent in holaspis, with front of glabella typically indenting anterior border; preglabellar field and preglabellar ridge generally present in meraspis; small occipital node behind midlength of occipital ring; anterior section of facial suture arcuate, moderately to strongly divergent; rostral suture traversing outer surface of anterior border; connective sutures converging to delimit wide (tr.) rostral plate; cephalic border continuous with long librigenal spine; intergenal angle may be present. Hypostome typically narrow (tr.) posteriorly, expanding forward to arched anterior margin; large anterior wing confluent with anterior lobe of middle body; small posterior lobe may be swollen distally, separated from lozenge-shaped anterior lobe by middle furrow that is obsolete medially; narrow (sag.) posterior border may carry pair of short spines. Thorax with up to 21 segments that may be fulcrate, nonfulcrate, or questionably both; axis well defined, occupying less than one-fourth to one-third of overall breadth; pleura may be directed slightly forwards abaxially, divided by nearly straight pleural furrow into subequal anterior and posterior bands, and ending in spine, often falcate; hindmost spines longer, directed more strongly backward, and last pair may be subparallel beside pygidial facets. Pygidium with posterior margin truncate, rounded, bluntly pointed or concave; postaxial region in some species prolonged to form long, spatulate extension that may end in pair of spines; axis may be large in relation to pleural field, with 2 or 3 rectangular axial rings and terminal piece rounded or bluntly pointed; anterior half rib directed backward, often long, with confluent lateral and posterior margins correspondingly short. Surface (excluding furrows) granulose, smooth, or covered with anastomosing terrace ridges. Includes some of the largest known trilobites, with length (sag.) of 40 to 50 cm. *upper Lower Cambrian–upper Middle Cambrian*.

Paradoxides BRONGNIART, 1822, p. 30 [**Entomostracites paradoxissimus* WAHLENBERG, 1818, p. 34; SD BARRANDE, 1852, p. 361; lectotype (WESTERGÅRD, 1953, p. 34, pl. 8, fig. 2), Ar 46147, RM, Stockholm] [= *Vinicella* ŠNAJDR, 1957, p. 237 (type, *Trilobites desideratus* BARRANDE, 1846, p. 20, based on teratological pygidium of *Paradoxides gracilis* BOECK, 1827, *vide* ŠNAJDR, 1978, p. 24–25)]. Glabella with S2 transglabellar and shallow medially; S3 and S4 short (tr.), often faint; anterior border narrow (sag.) medially; eye lobe short (S1 to S3), with moderately deep palpebral furrow; eye ridge may be present; strongly arcuate anterior section of facial suture cutting anterior margin almost in exsagittal line with outer margin of eye lobe; posterior section of facial suture straight or sigmoidal, cutting posterior margin almost in exsagittal line with outer margin of eye lobe; large rostral-hypostomal plate with strongly convex anterior margin. Thorax with 19 to 21 segments where known; segments directed slightly forwards abaxially; hindmost pair of pleural spines subparallel, ending far behind tip of pygidium. Pygidium small, subhexagonal, widest behind midlength, at posterior end of long facet directed strongly backward; lateral margin short, slightly convex; posterior margin convex, straight, or concave; axis subtriangular; pleural and postaxial regions confluent and uniformly convex. [Many specimens supposedly of *Paradoxides* are based on material too incomplete for confident generic determination; for example, specimens from Colombia, South America (RUSHTON, 1963), and a record from Australia (WHITEHOUSE, 1939, p. 276) are here excluded.] *middle Middle Cambrian–upper Middle Cambrian*: England, Wales, *H. parvifrons?*–*Pt. punctuosus* Zones; Sweden, Norway, Denmark, *P. paradoxissimus* and *P. forchhammeri* Stages; Czech Republic, *P. gracilis* Zone; Canada (eastern Newfoundland), *Pt. punctuosus* Zone; ?USA (South Carolina), ?Russia (Novaya Zemlya).—FIG. 304, 1a. **P. paradoxissimus* (WAHLENBERG), middle Middle Cambrian (*P. paradoxissimus* Stage), Sweden (Öltoorp, Västergötland); lectotype, exoskeleton, RM Ar46147, ×1 (new).—FIG. 304, 1b. *P. gracilis*, middle Middle Cambrian, Czech Republic (Jince); rostral-hypostomal plate, SM A.1561, ×1 (new).

Acadoparadoxides ŠNAJDR, 1957, p. 238 [**Paradoxides Sacheri* BARRANDE, 1852, p. 369; OD; holotype (ŠNAJDR, 1958, p. 147), ČC 185, No. 76, NMP, Prague] [= *Eoparadoxides* SOLOVIEV, 1969, p. 16 (type, *Paradoxides harlani* GREEN, 1834, p. 335; OD)]. Glabella widening anteriorly, either with axial furrow nearly straight, or with stronger widening in front of L2; S2 transglabellar, S3 and S4 faint; palpebral lobe arcuate, long (SO to L4); palpebral area narrower (tr.) and palpebral lobe wider than in *Eccaparadoxides*; intergenal angle obtuse. Librigena with broad-based genal spine; inner spine angle obtuse. Thorax (where known) with 17 to 19 segments, inner pleural region narrower (tr.) than axis; pleural spines short, hindmost extending back only to tip of pygidium. Pygidium rounded to

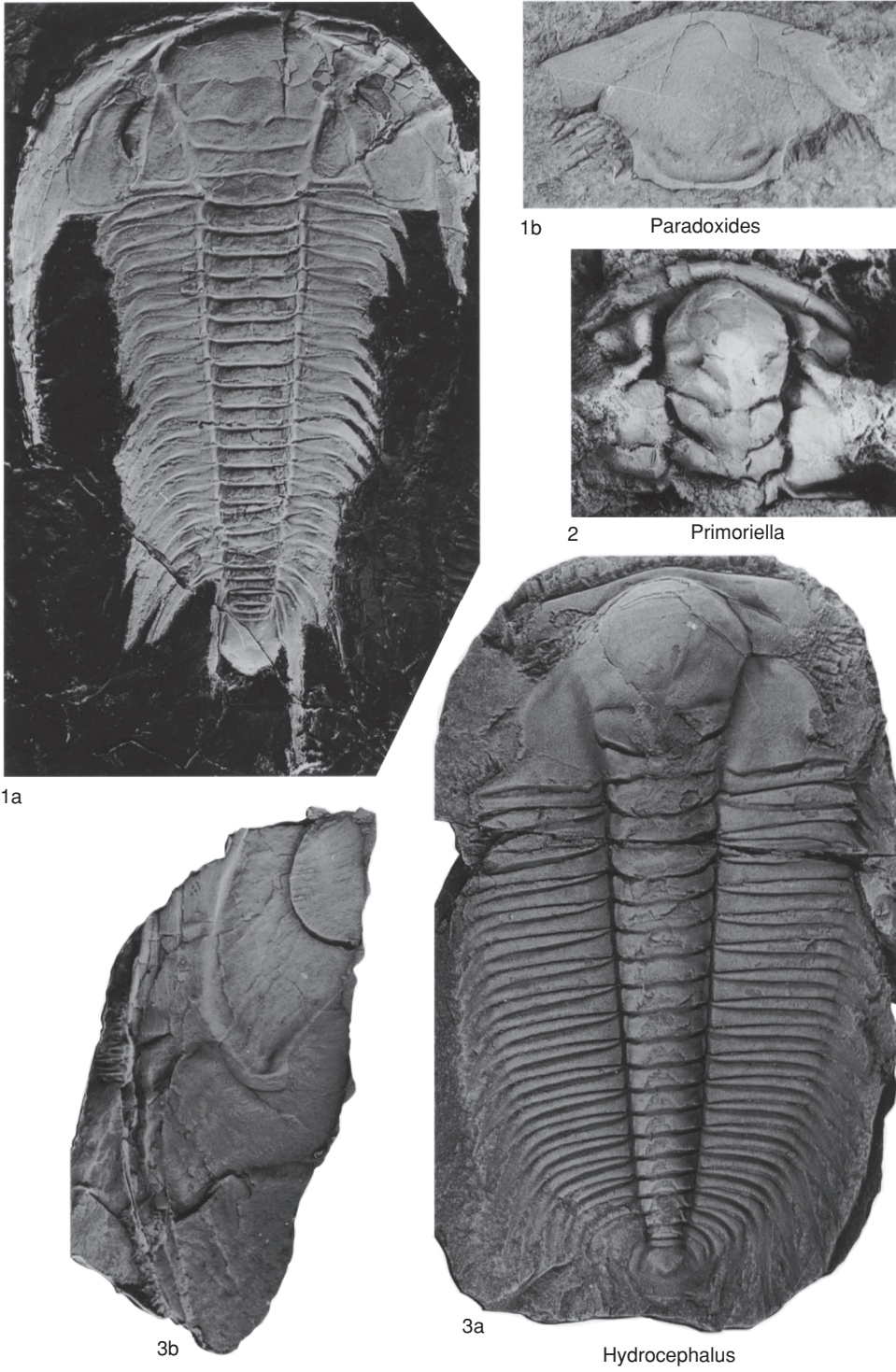


FIG. 304. Paradoxididae (p. 472–478)

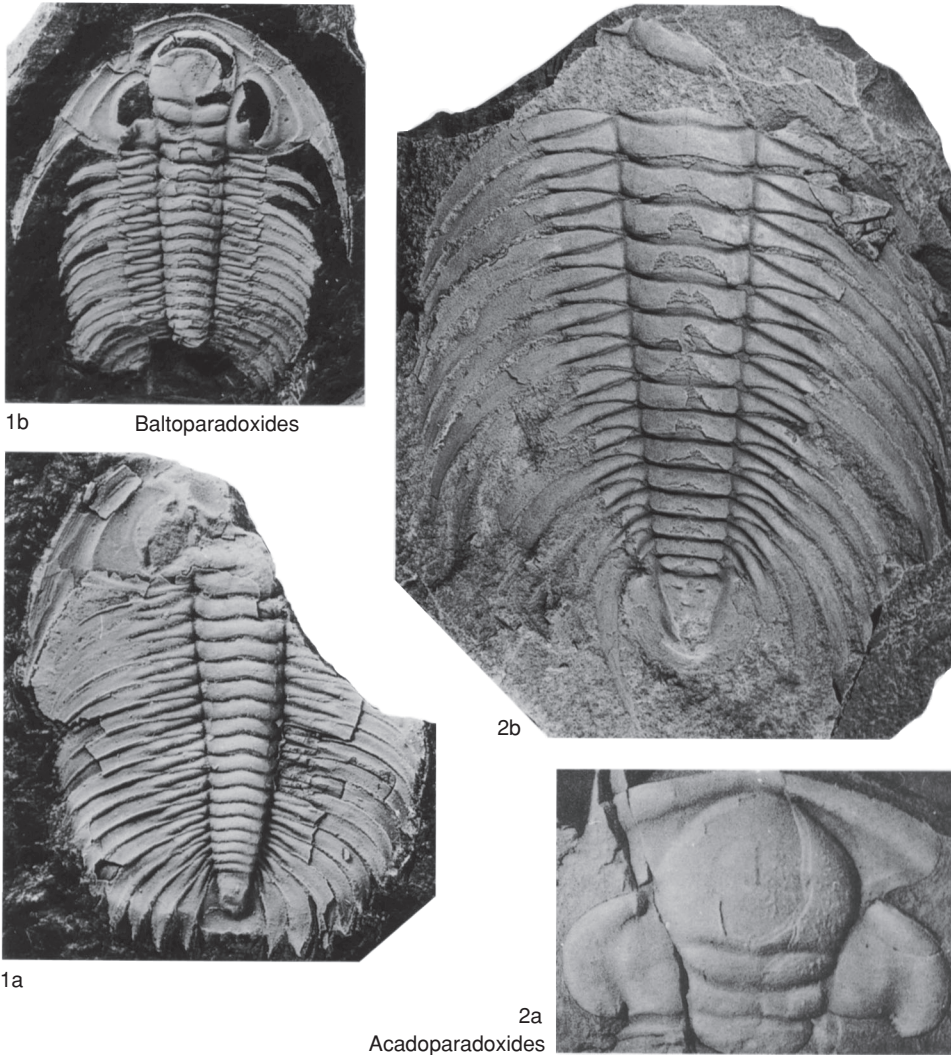


FIG. 305. Paradoxididae (p. 474–475)

hexagonal. *lower Middle Cambrian–upper Middle Cambrian*: England, Wales, Scandinavia (Sweden, Norway), Czech Republic, Poland, Spain, Morocco, Turkey, eastern Canada, USA (Massachusetts), Russia (northern Siberia), ?western Mongolia.

A. (Acadoparadoxides). S2 shallow medially. Thorax (where known) with 19 segments. Pygidium widest at or in front of midlength, as wide as or slightly wider than long; margin rounded or subangular posteriorly; axis subtriangular, about half of pygidial length, with up to 2 axial rings; pleural fields behind axis form ridge that may be as high as, and coalesce with, terminal piece of axis. *lower Middle Cambrian–upper Middle Cambrian*: England, Wales, Czech Republic, Scandi-

navia (Sweden), Poland, eastern Canada (eastern Newfoundland, New Brunswick), Spain, Morocco, Turkey, USA (Massachusetts), Russia (northern Siberia), ?western Mongolia.—FIG. 305,2a,b. *A. (*A.*) *sacheri* (BARRANDE), *E. pusillus* Zone, middle Middle Cambrian, Czech Republic (Jince); a, cranidium, MŠ 360, ×2 (Šnajdr, 1958, pl. 16, fig. 5); b, thorax and pygidium, Schary Collection, MCZ 2752, ×1 (new).

A. (Baltoparadoxides) ŠNAJDR, 1986, p. 174 [**Paradoxides oelandicus* SJÖGREN, 1872, p. 72; OD; holotype (SJÖGREN, 1872, pl. 5, fig. 1, *fide* WESTERGÅRD, 1936, p. 35), Ar 1449, RM, Stockholm]. Glabella nearly straight sided, in holaspis expanding forward slightly, in meraspis

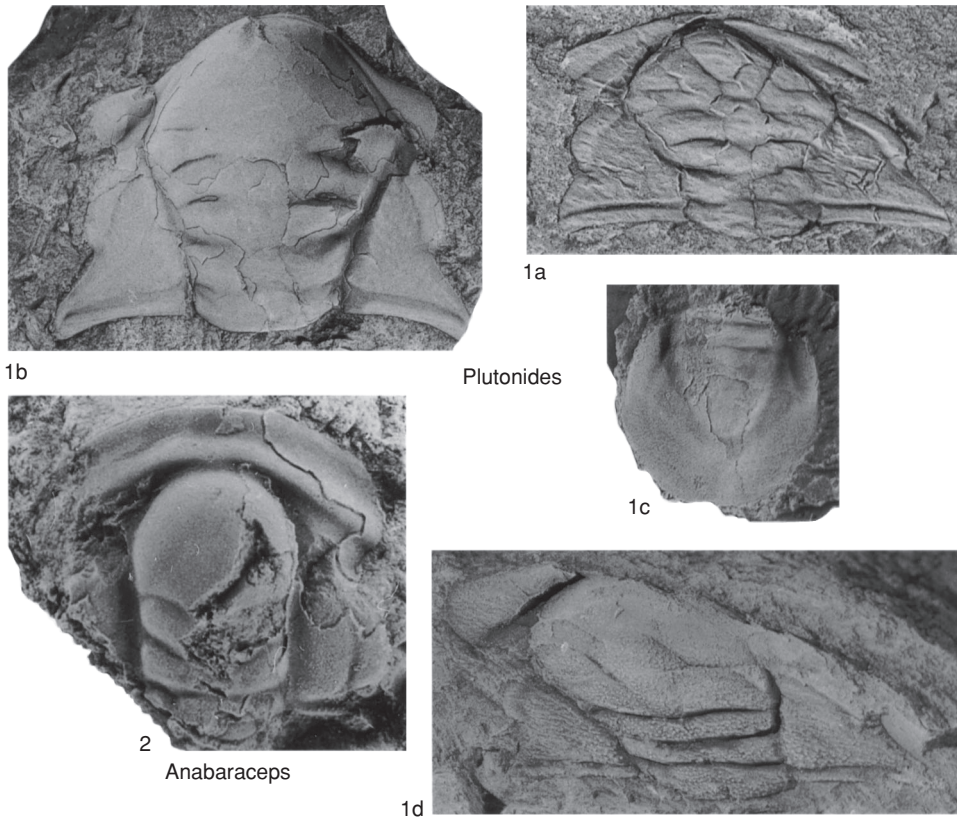


FIG. 306. Paradoxididae (p. 475–478)

almost parallel sided; S2 deep medially. Thorax in type species with 17 segments; outer pleural region wider ($\times 1.25$) than axis. Pygidium subhexagonal, widest at or behind midlength, with long, convex axis; posterior margin with 2 to 4 pairs of short spines that are progressively shorter from outermost to innermost. *lower Middle Cambrian*: Sweden, Norway, Poland, *A. (B.) oelandicus* Stage; ?western Mongolia.—FIG. 305, 1a, b. **A. (B.) oelandicus* (SJÖGREN), Sweden (Öland); a, ?topotype, Borgholm, RM Ar 46245, $\times 1.5$ (new); b, holotype, Borgholm or Storå Fro, RM Ar 1449, $\times 1$ (new).

Anabaraceps REPINA, 1972, p. 29 [**A. kharaulachiensis*; OD; holotype (REPINA, 1972, p. 29, pl. 2, fig. 6–7), N383/101, CNIGR, St. Petersburg]. Glabella convex, widening anteriorly very slightly to subsemicircular frontal lobe and extending to anterior border; S2 transglabellar, shallow medially; L1 and L2 of equal size; palpebral area narrow (0.4 of glabella at S1); palpebral lobe extending from L3 almost to SO, with deep palpebral furrow; frontal area has distinctive, broad ridge subparallel to anterior border furrow; preglabellar field only slightly longer (sag.) than low anterior border; posterior

section of facial suture short; anterior section of facial suture cuts anterior margin almost in exsagittal line with outer edge of palpebral lobe. *Lower Cambrian (Toyonian)*: Russia (northeastern Yakutia), *Paramicmacca* Zone.—FIG. 306, 2. **A. kharaulachiensis*; holotype, cranidium, CNIGR N383/101, $\times 1.5$ (new).

Anabaraspis LERMONTOVA, 1951a, p. 91 [**A. splendens*; OD; syntypes (LERMONTOVA, 1951a, pl. 13, fig. 1, 1a–1f), N120/5156, CNIGR, St. Petersburg]. Glabella subpentagonal, bluntly pointed frontally, widening gently to maximum width (tr.) across L4; S2 transglabellar, shallow medially; S3 and S4 faint; fixigena wide; palpebral lobe long, curved, extending from L1 to S3 and confluent with short eye ridge that meets glabella at or near S4; trace of parafacial band near S4; frontal area relatively long (sag., exs.); preglabellar field and anterior border undifferentiated; frontal area large, about as wide (tr.) as distance across palpebral lobes; anterior section of facial suture long, strongly divergent; posterior section short; genal spine short, stout. Thorax with 15 to 18 segments having long, falcate spines; inner pleural region about as wide as axis. Pygidium longer than wide, subhexagonal, with long, flat

posterior area; posterior margin truncate or indented; axis short, with 1 axial ring. Surface smooth. *Lower Cambrian (Toyonian)–Middle Cambrian (lower Amgan)*: Russia (northwestern and southeastern Yakutia), *A. splendens* and *Oryctocara* Zones.—FIG. 307,2a,b. **A. splendens*; a, lectotype, cranidium, eastern Siberia, locality not specified. Lower Cambrian (“*Protolemus* Zone”), $\times 1$; b, exoskeleton lacking librigenae, Upper Toyonian to lower Amgan, north central Siberia (River Olenek), $\times 2$ (Demokidov & Lazarenko, 1964, pl. 22, fig. 1).

Eccaparadoxides ŠNAJDR, 1957, p. 238 [**Paradoxides pusillus* BARRANDE, 1846, p. 11; OD; lectotype, meraspid cranidium (ŠNAJDR, 1958, p. 117), ČC 321, No. 1244, NMP, Prague] [= *Phanoptes* HAWLE & CORDA, 1847, p. 17, ICZN application pending; *Macrocerca* PILLET in COURTESOLE, PILLET, & VIZCAÍNO, 1988, p. 41 (type, *Eccaparadoxides macrocercus* COURTESOLE, 1967, p. 495; OD)]. Glabella widest across L4 or S4, well rounded frontally; S2 shallow medially; S3 and S4, if present, moderately deep, not reaching axial furrow; palpebral lobe extending from almost SO to L4; anterior section of facial suture moderately divergent in holaspis, almost transverse in meraspis; posterior section of facial suture short, cutting posterior margin almost in line (exs.) with edge of palpebral rim; preglabellar field in meraspis long (sag.), with sagittal preglabellar ridge; in holaspis preglabellar field is absent, anterior border is narrow (sag.) medially; hypostome not fused with rostral plate. Thorax with 16 to 18 segments having short to long, falcate pleural spines; inner pleural region narrow. Pygidium typically hexagonal, with terminal area short, long and spatulate, or very long; posterior margin straight or concave, ending in posterolateral angle or spine. *lower Middle Cambrian–upper Middle Cambrian*: England, Wales, France, Spain, Czech Republic, Sardinia, Sweden, Norway, northern Africa (Morocco, Algeria, Egypt), Russia (northern Siberia), western Mongolia, eastern USA (New York), eastern Canada (eastern Newfoundland, Nova Scotia, New Brunswick), Turkey.—FIG. 307,1a,b. **E. pusillus* (BARRANDE), middle Middle Cambrian (*E. pusillus* Zone), Czech Republic (Skryje); a, cranidium, MCZ 2754, $\times 1.5$; b, pygidium, MCZ 2757b, $\times 4$ (new).

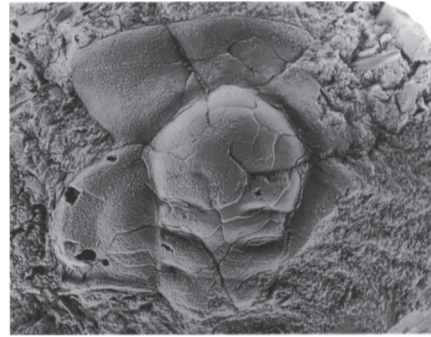
Hydrocephalus BARRANDE, 1846, p. 19 [**H. carens*; SD ŠNAJDR, 1958, p. 129; lectotype, meraspid stage 8 or 9 (ŠNAJDR, 1958, pl. 24, fig. 32), ČC 210, No. 1053, NMP, Prague] [= *Phlysiacium* HAWLE & CORDA, 1847, p. 16 (type, *P. paradoxum* HAWLE & CORDA, 1847, p. 16; M); *Rejkocephalus* KORDULE, 1990, p. 55 (type, *Paradoxides rotundatus* BARRANDE, 1846, p. 11; OD)]. Glabella reaching to maximum width (tr.) across L4, about 1.5 times wider than across LO; S1 and S2 transglabellar; S3 and S4 short, shallow; in meraspis, glabella is relatively large and subcircular in front of SO; palpebral lobe moderately long, extending from L1 to S3; posterior branch of facial suture longer than in

Eccaparadoxides and *Acadoparadoxides* and cutting posterior margin at acute angle just inside genal angle; posterior border curving forward to acute inner spine angle that is not present in *Plutonides*. Hypostome not fused with rostral plate, with short spine in front of posterolateral angle. Thorax with 17 to 18 segments ending in short pleural spines; hindmost pleurae curving backwards more strongly; inner pleural region wider (tr.) than axis. Pygidium 1.6 times wider (tr.) than long, with bluntly rounded posterior margin; axis large, bluntly pointed, occupying 80% of length and more than one-half width of pygidium. [Supposed examples of genus in the United Kingdom, eastern Canada, and Scandinavia are here referred to *Plutonides* or are of uncertain generic position.] *lower Middle Cambrian–middle Middle Cambrian*: Czech Republic, Spain, Morocco.—FIG. 304,3a. *H. lyelli* (BARRANDE), middle Middle Cambrian (Jince Formation, *H. lyelli* Zone), Czech Republic (Jince); exoskeleton lacking librigenae, IRScNB 189, $\times 1$. —FIG. 304,3b. **H. carens*, middle Middle Cambrian, *E. pusillus* Zone, Czech Republic (near Skryje); latex cast of left librigena, BMNH It.529b, $\times 1$ (new).

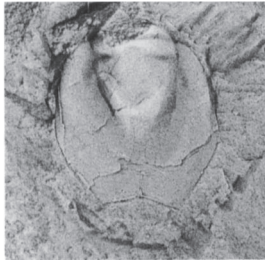
Plutonides HICKS, 1895, p. 230, *nom. nov. pro Plutonia* HICKS, 1871, p. 399 (1869, p. 69, *nom. nud.*), *non* STABILE, 1864, p. 121 [**Plutonia Sedgwickii* HICKS, 1871, p. 399; M; lectotype, cranidium (here selected), A1086, SM, Cambridge]. Holaspis: glabella widening markedly to L4; frontal lobe long, up to 0.4 glabellar length (sag.), bluntly pointed, hanging over narrow (sag.) anterior border; S1 transglabellar, shallow medially; S2 to S4 well defined only abaxially; S3 and S4 may be effaced; preocular field small, narrower (tr.) than distance across palpebral lobes; palpebral lobe oblique, extending from L1 or S1 to about S4; posterior section of facial suture short, sigmoidal; hypostome not fused with rostral plate. Meraspis: glabella widening only slightly to broadly rounded; frontal lobe short (0.15 glabellar length); preglabellar field long (sag.), with sagittal preglabellar ridge; anterior border well defined, broadly curved, uniformly wide (sag.); S1 transglabellar; S2 to S4 deep, transverse; palpebral lobe long, well defined, confluent with eye ridge to axial furrow at or in front of S4. Thorax (where known) with 19 segments; transverse pleurae ending in short, falcate spines; inner pleural region slightly wider (tr.) than axis. Pygidium (not known for type species) subhexagonal, bluntly truncate posteriorly; axis convex, about one-half length of pygidium, with rounded tip; postaxial region slightly convex; 1 axial ring. Surface coarsely granulate or with meshlike pattern of fine, anastomosing ridges, or both. *middle Middle Cambrian*: Russia (Siberia); Mongolia; England, Wales, *T. gibbus* and *T. fissus* Zones; Sweden, *T. fissus*–*Pt. atavus* Zone; eastern Canada (eastern Newfoundland, Nova Scotia), *P. hicksii* Zone.—FIG. 306,1a–c. *P. hicksii* (SALTER); a, cranidium, southwestern Wales (Solva), NMW 91.19G.2, $\times 4$; b, cranidium, GSC



1a Eccaparadoxides



2a Anabaraspis



1b



3a



3b Schagonaria



2b

FIG. 307. Paradoxididae (p. 475–478)

13070, $\times 1$, and *c*, pygidium, GSC 101839, eastern Newfoundland (Trinity Bay and Random Island), $\times 2$ (new).—FIG. 306, *1d*. **P. sedgwickii* (HICKS); lectotype, cranidium, southwestern Wales (St. David's), $\times 2.5$ (new).

?*Primoriella* REPINA, 1973, p. 170 [**P. bella*; OD; holotype (REPINA, 1973, p. 171, pl. 35, fig. 1–2), 501/1551, CSGM, Novosibirsk]. Cranidium wider (tr.) than long; glabella convex, parallel sided posteriorly, expanding slightly to maximum width (tr.) at S4; frontal lobe subrounded, indenting roll-like anterior border; S1 transglabellar but faint medially; S2 transglabellar or not; S3 and S4 short (tr.), well defined; palpebral area and frontal area of equal width; eye lobe short, extending from L1 to S2 and continuous with eye ridge that ends at L4; anterior section of facial suture slightly divergent, posterior section relatively long. *uppermost Lower Cambrian*: Russia (far eastern Siberia), *Redlichina culmenica* beds.—FIG. 304, *2*. **P. bella*, Siberia (Primorye); holotype, cranidium, CSGM 501/1511, $\times 2$ (new).

Schagonaria POLETAEVA in EGOROVA & others, 1955, p. 111 [**S. tannuola*; OD; syntypes (EGOROVA & others, 1955, pl. 12, fig. 1a–1b), repository and numbers not specified]. Glabella elongate, widening anteriorly only slightly to maximum width (tr.) between S2 and preglabellar furrow; frontal lobe may reach anterior border; preglabellar ridge may be present in some specimens; S1 and S2 oblique inwards and backwards, nearly straight, meeting at sagittal line; fixigena narrow; palpebral lobe long, extending from L1 to L3 and merging with short eye ridge. Thorax with 16 segments. Pygidium poorly known but spatulate. *Middle Cambrian (Amgaian)*: Russia (Ulukhema River, Tuva Region).—FIG. 307, *3a, b*. **S. tannuola*; *a*, dorsal exoskeleton, CSGM 296/75, $\times 4$; *b*, cranidium, CSGM 296, $\times 2$ (new).

Family CENTROPLEURIDAE Angelin, 1854

[Centropleuridae ANGELIN, 1854 in 1851–1878, p. 87]

Glabella widest (tr.) across L4; S1 transglabellar, relatively wide and deep; S2 and S3 incised, narrow, not transglabellar; S4 very oblique forwards and outwards, making large angle with S3; palpebral lobe generally long; fixigena bearing exsagittal, ridgelike baccula; anterior section of facial suture transverse or retrodivergent; genal spine long; distal end of posterior border may curve forwards to form intergenal angle; hypostome subquadrate. Thorax with 14 or 15 to 20 (?or more) segments; pleurae flat, truncate or with short spines; last 3 larger, with strongly falcate pleural spines. Pygidium transverse, with 2 to 4 pairs of mar-

ginal spines; width (tr.) may be one-half to two-thirds that of cephalon; surface commonly with anastomosing ridges. *Middle Cambrian*.

Centropleura ANGELIN, 1854 in 1851–1878, p. 87 [**Paradoxides Loveni* ANGELIN, 1851 in 1851–1878, p. 2; OD; ANGELIN's figured specimens (1851 in 1851–1878, pl. 3, fig. 1–3) from Andrarum, Sweden, are not identified with certainty, but a syntype and topotypes were illustrated by WESTERGÅRD, 1950a, pl. 1, fig. 1–3]. S2 and S3 straight, transverse; anterior section of facial suture retrodivergent; palpebral lobe narrow (tr.); fixigena with elongate (exsag.) baccula; posterior border curving forwards distally. Thorax (where known) with 16 segments; pleural tips truncate or with short spine. Pygidium transversely oval; axis slightly more than one-half length of pygidium, with about 4 pairs axial rings; 2 pairs of marginal spines. *upper Middle Cambrian*: Scandinavia, Greenland, Canada, USA, Australia, Siberia, China (Xinjiang: Tianshan), *L. laevigata* to *Centropleura* Zone (Gansu, Hunan-Guizhou border).

C. (*Centropleura*). Glabella with prominent frontal lobe; palpebral lobe long (extending from opposite SO or L1 to L4), curving inwards posteriorly, ending near to or well forward of posterior border; fixigena widest (tr.) opposite S1 or L2. *upper Middle Cambrian*: Sweden, Denmark, *S. brachymetopa* Zone; Greenland, *L. laevigata* Zone; Canada (Gaspé; ?western Newfoundland: Cow Head boulders); USA, Vermont (St. Alban's Shale), New York, western Nevada; Australia, *L. laevigata* Zone; Bennett Island; eastern Siberia, *P. forchhammeri* Zone; China (Xinjiang: Tianshan), *L. laevigata* to *Centropleura* Zone (Gansu, Hunan-Guizhou border).—FIG. 308, *2a, b*. **C. (C.) loveni* (ANGELIN); *a*, lectotype, small cranidium, Andrarum, Skåne, RM Ar32354, $\times 8$; *b*, pygidium, probably same locality, RM Ar1613, $\times 3$ (new).

C. (*Beishanella*) XIANG & ZHANG, 1985, p. 97 [**Centropleura? beishanensis* LIU & ZHANG, 1979, p. 5; M; figured syntypes (LIU & ZHANG, 1979, pl. 1, fig. 15–17), XTr. 908–910, repository not ascertained]. Differs from *C. (Centropleura)* in having more weakly clavate glabella with less prominent frontal lobe; fixigena very narrow (tr.), about 0.3 of glabellar width. Thorax unknown. Pygidium similar to *C. (Centropleura)*. *upper Middle Cambrian*: northwestern China (Gansu), lower part of Shuangyingshan Formation, (Tianshan), *L. laevigata*–*Centropleura* Zone.—FIG. 308, *3a, b*. **C. (B.) beishanensis* (LIU & ZHANG), Tianshan, lower part of Shuangyingshan Formation; *a*, syntype cranidium, XTr. 908, $\times 1$; *b*, syntype pygidium, XTr. 909, $\times 2.5$ (Liu & Zhang, 1979, pl. 1, fig. 15–16).

Anopolenus SALTER, 1864c, p. 236 [**A. Henrici*; M; lectotype (MORRIS, 1988, p. 20), 42644, BMNH,

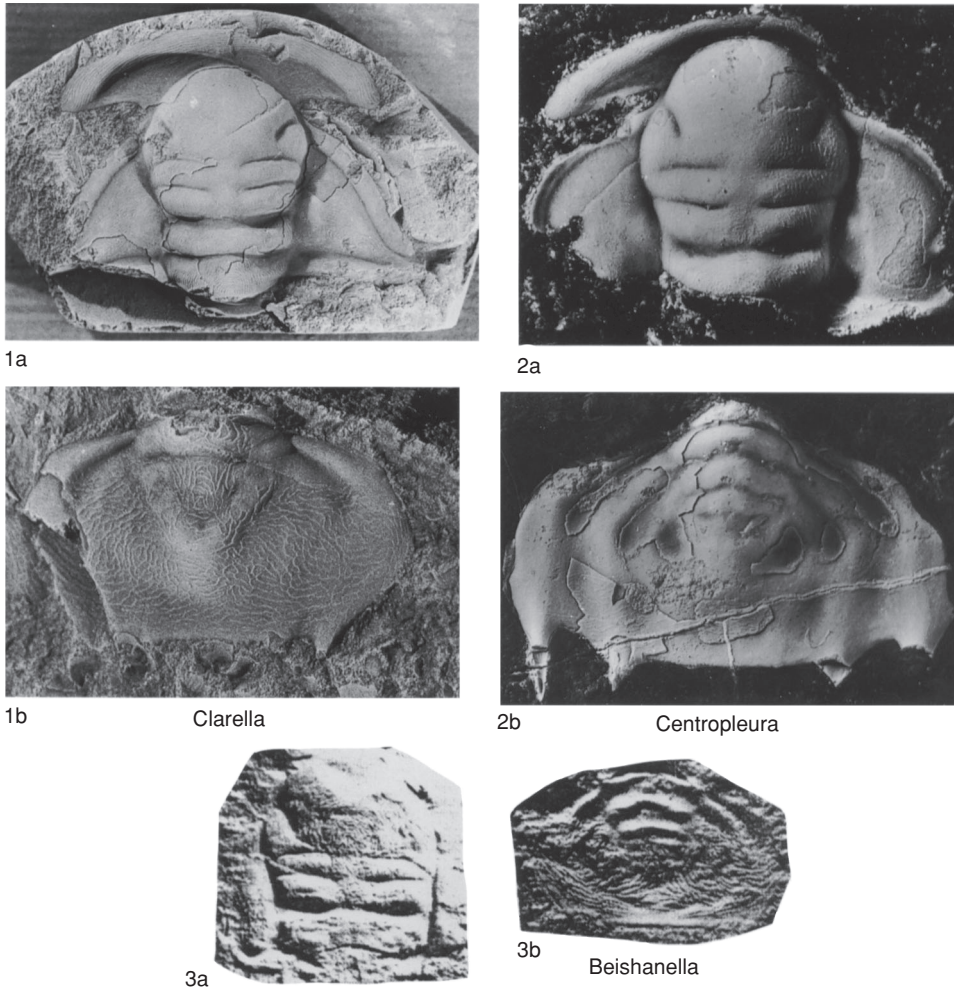


FIG. 308. Centroleuridae (p. 478–480)

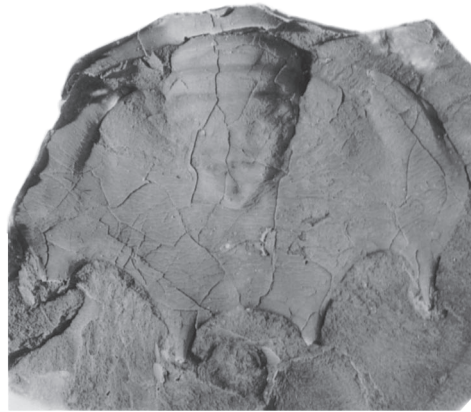
London; A.5367, SM, Cambridge, Menevian Beds, St. David's, southwestern Wales]. Glabella only slightly clavate; S2 and S3 approximately transverse but slightly curved, convex forwards; anterior section of facial suture long, transverse; baccula shorter than in *Centroleura*; palpebral lobe broader than in *Centroleura*, long and evenly curved, extending from L4 to SO and reaching to posterolateral corner of cranium; posterior margin almost straight, transverse. Thorax with 16 segments, all except last 3 having truncate pleural tips. Pygidium transversely ovate in outline, with border and 3 pairs of marginal spines; axis more than three-fourths pygidial length, with about 4 axial rings. *middle Middle Cambrian*: United Kingdom, *Pt. punctuosus* Zone; Canada (eastern Newfoundland), *P. davidis* Zone; Russia (eastern Siberia), *P. davidis* Zone.—

FIG. 309,2a-c. **A. henrici*; a,c, eastern Newfoundland (Manuels River); a, cranium, GSC 13109, $\times 1.5$; c, pygidium, GSC 13114, $\times 2$ (new); b, cranium, topotype, middle Middle Cambrian, Menevian Beds, southwestern Wales (St. David's), NMW 91.19G.3, $\times 3$ (new).

Clarella HOWELL, 1933, p. 219 [*Anapolenus* [sic] *venustus* BILLINGS, 1872, p. 474; OD; lectotype selected herein, 284a, GSC, Ottawa]. Like *Anapolenus*, but glabella showing greater expansion forward of S1 and palpebral lobe broader and slightly curved sigmoidally. Thorax with 14? or 15 segments, where known; pygidium without border but with 3 to 4 pairs of short, marginal spines; axis short, with 1 to 2 axial rings. *middle Middle Cambrian–upper Middle Cambrian*: Canada (eastern Newfoundland), *P. hicksii*–*P. davidis* Zones; United



1a

1b
Luhops2a
Anopolenus

1c



2b



2c

FIG. 309. Centroleuridae (p. 479–481)

Kingdom, *H. parvifrons*–*Pt. punctuosus* Zones; southern France, *Pt. punctuosus* Zone; Sweden, *Pt. punctuosus*–*S. brachymetopa* Zones.—FIG. 308, 1a, b. **C. venusta* (BILLINGS), *P. hicksii* Zone, eastern Newfoundland; a, cranium, lectotype, Manuels River Formation, Trinity Bay, GSC 284a, ×3; b, pygidium, St. Marys Bay, GSC 13106, ×5 (new).

Luhops ŠNAJDR, 1957, p. 239 [*Paradoxides expectans* BARRANDE, 1852, p. 918; OD; lectotype, Skryje Formation, *E. pusillus* Zone, Skryje, Czech Republic (ŠNAJDR, 1958, p. 153), ČC 313, No. 1125, NMP, Prague]. Diagnosis based on type specimens only. Thoracic pleural tips with short spines, except for posterior 3 segments; pygidium with relatively short axis having 2 to 3 axial rings and 2 pairs of

robust marginal spines. Assigned cranidium (FATKA, KORDULE, & ŠNAJDR, 1981) with S2 and S3 convex forwards, S3 oblique inwards and forwards; anterior section of facial suture relatively short; palpebral lobe broad at midlength, shorter than in *Clarella*, extending from L4 to L1, and with posterior end tapered, turned outwards, and lying well forward of posterior margin. *middle Middle Cambrian*: Czech Republic, *E. pusillus* Zone; United Kingdom, *T.*

fissus or *H. parvifrons* Zones; Denmark, *Pt. punctuosus* Zone.—FIG. 309, 1a–c. **L. expectans*, Czech Republic; a, thorax and pygidium, Skryje, Schary Collection, MCZ 3151, $\times 1.5$ (Barrande, 1872, pl. 14, fig. 35); b, pygidium, Týřovice, NMP L.14078, $\times 1$ (Šnajdr, 1977, pl. 1, fig. 3); c, cranidium, Týřovice, $\times 2.75$ (Fatka, Kordule, & Šnajdr, 1981, pl. 2, fig. 8).